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ExxonMobil Environmental Services Company

Site Delineation Work Plan

Former Virginia-Carolina Chemical Corporation
Memphis Site
152 Collins Street
Memphis, Tennessee
TDEC Ref No.: 79-557

May 2012

ARCADIS

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Tables

Figures

Appendices

LIST OF ACRONYMS AND ABBREVIATIONS

ARCADIS	ARCADIS U.S., Inc.
bgs	below ground surface
Black & Veatch	B&V Waste Science and Technology Corp.
EDR	Environmental Data Resources, Inc.
EMES	ExxonMobil Environmental Services Company
ESI	Expanded Site Inspection
°F	degrees Fahrenheit
FMD	Fertilizer Manufacturer's Directory
FSP	Field Sampling Plan
HASP	Health and Safety Plan
IDW	investigation-derived waste
J	Estimated
mg/kg	milligrams per kilogram
MLGW	Memphis Light, Gas and Water
QAPP	Quality Assurance Project Plan
RSE	Removal Site Evaluation
Sanborn® Map	Sanborn® Fire Insurance Map
SDR/RAWP	Site Delineation Report/Removal Action Work Plan
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
Tetra Tech	Tetra Tech EM Inc.
USEPA	U.S. Environmental Protection Agency
VCC	Virginia-Carolina Chemical Corporation
Work Plan	Site Delineation Work Plan
XRF	x-ray fluorescence

1. Introduction

This Site Delineation Work Plan (Work Plan) has been prepared by ARCADIS U.S., Inc. (ARCADIS), on behalf of ExxonMobil Environmental Services Company (EMES), to outline the technical approach and methods for conducting soil and groundwater sampling activities to investigate constituents of concern associated with the former Virginia-Carolina Chemical Corporation (VCC) Memphis Site located in Memphis, Shelby County, Tennessee (the Site). Figure 1 identifies the location of the Site on the United States Geological Survey 7.5-minute quadrangle map for Northeast Memphis, Tennessee.

This Work Plan has been developed based on the findings presented in the *Removal Site Evaluation Report, Former Virginia-Carolina Chemical Corporation Memphis Site, Memphis, Tennessee* prepared by ARCADIS on behalf of EMES and submitted to the U.S. Environmental Protection Agency (USEPA) Region 4 in April 2011. In addition, this Work Plan provides a summary of previous environmental investigations conducted at the Site.

1.1 Project Objectives

The primary objective of the delineation activities is to determine the magnitude and extent of arsenic and lead concentrations in soil at the Site. A second objective is to determine if arsenic and lead are present in groundwater at concentrations above USEPA screening levels, and if so, to determine their magnitude and extent. These data will be used to support the development of a work plan to guide implementation of the anticipated future activities at the Site. This Work Plan and supporting documents describe and guide the activities that will be undertaken to achieve these objectives.

1.2 Description and History of Former Phosphate Fertilizer Plants

As stated above, VCC operated a former fertilizer plant in Memphis, Tennessee. The following description and history of former phosphate fertilizer plants in the southeast was originally presented by USEPA and is included here to provide an understanding of the history and processes associated with the historical production of phosphate fertilizers.

Phosphorus is one of the major elements essential for normal plant growth. In the mid-1800s, patent fertilizers and superphosphates were unknown; rather, manure, guanos, ground-up bone, and other mineral-rich materials were used by farmers. The discovery of large deposits of phosphate rock, combined with the demand for superior fertilizers, resulted in the growth of the phosphate fertilizer industry in the southeastern United States.

Naturally occurring phosphorus in phosphate rock is largely insoluble. When properly dried, the phosphate rock can be easily ground and crushed. It was initially discovered in England that, when treated with sulfuric acid, ground phosphate rock is converted to phosphoric acid, which is more easily assimilated by plants. In most production facilities, sulfuric acid was generally manufactured on site using the lead chamber process. Sulfur was burned in a combustion chamber at 1,800 degree Fahrenheit (°F) to 2,000°F to create sulfur dioxide. In the early years of operation, pyrite ores (FeS_2) were used as the sulfur source. Elemental sulfur was later discovered in Texas and most production facilities switched to burning sulfur due to advantages in product purity and economics. Sulfur dioxide was reacted with oxygen from air to form sulfur trioxide. Water was passed over packing media in a glover tower to react with the sulfur trioxide gas. This reaction produced sulfuric acid.

Ground phosphate rock and sulfuric acid were then mixed in a reaction vessel to produce phosphoric acid, the building block for phosphate fertilizers. The resultant mixture was then held in a den area for solidification and later transferred to a storage area for curing. This process produced a bulky phosphate mass that had to be mechanically crushed and screened to product size. Agricultural fertilizers differ in the amount and chemical form of three primary plant nutrients: nitrogen, phosphorus, and potassium. Superphosphate contains only one nutrient, phosphorus. Therefore, processed phosphate rock was mixed with other components such as ammonia (for nitrogen) and potash (for potassium) to produce a three-component product. The finished product was bagged or otherwise prepared for distribution in the storage facility.

The acid chambers used in the fertilizer production process represent the most relevant feature of fertilizer operations regarding the potential for adverse environmental impacts. During periodic cleaning of the lead chambers, wash down water containing acid and soluble lead was typically flushed onto the ground surface, although the specific operations at this Site are unknown. Pyrite cinders that did not burn completely in the combustion chambers were sometimes used as on-site fill material. This slag material has a reddish (magenta) appearance and has been found to contain elevated levels of inorganic constituents, including arsenic and lead.

1.3 Work Plan Organization

The introduction provided in this section is followed in Section 2 by a Site description and a discussion of previous investigation activities performed at the Site. Section 3 presents the components of the delineation activities that will be performed, and Section 4 describes the contents of the summary report that will be prepared. Section 5 describes the project team organization, and Section 6 provides the schedule for implementing the Site characterization activities. Finally, Section 7 lists the references cited in this Work Plan.

This Work Plan has three appendices. Appendix A contains the Field Sampling Plan (FSP), Appendix B contains the Quality Assurance Project Plan (QAPP), and Appendix C contains the Health and Safety Plan (HASP). These documents will be used to guide the proposed field investigation activities required to complete the delineation activities.

2. Site Description and Background

2.1 General

The former VCC Memphis Site occupied approximately 27 acres. Virginia-Carolina Chemical Company purchased the Site from J.O. Shelton et al. in 1900. At the conclusion of Virginia-Carolina Chemical Company's bankruptcy and reorganization proceedings in 1926, VCC of Richmond, Virginia emerged as a new company and acquired the Site and associated property. VCC sold 9.34 acres of the Site (currently owned by YSI VI LLC) to the City of Memphis in 1928. VCC merged into Socony Mobil Oil Company, Inc., in 1963 and the company name changed to Mobil Oil Corporation in 1966. Mobil Oil Corporation sold the remaining 17.5 acres of the former VCC Memphis Site to Swift Agricultural Chemical Corporation in 1970. Swift, through various corporate reorganizations, became Estech, Inc. In 1986, Estech, Inc., sold the 17.5 acres of the Site to the Acee Company. In 1999, the Acee Company also purchased the southernmost parcel (9.34 acres) from the City of Memphis. This parcel is currently owned by YSI VI LLC.

In 1999, Exxon Corporation merged with Mobil Corporation to form Exxon Mobil Corporation. Mobil Oil Corporation became ExxonMobil Oil Corporation, the corporate successor to VCC. Exxon Mobil Corporation is the parent company of ExxonMobil Oil Corporation.

This section of the Work Plan is based on information previously provided to USEPA in the Removal Site Evaluation (RSE) Report (ARCADIS 2011).

2.2 Site Location

The Site is located in Memphis, Shelby County, Tennessee, near the intersection of Poplar Avenue and Collins Street. The property that contains most of the Memphis Site has a street address of 152 Collins Street. The approximate geographical location of the center of the Site is at 35.1392° North Latitude and 89.9720° West Longitude (North American Datum of 1983).

2.3 Facility Description and Operational Status

Historical information indicates that a fertilizer plant with an acid chamber was constructed at the Site prior to 1907. The Fertilizer Manufacturers' Directory (FMD) yearbook entries begin to list the former VCC Memphis plant in 1911; however, the former VCC Memphis plant is not classified until 1913, when it is listed as a code "A" plant, indicating that it was a complete plant with an acid chamber. The FMD and American Fertilizer Handbook continue to indicate that the former VCC Memphis facility operated with an acid chamber structure through 1958, when the yearbooks were discontinued. Sanborn® Fire Insurance Maps (Sanborn® Maps) from 1927 indicate that the acid chamber structure depicted on the 1907 Sanborn® Map had been replaced with a smaller acid chamber structure at the same location, which was also present on the 1952 Sanborn® Map. Minutes from the VCC Board of Directors meetings from 1947 indicate the appropriation of funds toward the purchase of sulfur-burning acid-producing equipment, indicating the possibility that sulfur was burned from 1947 forward.

Structures associated with the former VCC Memphis plant included a fertilizer mill dumping pit, two different acid chamber structures, a burner house, a mill, an engine house, a bag house, a carpenter shop, a nitre house, a deep well pump, a 170,000-gallon reservoir, a shed, an office, a stage, a storage house, and rail sidings. Figure 2 depicts the general locations of the former Site features.

2.4 Current Uses of the Former Site

The VCC Memphis Site is in an old industrial area located within downtown Memphis, northeast of the intersection of Collins Street and Poplar Avenue (Figure 3). The northern portion of the Site (17.5 acres) currently contains the Acee Business Center, while a self storage facility [CubeSmart (formerly U-Store-IT)] is located on the southernmost parcel. The physical address of this southernmost parcel is 2700 Poplar Avenue, Memphis, Tennessee, and it occupies 9.34 acres. The majority of the former Site is currently paved as a parking lot or covered by buildings that comprise the Acee Business Center.

The former Site is bordered to the north by the City of Memphis Department of Public Works; to the east by railroad tracks associated with the Illinois Central Gulf Railroad, followed by the Bell Park Industrial Plaza; to the south by Poplar Avenue (U.S. Route 72), followed by commercial and industrial development (i.e., Bank of America and Clear Channel Television Center); and to the west by Collins Street, followed by residential areas, with minor commercial development to the southwest.

Almost all of the land within 500 feet to the north, east and south of the Site can be characterized as commercial or industrial. Several residences are located approximately 100 feet from the Site, adjacent to the western side of Collins Street.

The broader area shown on Figure 2 includes a mixture of commercial, industrial, government and residential land uses. Areas north and south of the Site are primarily commercial and industrial. Areas to the distant east and distant west of the Site are primarily residential.

Figure 2 depicts the approximate boundaries of the former VCC Memphis property superimposed on a 2009 Shelby County tax map and a 2009 aerial photograph. Figure 2 also depicts the approximate locations of major structures, improvements and other features now or formerly situated within the boundaries of the former property. Historical features were digitized from the 1907, 1927, and 1952 Sanborn® Maps. Currently, the former VCC Memphis site is occupied by four tax parcels. Current property boundary information was provided by a 2009 Shelby County Tax Map.

2.5 Area Geology and Hydrogeology

Geologic maps indicate that the Site is immediately underlain by loess deposits of Quaternary (late Pleistocene) age. These deposits consist of brown and light brown silt, with less than 10 percent sand and less than 10 percent clay. Regionally, the loess deposits predominantly are composed of quartz, with minor amounts of plagioclase, orthoclase, and dolomite (Cox 2004). These deposits typically have a maximum thickness of about 70 feet.

The loess deposits generally retard downward movement of the water that provides recharge to older, underlying aquifers, such as fluvial (terrace) deposits of Quaternary and Tertiary age. The fluvial deposits consist of sand, gravel, minor clay, and ferruginous sandstone from 0 to 100 feet thick. These deposits provide water to farm and domestic wells in rural areas (Parks and Carmichael 1990).

Units of the Claiborne Group of Tertiary age underlie the fluvial deposits. The primary water-bearing unit within the Claiborne Group is the Memphis Sand (sometimes referred to as the “500-foot sand”). The Memphis Sand unit generally varies from 400 to 890 feet of sand, silt, clay, and minor lignite. The unit includes a thick body of fine to very coarse sand with clay lenses at various horizons. The Memphis Sand is the principal aquifer supplying water to the City of Memphis and is the major aquifer providing water for most public and industrial supplies in the western part of western Tennessee (Parks and Carmichael 1990).

Based on the limited data collected from shallow soil borings advanced at the Site, the subsurface generally consists of dark gray to brown silt and clay with varying amounts of sand and pebbles. Small angular/rounded pebbles and wood fragments were encountered at depths varying from 0 to 8 feet below ground surface (bgs) at various locations across the Site. Magenta-colored slag was observed in soil recovered from three boring locations.

Shallow (possibly perched) groundwater was encountered in two soil borings advanced during field activities at the Site at depths varying from approximately 4 to 8 feet bgs. Groundwater was not encountered in any of the remaining soil borings, which were advanced to a maximum depth of 6 feet bgs.

2.6 Surface Water Bodies

The Site is located on a relatively flat plain that slopes gently to the northeast. The majority of the Site is drained by stormwater inlets in the paved areas. There is also a concrete-lined channel in the southeastern portion of the Acee Business Center that drains surface run-off to the east towards a box culvert running under the Illinois Central Railroad tracks. The ditch and the storm drain flow into a small drainage ditch located just east and parallel of the railroad tracks that run along the eastern side of the Site. This drainage ditch flows approximately 1 mile into Cypress Creek. Cypress Creek flows north approximately 3 miles into the Wolf River, which flows 2 miles west into the Mississippi River. The 15-mile surface water pathway ends in the Mississippi River (Black & Veatch 1993). The Site is located outside the 500-year floodplain.

2.7 Description of Drinking Water Sources

Drinking water in the City of Memphis is supplied by the Memphis Light, Gas and Water (MLGW) Division. The Memphis Sand aquifer serves as the sole source of drinking water for the MLGW System. The Memphis Sand aquifer is the major aquifer providing water for most public and industrial supplies in the western part of western Tennessee (Parks and Carmichael 1990).

The Environmental Data Resources, Inc. (EDR; 2010), Geocheck® Report listed two public water supply wells in the vicinity of the Site, which were located approximately 1,500 feet south of the former VCC Site. These wells are owned by MLGW. In addition, an industrial well, owned by Virginia Chemical SH: P-33, was reported to be located approximately 900 feet south of the former VCC Memphis Site. Finally, two monitoring wells were observed at the Site during RSE activities.

2.8 Summary of Previous Investigation

In 1989, MCI Telecommunications Corporation evaluated purchasing the northern 17.5 acres of the Site (currently owned by Acee Business Center) and performed a "review of past land uses" (Davis 1989). In May 1992, B&V Waste Science and Technology Corp. (Black & Veatch), on behalf of USEPA, conducted an inspection of this portion of the Site (also known as former General Estech General Chemicals facility, EPA ID No.: TND050242361) (Black & Veatch 1993). Twelve samples were collected for the site investigation, including 9 surface soil, 1 surface water, and 2 subsurface soil.

Black & Veatch, on behalf of USEPA, conducted an Expanded Site Investigation (ESI) in August 1992 (Black & Veatch 1994). During this investigation, one temporary well was installed on the northern portion of the Site. One groundwater sample, 3 surface soil samples, and 3 subsurface soil samples were collected during this investigation.

In February 2000, Tetra Tech EM Inc. (Tetra Tech) Superfund Technical Assessment and Response Team and the Tennessee Department of Environment and Conservation (TDEC) were tasked by USEPA to conduct an ESI Addendum at the Site (Davis 2000; Tetra Tech 2000). During this investigation, eight monitor wells were installed on the Site and eight surface soil, 32 subsurface soil, and 8 groundwater samples were collected. In April 2001, USEPA determined that the Site is not eligible for further remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (USEPA 2001).

In November 2010, ARCADIS, on behalf of EMES, collected soil samples from the Site as described in the *Removal Site Evaluation Work Plan, Former Virginia-Carolina Chemical Corporation Site, Memphis, Tennessee* (ARCADIS 2009). A total of 79 soil samples were collected from 24 soil borings advanced at the Site (Figure 3). In general, samples were collected from 0-0.5 foot bgs, 0.5-2 feet bgs, and 2-4 feet bgs unless groundwater or auger refusal was encountered prior to reaching 4 feet bgs. In cases where field screening dictated, soil samples were also collected at some locations at depths greater than 4 feet bgs. Soil samples were screened in the field for arsenic and lead using a portable x-ray fluorescence (XRF) instrument. The soil samples were then submitted to, and analyzed by, TestAmerica Laboratories, Inc., of Nashville, Tennessee, for arsenic and lead.

Laboratory analytical results for soil samples were compared to USEPA Region 4 industrial screening levels of 27 milligrams per kilogram (mg/kg) and 800 mg/kg for arsenic and lead, respectively. The screening level for arsenic of 27 mg/kg is a USEPA-determined value which is used as a remediation endpoint at similar former VCC fertilizer sites in USEPA Region 4. The screening level for lead of 800 mg/kg is based on the USEPA Regional Screening Level for lead with industrial site use.

Arsenic and lead concentrations greater than screening levels were most frequently detected in samples collected from the northern and central portions of the Site, almost exclusively on the Acee Business Center property (Figure 3). The maximum arsenic and lead concentrations detected in soil were 1,460J (estimated) mg/kg and 18,400 mg/kg, respectively, collected from soil boring MEM-SB-10 at a depth of 2 to 4 feet bgs. The depth of impacted soil varied from 0 to 8 feet bgs. Due to hand auger refusal at some locations and the limited scope of the RSE sampling activities, vertical delineation was not achieved at eight soil borings (MEM-4, -6, -10, -11, -12, -13, -16, and -18). The pH of the soil samples varied between 4.10 and 10.00 standard units. Magenta slag was observed in soil recovered from boring locations MEM-SB-9, MEM-SB-10, and MEM-SB-12 at depths varying from approximately 0 to 6 foot bgs interval (ARCADIS 2011, Appendix A). A summary of the RSE sample analytical program is provided in Table 1. A complete summary of the sample analytical results is presented in Table 2 and shown on Figure 3.

3. Site Delineation Rationale and Activities

3.1 Data Requirements

As described in Section 2.8, data generated during the RSE activities indicated the presence of elevated concentrations of arsenic and lead in specific areas of the Site. The Site delineation activities described in this section will focus on the collection of soil samples in and around these areas to identify and delineate the extent of arsenic and/or lead in Site soils. Soil samples will be collected from both the surface and at depth to horizontally and vertically delineation the concentrations of arsenic and lead above screening values at the Site.

Groundwater monitoring wells will be installed and sampled to investigate the presence of arsenic and/or lead in groundwater. Existing wells onsite installed by others will be sampled where possible. Where existing wells are not available, one of the following three alternatives will be used for the installation of new groundwater monitoring wells at the Site:

Alternative 1: Install Geoprobe® pre-packed well screens to collect screening-level groundwater data, followed by conversion to permanent monitoring wells to collect shallow groundwater samples (for selected locations, if required after initial data screening).

Alternative 2: Install Geoprobe® pre-packed well screens to collect screening-level groundwater data, followed by installation of traditional permanent monitoring wells to collect shallow groundwater samples, if required after initial data screening.

Alternative 3: Install Hydropunch™ or similar temporary direct-push technology well points to collect screening-level groundwater data, followed by installation of traditional permanent monitoring wells to collect shallow groundwater samples, if required after initial data screening.

The use of Alternative 1 is recommended for this Site based on the anticipated depth to groundwater (15 to 25 feet below ground surface). However, if the geologic conditions (e.g., site soils contain high percentage of gravels and cobbles or are highly compacted or the groundwater exists at depth greater than 60 feet) are not favorable for Alternative 1, Alternative 2 or 3 may be adopted for collecting groundwater samples.

This section describes the sampling activities that will be performed to delineate the extent of these constituents in Site media.

3.2 Site Access

Prior to conducting RSE sampling activities, EMES had secured access agreements with the following two property owners affected by the proposed RSE activities:

- Acee Business Center (Mr. A. Curtis Goldtrap, Jr.); and
- CubeSmart (formerly U-Store-It, YSI VI, LLC).

However, the access agreement with one of the Site owners (YSI VI, LLC) has expired, and access to additional properties owned by other parties (shown below) is required for access to some of the proposed locations. Prior to beginning the Site delineation activities, EMES will work with the following property owners to get the access agreements revised or to secure new access agreements:

- CubeSmart (YSI VI, LLC);
- Illinois Central Gulf Railroad; and
- City of Memphis.

3.3 Utility Clearance

Necessary permits and utility clearances will be obtained prior to any subsurface activities. A utility markout will be performed at the Site to identify all subsurface utilities (e.g., gas, electrical, telephone, water, sewers, and cable). No drilling will be performed within 10 feet of a utility markout. To further confirm the absence of utilities in the drilling area, a private utility locating company will also be used to clear all areas where subsurface work will be performed. Detailed utility clearance procedures are contained in the HASP (Appendix C).

3.4 Soil Sampling Program

3.4.1 Soil Sampling Analyses and Rationale

Soil borings will be installed across the Site to delineate the horizontal and vertical extent of arsenic- and/or lead-impacted soil, focusing on those areas identified during the RSE sampling event. All soil sample results will be compared to the Site-specific screening levels. As discussed in Section 2.8, the Site-specific USEPA screening levels are 27 mg/kg for arsenic and 800 mg/kg for lead.

Soil borings are proposed at thirty four locations (which include 4 contingency boring locations) across the Site (Figure 4). The thirty four proposed soil boring locations will include the following:

- Installation of four soil borings on the western side of the Illinois Central Gulf Railroad right-of-way in order to delineate off-site arsenic and/or lead impacts on the eastern side of the Site boundary;

- Installation of a soil boring north of SB-1 to delineate potential off-site lead and/or arsenic impacts on the northern side of the Site boundary;

- Installation of three soil borings to more finely delineate lead and/or arsenic impacts along the western boundary of the Acee Business Center;

- Installation of a soil boring, southwest of SB-2, to delineate lead and/or arsenic impacts (if any) in the small grassy area along the northeastern corner of one of the buildings on the Acee Business Center parcel;

- Installation of a soil boring, southwest of SB-16, to delineate lead and/or arsenic impacts (if any) in the small grassy area on the south side of the building located in the southwest corner of the Acee Business Center parcel;

- Installation of a soil boring in the grassy area between two parking areas on the south side of Acee Business Center parcel to delineate lead and/or arsenic impacts (if any) in the small grassy area on the south side of the building located on the southeast portion of the Acee Business Center parcel;

- Installation of a soil boring between SB-9 and SB-10 to delineate lead and/or arsenic impacts (if any) in the small grassy area along the northwestern corner of one of the buildings on the Acee Business Center parcel;

- Installation of a soil boring, southeast of SB-13, to delineate lead and/or arsenic impacts (if any) in the grassy area on the south side of one of the buildings on the Acee Business Center parcel;

- Installation of a soil boring between SB-3 and SB-6 to more finely delineate lead and/or arsenic impacts north of boring SB-6;

- Installation of three soil borings to better delineate lead and/or arsenic impacts along the southern boundary of the Acee Business Center and along the northern boundary of the CubeSmart property;

- Installation of five soil borings at the locations of proposed monitoring wells;

- Installation of four contingency borings adjacent to the aforementioned borings. Contingency borings will be sampled if adjacent borings are impacted based on the results of field screening (described below); and

- Collection of additional samples from eight sample locations installed during the RSE (MEM-SB-4, -6, -10, -11, -12, -13, -16, and -18) to delineate the vertical extent of lead and/or arsenic impacts. Sample intervals will be added below the last interval previously sampled using the approach outlined below.

Based on a review of the available historical aerials and Sanborn® Maps, it appears that Collins Street (formerly known as Collins Avenue) and Illinois Central Gulf Railroad pre-dated the VCC site development and had served as the western and eastern boundaries for the Site ever since the former fertilizer plant was in operation. Hence, the Collins Street and Illinois Central Gulf Railroad tracks are considered to be physical boundaries to the west and to the east, respectively, for the lead and/or arsenic impacts that are found at the Site as a result of the former plant operations. Therefore, no further investigation activities are planned west of Collins Street or east of the railroad tracks.

At each soil boring location, soil samples will be collected using hand augers and/or direct-push techniques. Samples will be collected at each soil boring from 0-0.5 foot, 0.5-2 feet, 2-4 feet, and in 2-foot intervals until XRF results for arsenic and lead are less than the screening levels and no magenta slag is observed. Borings will be advanced to a maximum depth of 8 feet bgs or until groundwater or refusal is encountered, whichever is shallower. If screening results for samples collected from 6-8 feet bgs indicate elevated arsenic and/or lead concentrations, or if visual evidence of magenta slag is present, deeper samples will be collected at 2-foot intervals until groundwater or refusal is encountered. Samples deeper than 4 feet bgs may be collected using direct-push techniques. Sample collection procedures are described in the FSP provided in Appendix A.

The presence of slag and the coloration of soil samples collected will be documented in the field notes for future reference. These observations will be included in the investigation summary report that will be prepared following implementation of the Work Plan along with a map showing the extent of stained/colored soils. Additional soil sampling activities may also be performed during this investigation at the discretion of EMES or at the request of USEPA and TDEC to further refine the limits of areas that contain elevated concentrations of arsenic and/or lead.

3.4.2 Soil Sample Analyses

3.4.2.1 XRF Screening

Soil samples collected will be screened in the field for arsenic and lead concentrations using a portable XRF device; samples will be retained and sent to a fixed-based laboratory for analyses as described below.

3.4.2.2 Laboratory Analyses

Soil samples collected from 0 to 4 feet bgs will be analyzed at the off-site commercial laboratory for arsenic and lead. Samples will be analyzed from successively deeper intervals until the concentrations of arsenic and lead are confirmed to be below the screening levels. Samples from deeper intervals will be analyzed as described below.

Soil Sample Depth Interval (feet bgs)	XRF Screening	Laboratory Analysis
0-0.5	Yes	Yes, always.
0.5-2	Yes	Yes, always.
2-4	Yes	Yes, always.
4-6	Yes[1]	Yes, if XRF results are above XRF screening levels of 20 mg/kg for arsenic or 600 mg/kg for lead in the 2-4 foot depth interval.
6-8	Yes[1]	Yes, if XRF results are above XRF screening levels of 20 mg/kg for arsenic or 600 mg/kg for lead in the 4-6 foot depth interval.
>8	Yes[1]	Yes, if XRF results are above the XRF screening levels of 20 mg/kg for arsenic or 600 mg/kg for lead in the 6-8 foot depth interval. Deeper samples will be collected at 2-foot intervals until groundwater or refusal is encountered.

bgs Below ground surface.
XRF X-ray fluorescence.
mg/kg Milligram per kilogram.
[1]XRF screening levels are based on 75% of the USEPA screening levels for arsenic and lead.

Select samples will be analyzed for Toxicity Characteristic Leaching Procedure (TCLP) metals to determine the appropriate disposal requirements for evaluating potential soil removal alternatives. TCLP analyses will be performed using a composite of the soil samples collected. The specific samples selected for TCLP analyses will be determined following receipt of preliminary laboratory analytical data. Soil borings selected for TCLP analyses will be biased toward those locations where elevated concentrations of arsenic and lead are detected or where significant amounts of magenta-stained soils are observed. The composite soil samples will be analyzed for total arsenic and lead and TCLP arsenic and lead.

The soil sampling analytical program is described in Table 3.

3.5 Groundwater Sampling Program

3.5.1 Groundwater Screening Data (Temporary Wells)

Up to five temporary wells will be installed across the Site to collect screening-level data for arsenic and lead in groundwater (Figure 4). Groundwater samples collected using Geoprobe® pre-packed well screens, Hydropunch™, or similar temporary direct-push technology are considered screening-level data, suitable for obtaining a general understanding of groundwater quality.

3.5.1.1 Temporary Well Installation using Pre-packed Well Screens

Groundwater samples from the first water-bearing zone will be collected by installing pre-packed well screens through the outer casing of the dual-tube Geoprobe® device. Groundwater samples collected from each temporary well will be field filtered and submitted to the laboratory for rapid turnaround time analysis for total and dissolved arsenic and lead. In addition, depth-to-water measurements and ground-surface elevations at each temporary well point will be determined to assess the direction and gradient of groundwater flow. All groundwater samples from the temporary wells will be collected in accordance with the procedures specified in the FSP provided in Appendix A.

3.5.1.2 Hydropunch™ Groundwater Screening

In case the installation of pre-packed well screens is not feasible due to Site geology, discrete-depth groundwater samples will be collected by driving the Hydropunch™ sampler through an open-ended drill casing or hollow-stem auger. Groundwater samples collected from each Hydropunch™ point will be field filtered and submitted to the laboratory for rapid turnaround time analysis for total and dissolved arsenic and lead. In addition, depth-to-water measurements and ground-surface elevations at each Hydropunch™ well point will be determined to assess the direction and gradient of groundwater flow. All Hydropunch™ samples will be collected in accordance with the procedures specified in the FSP provided in Appendix A.

3.5.2 Groundwater Monitoring Well Sampling Analyses and Rationale

Based on the results of screening data, select temporary monitoring wells may be converted to permanent shallow groundwater monitoring wells to assess the potential impacts to the shallow aquifer resulting from rainwater infiltrating through soils containing elevated concentrations of arsenic and/or lead. Permanent monitoring wells may be installed at or near temporary locations showing where samples are collected containing arsenic and/or lead above USEPA maximum contaminant level. Groundwater monitoring well locations will be determined based on preliminary screening data. In the event that no elevated concentrations of arsenic or lead are detected in the shallow groundwater collected from temporary wells, no permanent wells will be installed at the Site.

The existing groundwater monitoring wells (shown on Figure 4) that were discovered during the RSE sampling event, will also be evaluated in terms of their integrity. In the event that the existing wells are found to be intact, an effort will be made to collect groundwater samples from those wells as well. If the wells are not intact, then additional temporary wells may be installed in the general vicinity of these locations.

As described in more detail below, groundwater samples will be collected from each of the permanent groundwater monitoring wells to assess groundwater quality at the Site. Groundwater elevations will also be gauged to determine the direction and gradient of groundwater flow. A Site-specific potentiometric surface map will be generated and included in the summary report that will be prepared following the completion of Site delineation activities.

3.5.3 Permanent Monitoring Well Installation

Permanent groundwater monitoring wells will be installed to facilitate the collection of shallow groundwater samples and the measurement of groundwater elevations. The preferred alternative is to convert the Geoprobe® temporary well pre-packed screens into permanent wells as described above. The wells will be screened so that the top of the well screen is just above the water table. Permanent groundwater monitoring wells will be installed to a maximum depth of 30 feet bgs or until groundwater is encountered, whichever is shallower. In the event groundwater is not encountered within 30 feet bgs, one deeper boring will be advanced until groundwater or refusal is encountered, whichever is shallower. The deeper boring will be used to provide a better understanding of the geology of the Site. All monitoring wells will be installed and developed in accordance with the procedures specified in the FSP provided in Appendix A. Procedures for both the conversion of Geoprobe® temporary wells to permanent wells and installation of traditional wells are provided in the FSP.

3.5.4 Groundwater Sample Collection and Analysis

A groundwater sample will be collected from each of the groundwater monitoring wells following installation and well development. Samples from the monitoring wells will be collected using low-flow/low-stress sampling techniques in accordance with the procedures specified in the FSP (Appendix A). All groundwater samples will be analyzed for the following analytical parameters using the analytical procedures specified in the QAPP (Appendix B):

- Arsenic and lead (total and dissolved); and
- pH, temperature, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity (field measurements).

The groundwater sample analytical program is summarized in Table 4.

3.5.5 Specific Capacity Testing

Specific capacity testing may be performed at all installed groundwater monitoring wells to provide data for calculating the hydraulic conductivity of the surficial aquifer beneath the Site. The specific capacity tests will be performed in accordance with the procedures specified in the FSP (Appendix A).

3.6 Groundwater Elevation Measurement

One round of groundwater elevation measurements will be recorded from the monitoring wells (temporary/permanent). The data will be used to develop a shallow groundwater potentiometric surface map for the Site. Depth-to-water measurements will be performed in accordance with the procedures specified in the FSP (Appendix A).

3.7 Surveying

All soil borings and monitoring well locations will be surveyed for horizontal and vertical control. Additional features such as roadways, building corners, property lines, and relevant historical Site features (e.g., railroad lines) will be surveyed. All survey data will be referenced to the North American Datum of 1983 and the North American Vertical Datum of 1988 and will be used to create an accurate map of the Site.

3.8 Investigation-Derived Waste Sampling and Disposal

Waste generated as part of the delineation activities (i.e., soil, water, decontamination fluids, and personal protective equipment) will be collected in drums and stored at the Site before removal. Laboratory analysis will be performed on a quick turnaround schedule to minimize the amount of time that the drums are at the Site. Drums containing solids will be analyzed for TCLP metals, while drums containing aqueous solutions will be analyzed for target analyte list metals and pH. The investigation-derived waste sample analytical program is summarized in Tables 3 and 4.

3.9 Analytical Data Validation

All laboratory analytical data generated from the sample analyses will be validated in accordance with the procedures listed in the QAPP (Appendix B).

4. Reporting

A Site Delineation Report/Removal Action Work Plan (SDR/RAWP) will be prepared that summarizes available data from the Site. It will present and evaluate the results of all data collection activities performed during implementation of this Work Plan as well as outline the technical approach and methods for conducting future activities at the Site. Specifically, the SDR/RAWP will include the components described below:

- **Data Collection Activities:** This section will describe the activities associated with the data collection activities described in this Work Plan.
- **Summary of Results:** This section will summarize all data collected during implementation of this Work Plan.
- **Removal Action Work Plan:** The data generated by previous investigations and during implementation of this Work Plan will be evaluated to provide a technical approach and describe the methods for conducting future actions at the Site.

The SDR/RAWP will be prepared and submitted in accordance with the schedule presented in Section 6.

5. Project Organization

5.1 Introduction

Several organizations will be directly involved in the performance and review of this project. These organizations have specific project functions and relate to each other in various ways according to their project responsibilities. The purpose of this section is to provide a description of the overall project organization. This section also describes the function and responsibility of various groups to aid in the exchange of information and to provide efficient project implementation. Table 5 provides contact information for key individuals working on the project.

5.2 U.S. Environmental Protection Agency

The USEPA Region 4 and EMES have agreed that EMES will perform Site delineation activities at the VCC Memphis Site in Memphis, Tennessee. The USEPA will review, comment upon, and ultimately approve all plans and reports submitted for the Site characterization. The USEPA contact for this Site is Ms. Alyssa Hughes.

5.3 Tennessee Department of Environment and Conservation

The TDEC will review and comment upon all plans and reports submitted for the Site characterization. The TDEC contact for the Site is currently Mr. Jordan English, P.G.

5.4 Responsible Party

EMES is the Responsible Party for the activities at the former VCC Memphis Site. Ms. Lauren Gordon is EMES' corporate representative overseeing the project.

5.5 Evaluation Contractor

ARCADIS has been selected by EMES as the Evaluation Contractor. All work will be performed under the supervision of the ARCADIS Project Manager, Mr. Matthew Pelton.

6. Schedule

It is expected that the activities outlined herein will be completed in accordance with the following schedule:

- Obtain USEPA and TDEC Approval of this Work Plan — 30 days
- Obtain/Extend Access Agreements — 30 days
- Procure Contractors and Equipment and Mobilize — 30 days
- Complete Site Delineation and Sampling Activities — 30 days
- Conduct Laboratory Analysis of Samples — 30 days
- Perform Data Validation — 30 days
- Prepare/Submit the SDR/RAWP — 60 days

In the event additional time is required due to unforeseen issues, the schedule will be adjusted accordingly.

7. References

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Davis, Delores. 1989. MCI Telecommunications Corporation. Memorandum to Thelma Pimentel, MCI Telecommunications Corporation. July 11.

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USEPA. 2001. Remedial Site Assessment Decision – EPA Region IV. EPA ID TND050242361. April 10.

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Tables

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Table 1
Summary of RSE Sampling and Analytical Program
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Sample Identification	Depth (ft bgs)	Sample Date	Arsenic and Lead Field Screening[a]	Laboratory Analyte: Arsenic and Lead	pH	TCLP Metals	TAL Metals	Flashpoint	Comments
Soil									
MEM_SB-1_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-1_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-1_2-4	2-4	11/10/10	X	X	X				
MEM_SB-1_4-6	4-6	11/11/10	X	X	X				
MEM_SB-2_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-2_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-2_2-4	2-4	11/10/10	X	X	X				
MEM_SB-3_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-3_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-3_2-4	2-4	11/10/10	X	X	X				
MEM_SB-4_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-4_0.5-2	0.5-2	11/10/10	X	X	X				MS/MSD
MEM_QAQC_DUP_04	0.5-2	11/10/10	X	X	X				Field duplicate of MEM_SB-4_0.5-2
MEM_SB-4_2-4	2-4	11/10/10	X	X	X				
MEM_SB-5_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-5_0.5-2	0.5-2	11/10/10	X	X	X				MS/MSD
MEM_SB-5_2-4	2-4	11/10/10	X	X	X				
MEM_SB-6_0-0.5	0-0.5	11/11/10	X	X	X				
MEM_SB-6_0.5-2	0.5-2	11/11/10	X	X	X				
MEM_SB-6_2-4	2-4	11/11/10	X	X	X				
MEM_SB-6_4-5.75	4-5.75	11/11/10	X	X	X				
MEM_SB-7_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-7_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_QAQC_Dup_02	0.5-2	11/10/10	X	X	X				Field duplicate of MEM_SB-7_0.5-2
MEM_SB-7_2-4	2-4	11/10/10	X	X	X				
MEM_SB-8_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-8_0.5-2	0.5-2	11/10/10	X	X	X				MS/MSD
MEM_SB-8_2-4	2-4	11/10/10	X	X	X				
MEM_SB-9_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-9_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_QAQC_DUP_03	0.5-2	11/10/10	X	X	X				Field duplicate of MEM_SB-9_0.5-2
MEM_SB-9_2-4	2-4	11/10/10	X	X	X				
MEM_SB-9_4-6	4-6	11/11/10	X	X	X				
MEM_SB-10_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-10_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-10_2-4	2-4	11/10/10	X	X	X				
MEM_SB-10_4-6	4-6	11/10/10	X	X	X				
MEM_SB-10_6-8	6-8	11/11/10	X	X	X				
MEM_SB-11_0-0.5	0-0.5	11/11/10	X	X	X				
MEM_SB-11_0.5-2	0.5-2	11/11/10	X	X	X				

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Table 1
Summary of RSE Sampling and Analytical Program
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

				Laboratory Analyte					
Sample Identification	Depth (ft bgs)	Sample Date	Arsenic and Lead Field Screening[a]	Arsenic and Lead	pH	TCLP Metals	TAL Metals	Flashpoint	Comments
MEM_SB-11_2-4	2-4	11/11/10	X	X	X				
MEM_SB-11_4-6	4-6	11/11/10	X	X	X				
MEM_SB-12_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-12_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-12_2-3	2-3	11/10/10	X	X	X				
MEM_SB-13_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-13_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-13_2-4	2-4	11/10/10	X	X	X				
MEM_SB-14_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-14_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-15_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-15_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-15_2-4	2-4	11/10/10	X	X	X				
MEM_SB-15_4-6	4-6	11/11/10	X	X	X				
MEM_SB-16_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-16_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-16_2-4	2-4	11/10/10	X	X	X				
MEM_SB-17_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-17_0.5-2	0.5-2	11/10/10	X	X	X				
MEM_SB-17_2-4	2-4	11/10/10	X	X	X				
MEM_SB-18_0-0.5	0-0.5	11/09/10	X	X	X				
MEM_SB-18_0.5-2	0.5-2	11/09/10	X	X	X				
MEM_SB-18_2-4	2-4	11/09/10	X	X	X				
MEM_SB-18_4-6	4-6	11/09/10	X	X	X				MS/MSD
MEM_SB-19_0-0.5	0-0.5	11/09/10	X	X	X				
MEM_SB-19_0.5-2	0.5-2	11/09/10	X	X	X				
MEM_SB-19_2-4	2-4	11/09/10	X	X	X				
MEM_SB-20_0-0.5	0-0.5	11/11/10	X	X	X				MS/MSD
MEM_SB-20_0.5-2	0.5-2	11/11/10	X	X	X				
MEM_SB-20_2-4	2-4	11/11/10	X	X	X				
MEM_SB-21_0-0.5	0-0.5	11/11/10	X	X	X				
MEM_SB-21_0.5-2	0.5-2	11/11/10	X	X	X				
MEM_SB-21_2-3.5	2-3.5	11/11/10	X	X	X				
MEM_SB-22_0-0.5	0-0.5	11/10/10	X	X	X				
MEM_SB-22_0.5-2	0.5-2	11/11/10	X	X	X				
MEM_QAQC_Dup_05	0.5-2	11/11/10	X	X	X				Field duplicate of MEM_SB-22_0.5-2
MEM_SB-22_2-4	2-4	11/11/10	X	X	X				
MEM_SB-23_0-0.5	0-0.5	11/11/10	X	X	X				
MEM_SB-23_0.5-2	0.5-2	11/11/10	X	X	X				
MEM_SB-23_2-4	2-4	11/11/10	X	X	X				
MEM_SB-24_0-0.5	0-0.5	11/09/10	X	X	X				

Table 1
Summary of RSE Sampling and Analytical Program
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Sample Identification	Depth (ft bgs)	Sample Date	Arsenic and Lead Field Screening[a]	Laboratory Analyte: Arsenic and Lead	pH	TCLP Metals	TAL Metals	Flashpoint	Comments
MEM_SB-24_0.5-2	0.5-2	11/09/10	X	X	X				
MEM_SB-24_2-4	2-4	11/09/10	X	X	X				
MEM_QAQC_Dup-01	2-4	11/09/10	X	X	X				Field duplicate of MEM_SB-24_2-4
Field Quality Control									
MEM_QAQC_EB-01	NA	11/09/10		X	X				Field Equipment Blank
MEM_QAQC_EB-02	NA	11/10/10		X	X				Field Equipment Blank
MEM_QAQC_EB_03	NA	11/11/10		X	X				Field Equipment Blank
Investigation-Derived Waste									
MEM_IDW-SO_01	NA	11/11/10			X	X			Investigative Derived Waste - Soil
MEM_IDW-AQ_01	NA	11/11/10			X		X	X	Investigative Derived Waste - Water

Notes:

[a] Field screening data obtained using a portable Niton XLT 898 unit.

1. Sample depths are measured in feet below ground surface (ft bgs).
2. Laboratory analyses were performed by TestAmerica, Inc., of Nashville, Tennessee.

NA - not applicable
MS/MSD - Matrix spike/matrix spike duplicate
TCLP - Toxicity characteristic leaching procedure
TAL - Target analyte list

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Table 2
Summary of RSE Soil Sample Analytical Results
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Sample ID	Depth (ft bgs)	pH	As (mg/kg)	Pb (mg/kg)
MEM-SB-1	0 - 0.5	7.20	19.4 J	127
	0.5 - 2	7.70	14.3 J	90.1
	2 - 4	7.70	38.8 J	860
	4 - 6	6.90	9.27	26.1
MEM-SB-2	0 - 0.5	9.70	13.1 J	114
	0.5 - 2	8.20	9.76 J	25.6
	2 - 4	5.80	9.71 J	8.98
MEM-SB-3	0 - 0.5	7.70	18.1	101 J
	0.5 - 2	7.40	22.4	271 J
	2 - 4	7.20	17.1	51.0 J
MEM-SB-4	0 - 0.5	7.20	16.5 J	96.2
	0.5 - 2	7.50 [7.70]	13.2 [12.0]	41.2 J [37.3 J]
	2 - 4	7.20	30.2	33.1 J
MEM-SB-5	0 - 0.5	7.40	117 J	121
	0.5 - 2	6.90	14.1 J	94.3
	2 - 4	5.80	8.58 J	10.6
MEM-SB-6	0 - 0.5	7.80	8.13 J	34.3 J
	0.5- 2	7.90	11.4 J	150 J
	2 - 4	7.40	39.5 J	970 J
	4 - 5.75	6.70	29.4	698
MEM-SB-7	0 - 0.5	8.10	13.6 J	62.6
	0.5 - 2	7.10 [7.40]	16.4 J [17.2 J]	148 [186]
	2 - 4	7.00	11.1 J	50.3
MEM-SB-8	0 - 0.5	7.30	36.1 J	444
	0.5 - 2	6.70	21.4 J	235
	2 - 4	5.20	10.6 J	11.2
MEM-SB-9	0 - 0.5	5.00	95.9 J	712
	0.5- 2	4.70 [4.50]	47.4 J [75.7 J]	290 [489]
	2 - 4	4.30	92.8 J	574
	4 - 6	4.10	6.82	19.1
MEM-SB-10	0 - 0.5	7.00	22.5 J	154
	0.5 - 2	4.90	89.1 J	3,180
	2 - 4	5.00	1,460 J	18,400
	4 - 6	8.30	1,170 J	3,840
	6 - 8	6.40	59.5	45.6
MEM-SB-11	0 - 0.5	7.50	37.1 J	659 J
	0.5 - 2	7.10	50.9 J	948 J
	2 - 4	6.70	103 J	1,540 J
	4 - 6	6.40	31.4	812
MEM-SB-12	0 - 0.5	9.80	163 J	1,000
	0.5 - 2	8.50	154 J	929
	2 - 3	6.50	379 J	323
MEM-SB-13	0 - 0.5	10.00	36.0 J	662
	0.5 - 2	8.30	16.3 J	145
	2 - 4	7.60	61.5 J	1,680
MEM-SB-14	0 - 0.5	7.10	99.8	1,020
	0.5 - 2	7.10	18.9	553
MEM-SB-15	0 - 0.5	5.90	43.7	1,510 J
	0.5 - 2	6.80	65.6	1,390 J
	2 - 4	7.30	84.5	978 J
	4 - 6	4.90	15.3	28.0
MEM-SB-16	0 - 0.5	8.50	51.3	227
	0.5 - 2	6.00	113	19.5
	2 -4	5.30	153	47.8

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Table 2
Summary of RSE Soil Sample Analytical Results
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Sample ID	Depth (ft bgs)	pH	As (mg/kg)	Pb (mg/kg)
MEM-SB-17	0 - 0.5	6.80	53.9 J	603
	0.5 - 2	7.10	79.3 J	614
	2 - 4	6.90	22.2 J	140
MEM-SB-18	0 - 0.5	7.60	37.5	276
	0.5 - 2	7.50	7.95	32.6
	2- 4	6.90	41.8	383
	4 - 6	6.00	60.1	617
MEM-SB-19	0 - 0.5	6.90	43.8	621
	0.5 - 2	7.50	54.7	410
	2 - 4	6.70	15.9	43.0
MEM-SB-20	0 - 0.5	7.20	8.04 J	23.4 J
	0.5 - 2	7.10	8.73 J	34.1 J
	2 - 4	6.30	14.0 J	36.1 J
MEM-SB-21	0 - 0.5	7.70	9.21 J	43.1 J
	0.5 - 2	7.80	13.5 J	37.5 J
	2 - 3.5	7.30	9.25 J	38.0 J
MEM-SB-22	0 - 0.5	6.30	14.5 J	132 J
	0.5 - 2	4.40 [4.40]	13.0 J [11.8 J]	45.8 J [47.0 J]
	2 - 4	4.30	13.3 J	13.2 J
MEM-SB-23	0 - 0.5	6.90	13.3 J	17.9 J
	0.5 - 2	7.20	19.5	19.9
	2 - 4	5.30	14.1	26.9
MEM-SB-24	0 - 0.5	7.30	10.2	12.4
	0.5 - 2	6.10	9.24	10.8
	2 - 4	6.10 [6.0]	9.27 [8.80]	10.1 [10.4]

Notes:
mg/kg - milligrams per kilogram
ft bgs - feet below ground surface
J - estimated value
Duplicate sample concentrations are in brackets
Arsenic screening value of 27 mg/kg is based on USEPA Region 4 screening levels.
Lead screening value of 800 mg/kg is based on USEPA Region 4 screening levels for lead with industrial site use.
Shaded values exceed screening levels.

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Table 3
Soil, Waste, and IDW Sample Analytical Program
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Parameter	Estimated Number of Borings	Estimated No. of Samples per Boring [/1]	Estimated No. of Field Samples [/1]	No. of Field QC Samples: Field Duplicate	Rinse Blank	Trip Blank	Total No. Field + Field QC Samples[/1]	No. of MS/MSD Samples Sets
Soil Delineation Samples								
Total Arsenic and Lead	26	5	130	7	5	0	142	7
pH	26	5	130	7	0	0	137	0
Vertical Delineation Soil Samples								
Total Arsenic and Lead	8	2	16	1	2	0	19	1
pH	8	2	16	1	0	0	17	1
Waste Disposal Characterization Samples								
TCLP Arsenic and Lead	5	1	5	1	0	0	6	1
Total Arsenic and Lead	5	1	5	0	0	0	5	1
IDW Samples (Solid)								
TCLP Metals	--	--	1	0	0	0	1	0

Notes:

[/1] The number of samples per boring and total number of samples are approximate. It is assumed that the samples will be collected up to 8 feet in each boring and that all contingency borings are necessary.

1. Field duplicate and field quality control (QC) samples will be collected at a frequency of 5% (1 for every 20 samples).
2. Equipment rinse blanks will be collected at a frequency of one per day.
3. Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 5% (1 for every 20 samples).
4. Number of soil delineation borings based on 22 new locations (including proposed monitoring well locations) and 4 contingency borings.
5. Vertical delineation samples will be collected at soil borings MEM-SB-4, -6, -10, -11, -12, -13, -16, and -18.
6. Number of waste disposal samples are estimated. The specific samples selected for TCLP analyses will be determined following receipt of preliminary laboratory analytical data.

IDW - Investigation-derived waste.
TCLP - Toxicity Characteristic Leaching Procedure.

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Table 4
Groundwater and IDW Sample Analytical Program
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Parameter	Estimated Number of Samples	No. of Field QC Samples: Field Duplicate	No. of Field QC Samples: Rinse Blank	No. of Field QC Samples: Trip Blank	Total No. Field + Field QC Samples	No. of MS/MSD Samples Sets
Groundwater (Monitoring Wells)						
Total Arsenic and Lead	11	1	1	0	13	1
Dissolved Arsenic and Lead	11	1	1	0	13	1
pH	11	1	1	0	13	1
IDW Samples (Aqueous)						
TAL Metals/pH	2	0	0	0	2	0

Notes:

1. Field duplicate and field quality control (QC) samples will be collected at a frequency of 5% (1 for every 20 samples).
2. Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 5% (1 for every 20 samples).
3. Equipment rinse blanks will be collected at a frequency of 1 per day of groundwater sampling.
4. In case the existing groundwater monitoring wells are found in a good condition, groundwater samples will be collected from those wells for total and dissolved arsenic and lead.

IDW - Investigation-derived waste
TAL - Target Analyte List

Table 5
Contact Information for Key Individuals
Site Delineation Work Plan
VCC Memphis Site - Memphis, Tennessee

Organization	Contact	Phone	Email
USEPA - Region 4	Ms. Alyssa Hughes On-Scene Coordinator United States Environmental Protection Agency Region 4 Atlanta Federal Center 61 Forsyth Street Atlanta, GA 30303-8960	404.562.8743	hughes.alyssa@epa.gov
TDEC	Mr. Jordan English, P.G. Environmental Field Office Manager State of Tennessee Department of Environment and Conservation Division of Remediation Memphis Environmental Field Office 8383 Wolf Lake Drive Bartlett, TN 38133-4119	901.371.3039	jordan.english@tn.gov
EMES	Ms. Lauren M. Gordon Project Manager, Major Projects ExxonMobil Environmental Services Company 3225 Gallows Road Room 8B1020 Fairfax, VA 22037	703.846.3804	lauren.m.gordon@exxonmobil.com
ARCADIS	Mr. Matthew Pelton Project Manager ARCADIS U.S., Inc. 801 Corporate Center Drive Suite 300 Raleigh, NC 27607	919.415.2308	matthew.pelton@arcadis-us.com

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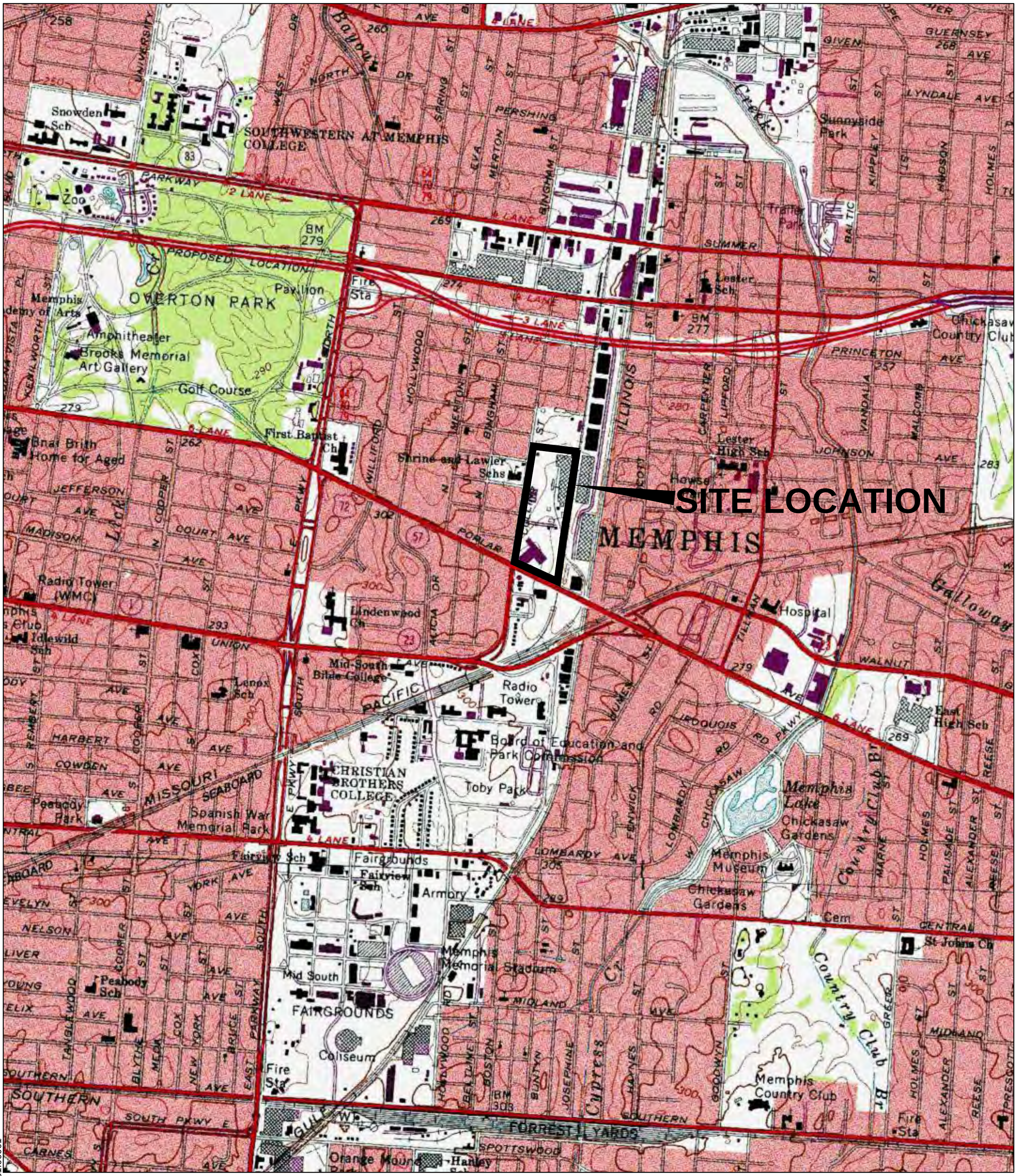
Figures



REFERENCE: USGS 7.5 MINUTE SERIES TOPOGRAPHIC QUADRANGLE, NORTHEAST MEMPHIS, 1900 PHOTOREVISED 1980.

0 2000
SCALE IN FEET

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
SITE DELINEATION WORK PLAN

SITE LOCATION MAP

ARCADIS

FIGURE
1

CITY:(CARY) DIV/GROUP:(ENV) DB: LD:(L.ELLIS) PIC:(Opt) PM:(Reqd) TM:(B.WILSON)
G:\ENVCAD\Cary\ACT\B0085789\1201\00002\DWG\85789N01.dwg LAYOUT: 1 SAVED: 12/21/2010 5:08 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 2/17/2012 1:18 PM BY: ELLIS, LEKOREY
XREFS: IMAGES: DRG.jpg PROJECT: B0085789.0001.00001

OVERVIEW

0 450 900 Feet

GRAPHIC SCALE

HISTORICAL BUILDING KEY: #

1. FERTILIZER MILL DUMPING PIT
2. ACID CHAMBERS
3. BURNER HOUSE
4. MILL
5. ENGINE HOUSE
6. BAG HOUSE
7. CARPENTER SHOP
8. NITRE HOUSE
9. DEEP WELL PUMP
10. 170,000 GALLON RESERVOIR
11. SHED
12. OFFICE
13. ACID CHAMBERS AND BURNERS (1927)
14. STAGE (1927)
15. STORAGE (1952)

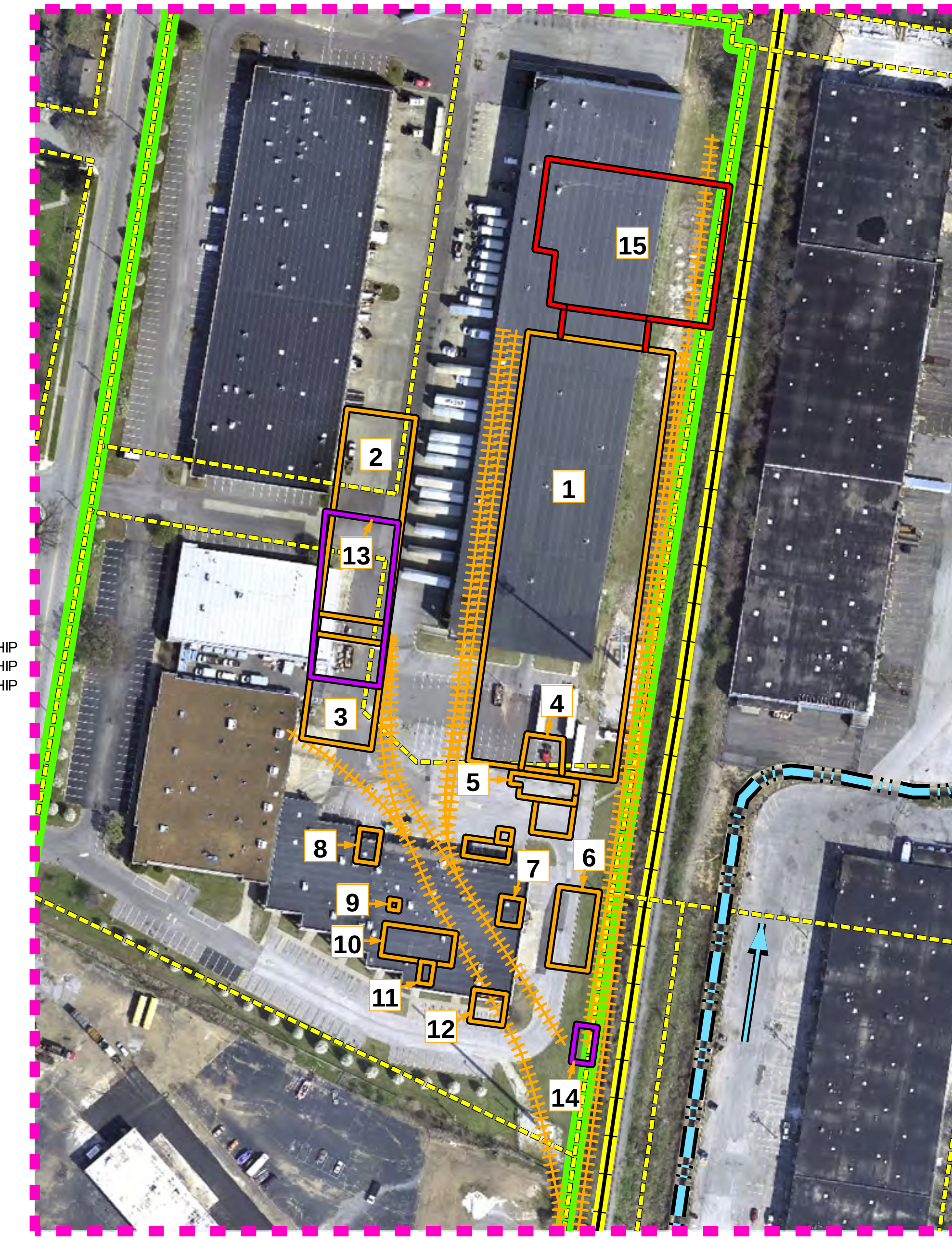
CURRENT PROPERTY OWNER KEY: #

LETTER	TAX	PARCEL ID	OWNER
A	033053	00007	YSI VI LLC
B	033053	00004	THE ACEE COMPANY
C	033053	00005	THE ACEE COMPANY
D	033053	00006	THE ACEE COMPANY
E	033051	00017	CITY OF MEMPHIS
F	033053	00002	BELL PROPERTY GROUP GENERAL PARTNERSHIP
G	033053	00008	BELL PROPERTY GROUP GENERAL PARTNERSHIP
H	033053	00009	BELL PROPERTY GROUP GENERAL PARTNERSHIP
I	033035	00010	WILLIAM STREET (RESIDENCE)
J	033034	00001	CITY OF MEMPHIS
K	033031	00007	STOUGH REVOCABLE TRUST
L	028047	0002C	NORMAN KANE
M	028050	0001C	LOEB REALTY CO. INC
N	020850	00019	NEWPORT TELEVISION LLC

CURRENT PROPERTY USAGE KEY: #

1. SELF STORAGE FACILITY (CUBESMART)
2. ACEE BUSINESS CENTER
3. CITY OF MEMPHIS DEPT. OF PUBLIC WORKS
4. POWER AND TELEPHONE SUPPLY CO. INC
5. ELECTRICAL ASSOCIATES INC.
6. CHURCH OF THE BLESSED SACRAMENT
7. EVERETT MEMORIAL UNITED METHODIST CHURCH
8. LOS COMPADRES (RESTAURANT)
9. R&W GALLERY
10. BANK OF AMERICA
11. CLEAR CHANNEL TELEVISION CENTER
12. BELL PARK INDUSTRIAL PLAZA
13. ASSOCIATED PRODUCTS
14. I.S. BELL GERHARDT
15. RADCO
16. CHICKSAW LUMBER
17. HABITAT FOR HUMANITY
18. OK STORAGE AND TRANSFER
19. NEIGHBORHOOD CHRISTIAN CENTER INC.
20. EPSTIEN
21. PETIT LAWN SCAPES
22. CITY OF MEMPHIS DEPT. OF SOLID WASTE MGMT.
23. THERMAL WQUIPMENT SALES INC.
24. ILLINOIS CENTRAL GULF RAILROAD TRACKS

N



INSET

0 200 400 Feet

GRAPHIC SCALE

LEGEND

- APPROXIMATE BOUNDARY OF THE FORMER VCC MEMPHIS PROPERTY
- APPROXIMATE LOCATION OF FORMER FERTILIZER PLANT FEATURES (1907)
- APPROXIMATE LOCATION OF FORMER FERTILIZER PLANT FEATURES (1927)
- APPROXIMATE LOCATION OF FORMER FERTILIZER PLANT FEATURES (1952)
- APPROXIMATE LOCATION OF CURRENT TAX PARCEL BOUNDARIES
- DRAINAGE DITCH
- DRAINAGE DITCH FLOW DIRECTION
- RAILROAD
- APPROXIMATE LOCATION OF FORMER RAILROAD SIDINGS

NOTES:

1. HISTORICAL SITE FEATURES DIGITIZED FROM 1907, 1927 AND 1952 SANBORN MAPS.
2. PARCEL BOUNDARIES DIGITIZED FROM 2009 TAX MAP OBTAINED FROM SHELBY COUNTY TAX ASSESSOR.
3. 2008 AERIAL PHOTOGRAPH OF SHELBY COUNTY, TENNESSEE PROVIDED BY USGS.
4. ALL LOCATIONS ARE APPROXIMATE.

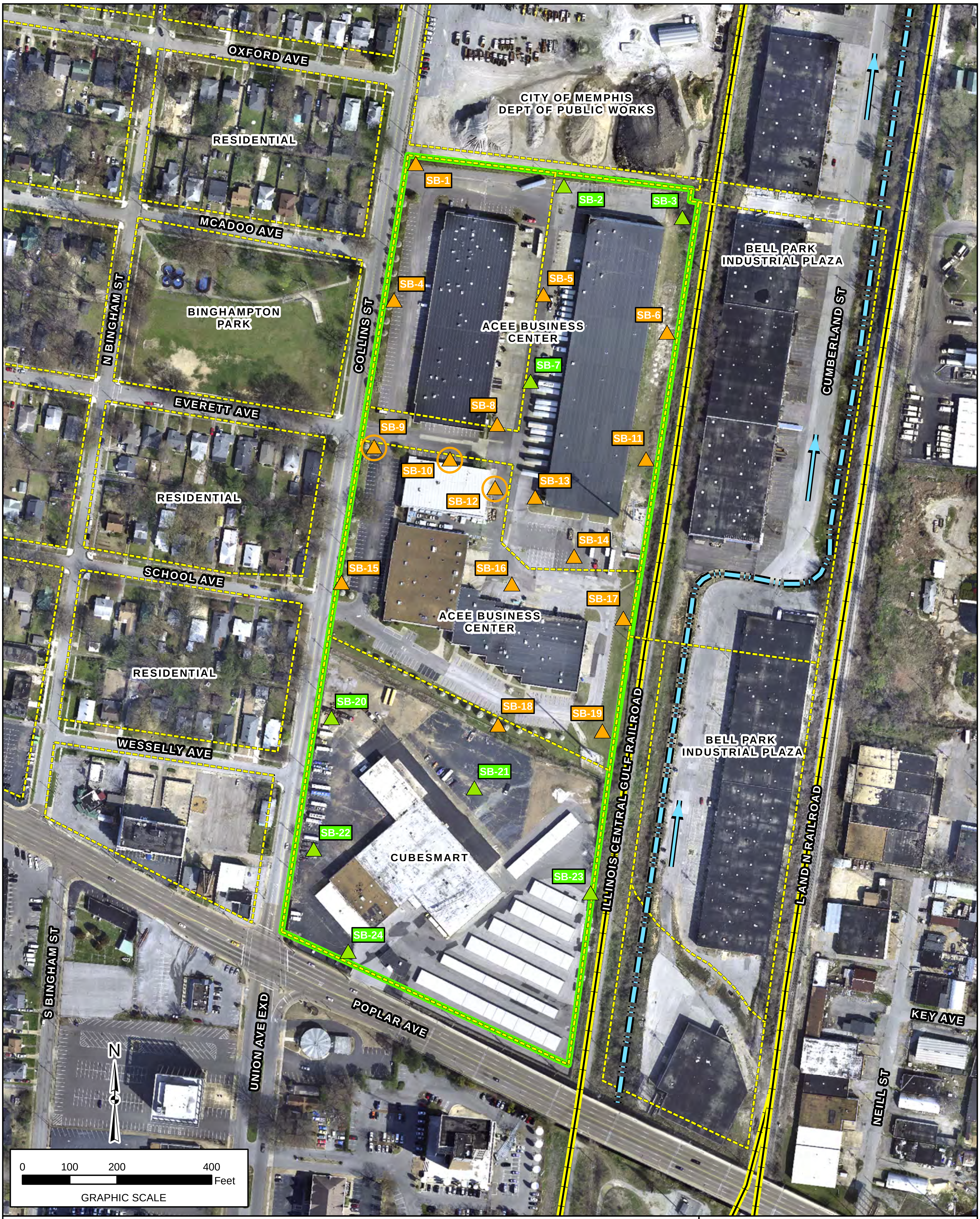
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
VCC MEMPHIS, SHELBY COUNTY, TENNESSEE

SITE DELINEATION WORK PLAN

HISTORICAL AND CURRENT SITE FEATURES

ARCADIS

PROJECT MANAGER: MP	CHECKED BY: MP/AB
DRAWING BY: NAV	DATE: 02/17/2012
PROJECT NUMBER: B0085789.1201	FIGURE NUMBER: 2



LEGEND

- APPROXIMATE BOUNDARY OF THE FORMER VCC MEMPHIS PROPERTY
- APPROXIMATE LOCATION OF CURRENT TAX PARCEL BOUNDARIES
- DRAINAGE DITCH
- DRAINAGE FLOW DIRECTION
- RAILROAD
- APPROXIMATE LOCATION OF SOIL BORING WITH As AND/OR Pb ABOVE SCREENING LEVELS
- APPROXIMATE LOCATION OF SOIL BORING WITH As AND Pb BELOW SCREENING LEVELS
- APPROXIMATE LOCATION OF SOIL BORING WHERE SLAG WAS NOTICED

USEPA REGION 4 INDUSTRIAL CRITERIA (mg/kg)	
ARSENIC	27
LEAD	800

NOTES:
1. HISTORICAL SITE FEATURES DIGITIZED FROM 1907, 1927 AND 1952 SANBORN MAPS.
2. PARCEL BOUNDARIES DIGITIZED FROM 2009 TAX MAP OBTAINED FROM SHELBY COUNTY TAX ASSESSOR.
3. 2008 AERIAL PHOTOGRAPH OF SHELBY COUNTY, TENNESSEE PROVIDED BY USGS.
4. ALL LOCATIONS ARE APPROXIMATE.
5. SOIL BORINGS WERE RECORDED IN THE FIELD USING A HANDHELD GPS UNIT.
6. SAMPLE LOCATION NAMES BEGIN WITH PREFIX "MEM-".
7. USEPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.
8. mg/kg = MILLIGRAMS PER KILOGRAM.

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
VCC MEMPHIS, SHELBY COUNTY, TENNESSEE

SITE DELINEATION WORK PLAN

LOCATION OF SOIL BORINGS WITH SOIL SAMPLES THAT EXCEED SCREENING LEVELS

ARCADIS

PROJECT MANAGER: MP	CHECKED BY: MP/AB
DRAWING BY: SDR	DATE: 02/17/2012
PROJECT NUMBER: B0085789.1201	FIGURE NUMBER: 3

USEPA REGION 4 INDUSTRIAL CRITERIA (mg/kg)	
ARSENIC	27
LEAD	800

LEGEND:

- APPROXIMATE BOUNDARY OF THE FORMER VCC MEMPHIS PROPERTY
- APPROXIMATE LOCATION OF CURRENT TAX PARCEL BOUNDARIES
- DRAINAGE DITCH
- DRAINAGE FLOW DIRECTION
- RAILROAD
- APPROXIMATE LOCATION OF SOIL BORING WITH As AND/OR Pb ABOVE SCREENING LEVELS
- APPROXIMATE LOCATION OF SOIL BORING WITH As AND Pb BELOW SCREENING LEVELS
- APPROXIMATE LOCATION OF SOIL BORING WHERE SLAG WAS NOTICED
- LOCATION OF PROPOSED SOIL BORING
- PROPOSED TEMPORARY WELL LOCATION
- APPROXIMATE LOCATION OF PREVIOUSLY INSTALLED WELLS
- CONTINGENCY BORING TO BE COLLECTED IF ADJACENT BORINGS ARE IMPACTED (BASED ON FIELD SCREENING)
- APPROXIMATE LOCATION OF FORMER FERTILIZER PLANT FEATURES (1907)
- APPROXIMATE LOCATION OF FORMER FERTILIZER PLANT FEATURES (1927)
- APPROXIMATE LOCATION OF FORMER FERTILIZER PLANT FEATURES (1952)
- APPROXIMATE LOCATION OF FORMER RAILROAD SIDINGS

NOTES:

1. HISTORICAL SITE FEATURES DIGITIZED FROM 1907, 1927 AND 1952 SANBORN MAPS.
2. PARCEL BOUNDARIES DIGITIZED FROM 2009 TAX MAP OBTAINED FROM SHELBY COUNTY TAX ASSESSOR.
3. 2008 AERIAL PHOTOGRAPH OF SHELBY COUNTY, TENNESSEE PROVIDED BY USGS.
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5. SOIL BORINGS WERE RECORDED IN THE FIELD USING A HANDHELD GPS UNIT.
6. SAMPLE LOCATION NAMES BEGIN WITH PREFIX "MEM-".
7. USEPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.
8. mg/kg = MILLIGRAMS PER KILOGRAM.

HISTORICAL BUILDING KEY: #

1. FERTILIZER MILL DUMPING PIT
2. ACID CHAMBERS
3. BURNER HOUSE
4. MILL
5. ENGINE HOUSE
6. BAG HOUSE
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8. NITRE HOUSE
9. DEEP WELL PUMP
10. 170,000 GALLON RESERVOIR
11. SHED
12. OFFICE
13. ACID CHAMBERS AND BURNERS (1927)
14. STAGE (1927)
15. STORAGE (1952)

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
VCC MEMPHIS, SHELBY COUNTY, TENNESSEE

SITE DELINEATION WORK PLAN

PROPOSED SOIL BORING AND GROUNDWATER MONITORING WELL LOCATIONS

ARCADIS

PROJECT MANAGER: MP	CHECKED BY: MP/AB
DRAWING BY: SDR	DATE: 03/29/2012
PROJECT NUMBER: B0085789.1201	FIGURE NUMBER: 4

Path: U:\projects\ExxonMobil\Memphis\ArcMap\B0085789-11-02008-03_FIG04_v3.mxd
G:\APROJECT\Exxon Mobil\B0085789.110X\Figures\SDWP_Figure4.pdf

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Appendix A

Field Sampling Plan

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Infrastructure · Water · Environment · Buildings

Imagine the result

ExxonMobil Environmental Services Company

Field Sampling Plan

Former Virginia-Carolina Chemical Corporation Memphis Site,
152 Collins Street
Memphis, Tennessee
TDEC Ref No.: 79-557

May 2012

ARCADIS

Ashima Bagga
Staff Environmental Engineer

Matthew Pelton
Project Manager

Geoffrey Germann
Principal Engineer

Field Sampling Plan

Former Virginia-Carolina Chemical Corporation Memphis Site
152 Collins Street
Memphis, Tennessee
TDEC Ref. No.: 79-557

Prepared for:
ExxonMobil Environmental Services Company

Prepared by:
ARCADIS U.S., Inc.
801 Corporate Center Drive
Raleigh
North Carolina 27607
Tel 919.854.1282
Fax 919.854.5448

Our Ref.:
B0085789.1201.00002

Date:
May 2012

Attachments

1. Project Description and History

This Field Sampling Plan (FSP) is to be used to provide procedures for collecting data in support of the Site characterization activities at the former Virginia-Carolina Chemical Corporation (VCC) Memphis Site located in Memphis, Shelby County, Tennessee (the Site). A description of the Site, along with a Site history, is provided in the *Site Delineation Work Plan, Former Virginia-Carolina Chemical Corporation Memphis Site, Memphis, Tennessee* (Work Plan), to which this FSP is an appendix. This FSP, along with the Quality Assurance Project Plan (QAPP) (also appended to the Work Plan), is intended to guide all sampling, measurement, and other field and laboratory measurement activities. T he procedures specified in this FSP are in accordance with the procedures presented in the U.S. Environmental Protection Agency's (USEPA's) *Field Branches Quality System and Technical Procedures* (USEPA 2012).

2. Sampling Objectives

The general objectives of the field sampling activities are to:

1. Install groundwater monitoring wells to assess if constituents of concern (COCs) are present in groundwater as specified in the Work Plan;

2. Collect soil and groundwater samples that are representative of the quality of these environmental matrices as specified in the Work Plan;

3. Delineate the magnitude and extent of COC concentrations in soil and groundwater as specified in the Work Plan; and

4. Collect groundwater elevation measurements to develop potentiometric surface maps.

All sampling is to be performed in accordance with the procedures outlined in this FSP to ensure that data of known quality are generated.

3. Field Data Collection Procedures

3.1 Sample Locations and Frequencies

The sample locations and frequencies are presented in Section 3 of the Work Plan, to which this FSP is an appendix.

3.2 Surface Soil Sample Collection

Surface soil samples will be collected from the locations specified in Section 3 of the Work Plan using the collection and screening procedures presented in Attachment 1.

3.3 Subsurface Soil Sample Collection

Subsurface soil samples will be collected from the locations specified in Section 3 of the Work Plan using the collection and screening procedures presented in Attachment 2.

3.4 X-Ray Fluorescence Screening

All soil sample intervals will be field screened using an X-Ray Fluorescence Spectrum Analyzer (XRF Analyzer). Standard operating procedures for the XRF Analyzer are presented in Attachment 3.

3.5 Groundwater Monitoring Well Installation and Development Procedures

Pre-packed Screen Monitoring Well Installation Procedures are presented in Attachment 4. Traditional Groundwater Monitoring Well Installation and Development Procedures are presented in Attachment 5. Double-Cased Groundwater Monitoring Well Installation and Development Procedures are presented in Attachment 6.

3.6 Groundwater Sampling Using Hydropunch™

Groundwater screening and sampling procedures using Hydropunch™ are presented in Attachment 7.

3.7 Groundwater Sample Collection Procedures

Groundwater samples will be collected from the monitoring wells specified in the Work Plan using the low-flow/low-stress procedures presented in Attachment 7.

3.8 Specific Capacity Testing Procedures

Specific Capacity tests may be conducted on the monitoring wells specified in the Work Plan using the procedures presented in Attachment 8.

3.9 Groundwater Elevation Measurement Procedures

Groundwater elevation measurements will be collected as specified in the Work Plan using the procedures presented in Attachment 9.

3.10 Equipment Cleaning Procedures

All equipment involved in field sampling activities will be decontaminated prior to use, between sample locations and intervals, and prior to leaving each site, as detailed in Attachment 10.

4. Sample Designation System

A sample designation code will provide each sample with a unique “name”. This alphanumeric system will apply to all samples that are to be transmitted to the analytical laboratories during implementation of the field data collection activities.

Each sample will be designated by an alphanumeric code that will identify the site name and matrix sampled and will contain a sequential sample number. Site-specific procedures are elaborated below.

The following is a general guide for sample identification:

First Segment	Second Segment		Third Segment (optional)
MEM--	AA	NN_	N_
Site Name	Location Type	Specific Location	Depth/Date/Other

The first segment will contain the project identifier: MEM for Memphis Site, Memphis, Tennessee.

The second segment will contain the location type and number. The location type describes if the sample is collected from a soil boring, permanent monitoring well, etc. The location number is unique to each location, beginning with 01 and increasing accordingly. The following abbreviations will be used for the location types:

- SB = Soil boring;
- SS = Surface soil grab sample;
- TW = Groundwater from a temporary monitoring well;
- MW = Groundwater from a permanent monitoring well;
- DUP = field duplicate sample;
- QAQC_TB = Trip blank; and
- QAQC_EB = Equipment rinse blank.

The third segment is optional and may contain the following:

- Groundwater samples may be collected more than once. Each event will be designated by its six-digit date (MMDDYY).
- Soil samples will be collected at specific depths. The third segment will be used to denote the sample collection depth in feet below ground surface (bgs).

For example, a soil sample obtained at soil boring location 03 from a depth of 0 to 0.5 foot bgs would be identified as “MEM-SB-03_0-0.5”. The soil sample obtained at the same location at a depth of 4 to 6 feet bgs would be identified as “MEM-SB-03_4-6”. A duplicate sample from this location would be identified using the “DUP” abbreviation followed by a number to differentiate between duplicate samples, such as “MEM-DUP-01”, where the “01" is the first field duplicate sample collected during the sampling event.

Equipment rinse blanks will be numbered sequentially. An example equipment rinse blank name would be MEM-QAQC_EB_01, where “MEM-QAQC_EB” stands for equipment rinse blank, and “01” is the sequential number of equipment rinsate blanks collected during the sampling event. Other field quality control samples will be named using a similar format.

Where necessary, the code system will be supplemented to accommodate additional sample identification information.

5. Sample Handling and Documentation

5.1 General

This section presents procedures to be used for sample handling and documentation, including:

- Sample containers and preservation;
- Packing, handling, and shipping requirements; and
- Documentation.

5.2 Sample Containers and Preservation

Appropriate sample containers, preservation methods, and laboratory holding times for soil and groundwater samples are summarized in the QAPP, which, like this FSP, is also an appendix to the Work Plan.

The analytical laboratories will supply sample containers cleaned and quality controlled in accordance with Office of Solid Waste and Emergency Response (OSWER) Directive No. 9240.0-5 Specifications and Guidance for Obtaining Contaminant-Free Sample Containers (USEPA 1992a). The analytical laboratories will also supply analyte-free water, sample labels, and preservatives. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate). Sample labeling procedures and the sample designation system are described in Section 4 of this FSP.

5.3 Packing, Handling, and Shipping Requirements

Sample custody seals and packing materials for filled sample containers will also be provided by the analytical laboratories. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to reduce the possibility of container breakage.

All samples will be packaged by field personnel and transported as low-concentration environmental samples. The packaged environmental samples will be shipped via overnight express carrier or other appropriate means by the sampling personnel to the laboratory within 24 hours of sample collection, whenever possible. General procedures for packing, handling, and shipping environmental samples are included in Attachment 11.

5.4 Documentation

Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis, and chain of custody. This documentation constitutes a record that allows reconstruction of all field events to aid in the data review and interpretation process. All documents, records, and information relating to the performance of the fieldwork will be retained in a project file at the ARCADIS office in Raleigh, North Carolina. The various forms of documentation that will be maintained throughout the field investigation activities are briefly outlined below.

5.4.1 Daily Production Documentation

Each field crew will maintain field documentation consisting of a waterproof, bound notebook that will contain a record of all activities performed at the Site. The specific measurements from field testing and sampling will be recorded in the field notebook or on separate documentation forms. At the time of sampling, detailed notes of the exact site of sampling will be recorded in the field notebook.

5.4.2 Sampling Information

During soil sampling, detailed notes will be made as to the exact site of sampling, physical observations, sample depths, and weather conditions. These notes will be recorded in the field notebook. In addition, all sample locations will be flagged in the field as well as "tied" to existing structures and/or landmarks and will be subsequently surveyed using either ground techniques or global positioning system to document their final location. Field screening measurements will be recorded in the field notebook or on appropriate forms.

Groundwater sampling field logs will be filled out during each sampling event and will contain sample location, data on water levels, well depths, physical observations of the water, and field measurements (turbidity, temperature, pH, and conductance). Water level readings will be measured to surveyed reference points, i.e., the top of inner casing.

5.5 Sample Chain of Custody

Field personnel will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. When samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

Chain-of-custody forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratories. The forms will be filled out at each sampling site, at a group of sampling sites, or at the end of each day of sampling by one of the field personnel designated to be responsible for sample custody. In the event that the samples are relinquished by the designated sampling person to other sampling or field personnel, the chain-of-custody form will be signed and dated by the appropriate personnel to document the sample transfer. The original chain-of-custody form will accompany the samples to the laboratories and copies will be forwarded to the ARCADIS Quality Assurance Officer.

6. Management of Investigation-Derived Waste (IDW)

6.1 General

IDW will include groundwater, soil, decontamination fluids, personal protective equipment, and disposable sampling materials. Groundwater will be produced during development and purging of monitoring wells. Soil will be produced during soil boring drilling, sampling, and monitoring well installation. Decontamination procedures associated with this investigation will produce water during steam cleaning and/or washing operations, soil from cleaning augers and other downhole tools, and solvent and acids from cleaning sampling equipment. Waste related to health and safety equipment and disposable sampling equipment will also be generated. All IDW will be containerized, sampled for laboratory analysis, and disposed of appropriately depending on the analytical results. The procedures for handling IDW are based on the Guide to Management of Investigation Derived Wastes (USEPA 1992b) and are specified in Attachment 12.

6.2 Groundwater and Soil

Groundwater generated from developing and purging monitoring wells and soil generated during drilling and sampling activities will be collected in drums. The drums will be labeled with the date, contents, and contact information including the company names of the contractor. Upon completion of field activities, the drums will be moved to a secure location on site, sampled for laboratory analysis, and disposed of appropriately depending on the analytical results. The need for collecting and analyzing IDW samples will be evaluated after review of the data generated from the analysis of the soil and groundwater samples collected during the implementation of the field sampling activities. Based on these data, as well as the analytical requirements of potential disposal facilities, a sampling and analytical program to support disposal of the IDW will be developed, if needed. The specific analytical parameters for the IDW will be determined at that time.

6.3 Disposable Equipment and Debris

Disposable equipment and debris such as health and safety equipment, polyethylene plastic sheeting, sampling equipment, spoons, and other equipment and/or sampling debris not reused in the investigation will be containerized in 55-gallon drums and disposed of with the drill cuttings. The data generated from the soil and groundwater samples will be used to determine disposal requirements in accordance with Section 6.2 of this FSP.

6.4 Decontamination Rinsate

Decontamination rinsate, including water from steam cleaning augers and downhole tools, water, solvents, and acid from cleaning sampling equipment, will be containerized in appropriately labeled steel drums and temporarily stored on site. The drums will be labeled with the date, contents (e.g., decontamination water from steam cleaning drilling tools, decontamination water and solvent from cleaning sampling pump), and contact information including the company name of the contractor. Upon completion of the field activities, a composite sample will be collected from the drums and analyzed for target analyte list metals and pH. IDW samples will be analyzed on a quick turnaround time basis.

7. Quality Assurance/Quality Control (QA/AC)

7.1 General

This section summarizes the QA/QC requirements for all field investigation activities associated with the implementation of the field data collection activities.

7.2 Field Instrument Calibration and Preventive Maintenance

The Field Activities Coordinator is responsible for ensuring that a calibration/maintenance log will be maintained following procedures specified in Attachment 3 for the XRF Analyzer device. The log will include at a minimum:

- Name of device and/or instrument calibrated;
- Device/instrument serial/I.D. number;
- Frequency of calibration;
- Date(s) of calibration(s);
- Results of calibration(s); and
- Name of person(s) performing calibration(s).

Equipment to be used each day will be calibrated prior to the commencement of the day's activities or as suggested by the manufacturer and anytime there is an ambient temperature change by more than 10 degrees Fahrenheit. Health and safety monitoring equipment and water quality testing equipment (pH, specific conductance, and temperature meters) will be calibrated and maintained in general accordance with manufacturer manual specifications.

7.3 Quality Assurance/Quality Control Sample Collection

An estimate of QA/QC field samples to be collected during each investigative activity is provided in the Work Plan. This estimate is based on the QA/QC sample collection frequency as discussed in the QAPP. Guidance on collecting the QA/QC samples is presented below.

7.3.1 Equipment Rinse Blanks

Rinse blanks will be prepared in the field by ARCADIS personnel by collecting demonstrated analyte-free water that has been poured over decontaminated sampling equipment to check the adequacy of the decontamination procedure and to allow evaluation of potential cross-contamination of samples due to the equipment. Rinse blanks will be collected at the frequency specified in the QAPP. Rinse blanks will be collected from sampling equipment including auger buckets or Geoprobe® drive shoe. For groundwater samples collected using a pump, a length of representative tubing will be attached to the pump during collection of the rinse blank. Rinse blanks will be collected at the beginning of the day before the sampling event and must accompany the samples collected that day. Rinse blanks will not be collected if no sampling equipment was used to collect the sample.

Rinse blanks will be prepared in the field. Laboratory- or vendor-supplied analyte-free water will be poured into or over the sampling equipment and then directly into the laboratory-supplied sample bottles. The intent is for the water making up the blank to follow the same path and, therefore, come in contact with the same equipment as the samples.

7.3.2 Field Duplicates

Duplicate samples will be sent for laboratory analysis to evaluate the reproducibility of the sampling techniques used. Duplicate results also provide an indication of the variability within the Site itself. Duplicate sample collection frequency will be as specified in the QAPP.

7.4 Quality Assurance/Quality Control Field Audits

QA/QC during the sampling program will be performed by the ARCADIS Quality Assurance Officer, as discussed in the QAPP.

7.5 Field Changes and Corrective Action

Any changes in the program to accommodate Site-specific needs or unforeseen events will be documented in the field log. Major changes will be discussed with the Project Manager, as needed. The Field Activities Coordinator is responsible for the control, tracking, and implementation of the identified changes.

8. References

USEPA. 1992a. Specifications and Guidance for Contaminant-Free Sample Containers. OSWER Publication 9240.0-05A. December.

USEPA. 1992b. Guide to Management of Investigation Derived Wastes. OSWER Publication 9345.3-03FS.

USEPA. 2012. Field Branches Quality System and Technical Procedures, USEPA Region 4, Athens, Georgia. January.

ARCADIS

Attachment 1

Surface Soil Sample Collection and Screening Procedures

Attachment 1: Surface Soil Sample Collection and Screening Procedures

Prior to commencing work, all underground utilities will be located by the Tennessee One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with ExxonMobil's subsurface drilling policies, each boring location will be hand cleared to a minimum of 5 feet below ground (ft bgs) surface in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas.

I. Introduction

This attachment presents protocols to collect and screen surface soil samples. Note that if subsurface soil samples are being collected at the same locations as surface soil samples, then the subsurface sampling procedures described in Attachment 2 may also be used to collect surface soil samples.

II. Materials

The following materials will be available, as required, during surface soil sampling:

- Health and safety equipment (as required by the Health and Safety Plan [HASP]);
- Equipment cleaning materials;
- Glass or stainless steel tray;
- Stainless steel trowels or disposable scoops;
- Stainless steel bucket auger;
- Ziploc®-type bags;
- Measuring device (ruler or tape measure);
- Appropriate sample containers and forms;
- Coolers with ice;
- Field book;
- Shovel;
- X-Ray Fluorescence Spectrum Analyzer (XRF Analyzer); and
- Photoionization Detector or equivalent.

III. Procedures

The following procedures will be employed to collect surface soil samples:

1. Don personal protective equipment (as required by the HASP).

2. Identify sample locations from the sample location plan and note locations in the field notebook.

3. If the sample location is a vegetated area, the vegetation should be removed prior to sample collection.

4. Samples will be collected by cutting into the soil to the desired depth with a precleaned stainless steel trowel, disposable scoop, or stainless steel bucket auger. Once the desired sampling depth has been achieved, the bucket will be replaced with a clean bucket for sample collection. That bucket can then be used to advance to the next sampling depth. A clean bucket will then be used to collect the sample at that depth interval. Sampling gloves will be changed between each sample collected.

5. Visually characterize the soil and classify according to Unified Soil Classification System soil classification procedures included as part of this attachment. In addition, observe and record color using a Munsell color chart, general moisture content, structure, consistency, odor, and other notable physical characteristics of the soil.

6. The soil sample will be homogenized by mixing in a clean Ziploc®-type bag or decontaminated stainless steel tray or bowl using a decontaminated stainless steel scoop. Remove any rocks, twigs, leaves, or other debris if it is not considered to be a part of the sample. After the initial mixing, quarter the sample and move the four quarters to the corners of the tray. Each quarter should be mixed individually and then moved back to the center of the tray for final mixing. Screen the sample with the XRF Analyzer and record the readings in the field notebook. All remaining sample containers should be filled after homogenization is complete.

7. Collect each composite aliquot from the prescribed location as specified in the Work Plan. Place approximately equal portions of each composite

aliquot in a clean Ziploc®-type bag or decontaminated stainless steel tray or bowl using a decontaminated stainless steel scoop and homogenize as specified in Step 6, above.

8. Label containers and place in a transportation cooler.

9. Duplicate samples will be obtained by dividing the sample into two sets of containers.

10. Handle, pack, and ship the samples with appropriate chain-of-custody procedures as specified in Attachment 11.

11. Record all other appropriate information in the field notebook.

IV. Field Cleaning Procedures

Sampling devices will be cleaned after each use following the procedures presented in Attachment 10.

Unified Soil Classification System				
Major Divisions			Group Symbols	Typical Names
Coarse-Grained Soils. More than half of materials is larger than No. 200 sieve size	Sand. More than half of coarse fraction is smaller than No. 4 sieve size	Clean gravels	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	Gravels. More than half of coarse fraction is larger than No. 4 sieve size	Clean sands	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands, gravelly sands, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils. More than half of materials is smaller than No. 200 sieve size.	Silts and Clay	Low Liquid Limit	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
		High Liquid Limit	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clay of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
High organic soils			Pt	Peat and other highly organic silts

Note: Well graded = poorly sorted and vise versa

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Attachment 2

Subsurface Soil Sample Collection and Screening Procedures

Attachment 2: Subsurface Soil Sample Collection and Screening Procedures

Prior to commencing work, all underground utilities will be located by the Tennessee One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with ExxonMobil's subsurface drilling policies, each boring location will be hand cleared to a minimum of 5 feet below ground (ft bgs) surface using in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas.

I. Introduction

This attachment describes the procedures used to collect and screen subsurface soil samples, which may also be used to collect and screen surface soil samples.

II. Soil Sampling

A. Soil Sampling Using a Drill Rig/Hollow-Stem Auger

Overburden material will be retrieved continuously in 2-foot intervals from the ground surface to the desired depth or to refusal material. The sampling method employed shall be ASTM D 1586/Split-barrel Sampling (Standard Method for Penetration Test and Split-Barrel Sampling of Soils, ASTM D 1586-98, published in Annual Book of ASTM Standards, Volume 04.08, which is included as part of this attachment). The split-spoon sampler will be composed of rust-free carbon steel.

Samples will be collected from the depth intervals specified in the Work Plan. The sample tube will be opened upon retrieval and the acetate liner containing the sample removed. The acetate liner will then be split with an appropriate cutting tool. The soil sample (not including any wash material) will be homogenized by mixing in a clean Ziploc®-type bag or stainless steel bowl with a decontaminated stainless steel scoop. To homogenize a sample of a soil matrix, first rocks, twigs, leaves, and other debris will be removed if they are not considered part of the sample, then thoroughly mixed using a stainless steel spoon. After this homogenization, the remaining laboratory sample containers will be filled.

A scientist will be on site during the drilling operations to fully describe each soil sample including: 1) soil type; 2) color using a Munsell color chart; 3) percent recovery; 4) general moisture content; 5) texture; 6) grain size and shape; 7) consistency; 8) visible evidence of contamination; and 9) miscellaneous observations. The descriptions will be according to the Unified Soil Classification System (USCS) (included as part of Attachment 1) and will be recorded in the field notebook. The supervising scientist will be responsible for documenting drilling events in the field notebook.

The drilling contractor will be responsible for obtaining accurate and representative samples, informing the supervising geologist of changes in drilling pressure, and keeping a separate general log of soils encountered, including blow counts (i.e., the number of blows from a soil sampling drive weight required to drive the split-barrel sampler in 6-inch increments).

In the event that the hollow-stem auger and split-barrel sampling methods are unsuccessful due to subsurface conditions, an alternate drilling method may be employed.

B. Soil Sampling Using Direct-Push Technology

Soil samples may be collected at depth using a direct-push method such as the Geoprobe® Macrocore or equivalent. The Geoprobe® tools will be advanced by driving 1- to 2-inch stainless steel diameter rods into the ground with a truck-mounted percussion hammer and hydraulic jack. Soil samples will be collected continuously using a Geoprobe® closed sampling tube with an acetate liner. The closed sampling tube will be driven to the desired depth, then an extension rod will be lowered through the stainless steel rods to open the end of the sample tube. After opening, the Geoprobe® sample tube will be driven to the desired depth interval to collect a discrete soil sample, then retrieved by removing the probe rods. Overburden material will be retrieved continuously in 2- to 4-foot intervals from the ground surface to the desired depth.

Samples will be collected from the depth intervals specified in the Work Plan. The sample tube will be opened upon retrieval and the acetate liner containing the sample removed. The acetate liner will then be split with an appropriate cutting tool. The soil sample (not including any wash material) will be homogenized by mixing in a clean Ziploc®-type bag or stainless steel bowl with a decontaminated stainless steel scoop. To homogenize a sample of a soil matrix, first rocks, twigs, leaves, and other debris will be removed if they are not considered part of the sample, then thoroughly mixed using a stainless steel spoon. After this homogenization, the remaining laboratory sample containers will be filled.

A scientist will be on site during the drilling operations to fully describe each soil sample including: 1) soil type; 2) color; 3) percent recovery; 4) general moisture content; 5) texture; 6) grain size and shape; 7) consistency; 8) visible evidence of contamination; and 9) miscellaneous observations. The descriptions will be according to the USCS (included as part of Attachment 1) and will be recorded in the field notebook. The supervising scientist will be responsible for documenting direct-push methods in the field notebook.

C. Soil Sampling Using a Hand Auger

A stainless steel bucket-type hand auger may be used to obtain subsurface (and surface) soil samples in areas of the Site that are not accessible to motor vehicles. At each location, the bucket will be turned into the soil using a detachable T-handle. The auger rods should be marked in increments of 0.5 foot so that the depth of the auger can be monitored as the boring is advanced. Soil retrieved from each sampling interval should be pushed out of the auger and into a glass or stainless steel mixing tray or Ziploc®-type bag for homogenization with all other samples to comprise the composite soil sample (see homogenization procedures described above for other soil sampling methods). After homogenization, the laboratory sample containers will be filled with the homogenized soil sample.

The bucket auger will be thoroughly decontaminated between each sampling location and each interval sampled in accordance with the decontamination procedures described in Attachment 10.

A scientist will be on site during field activities to fully describe each soil sample including: 1) soil type; 2) color; 3) percent recovery; 4) general moisture content; 5) texture; 6) grain size and shape; 7) consistency; 8) visible evidence of contamination; and 9) miscellaneous observations. The descriptions will be according to the USCS (included as part of Attachment 1) and will be recorded in the field notebook. The supervising scientist will be responsible for documenting hand auger methods in the field notebook.

III. Soil Cutting Handling Procedures

The soil cuttings generated from each boring will be contained in 55-gallon drums and moved to a secured area on site. A label describing the drum contents, date of collection and contractor contact information will be affixed to each drum as described in Attachment 10.

IV. Survey

A field survey control program will be conducted by a qualified survey crew using standard instrument survey techniques to establish horizontal and vertical control for each soil sample location based on any existing baseline for the Site, the North American Datum of 1983, and the North American Vertical Datum of 1988.

V. Equipment Cleaning

Equipment cleaning will occur prior to use on the Site, between each sample location, and upon completion of the sampling program prior to leaving the Site. All drilling, spooning, probing, and augering equipment and associated tools including augers, drill rods, sampling equipment, wrenches, core barrel, core rods and any other equipment or tools that may have come in contact with the soils will undergo steam cleaning and/or manual scrubbing/rinse as described in Attachment 10. Any drilling equipment coming into direct contact with sampled soil (e.g., split spoons) will undergo additional decontamination in accordance with the provisions of Attachment 10.

Designation: D 1586 – 98

Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

NOTE 1—Practice D 6066 can be used when testing loose sands below water table for liquefaction studies or when a higher level of care is ed when drilling these soils. This practice provides information on ag methods, equipment variables, energy corrections, and blow-count normalization.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

D 6066 Practice for Determining the Normalized Penetration Resistance Testing of Sands for Evaluation of Liquefaction Potential[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved June 10, 1998. Published January 1999. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 84 (1992)[ε1].

[2] Annual Book of ASTM Standards, Vol 04.08.

[3] Annual Book of ASTM Standards, Vol 04.09.

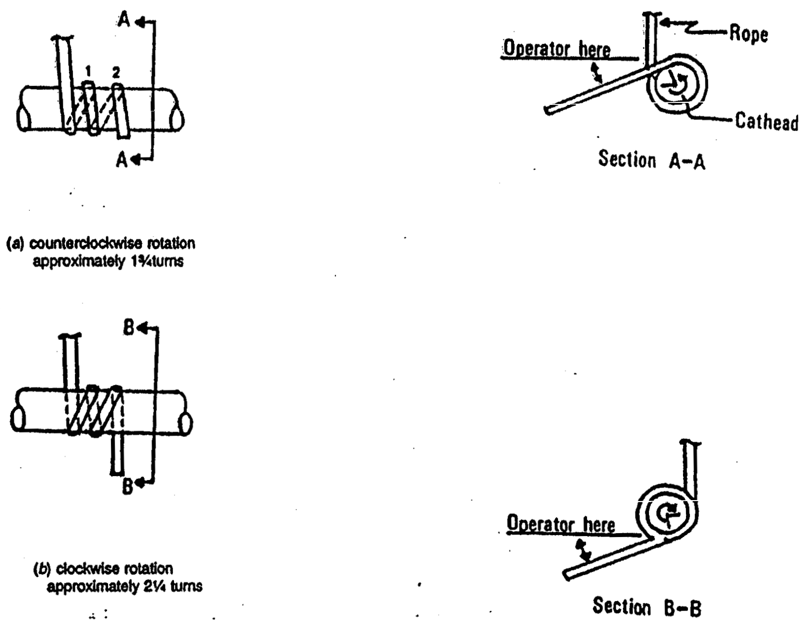


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝in. (41.2 mm) and an inside diameter of 1⅛in. (28.5 mm).

NOTE 2—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

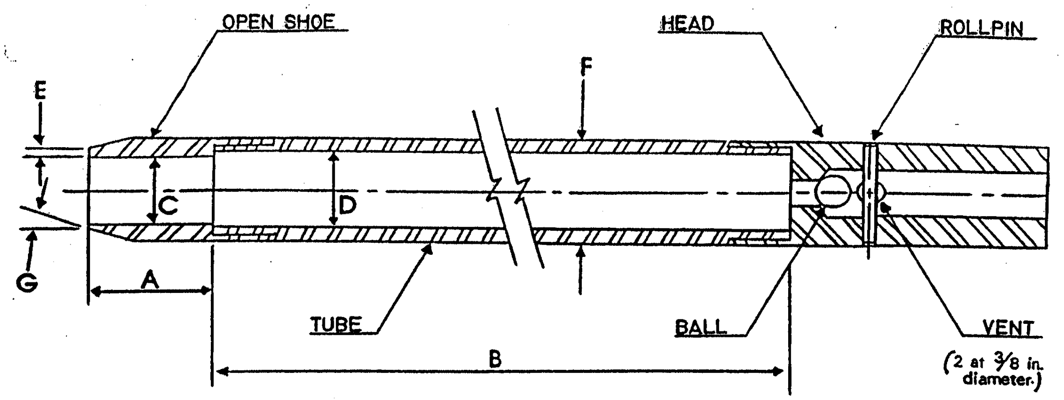
5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 3—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall

D 1586



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 – 0.00 in. (38.1 ± 1.3 – 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 – 0.00 in. (50.8 ± 1.3 – 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 4—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean stable hole before insertion of the sampler and assures that penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.
6.2.2 Continuous flight hollow-stem auger method.
6.2.3 Wash boring method.
6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 5—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is given in Test Method D 4633.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

ARCADIS

Attachment 3

Standard Protocol and Basic Operation of the Innov-X Systems X-Ray Fluorescence (XRF) Spectrometers and Standard Protocol and Basic Operation of the Thermo Niton XRF Analyzer

Attachment 3: Standard Protocol and Basic Operation of the Innov-X Systems X-Ray Fluorescence (XRF) Spectrometers

Soil Analysis

The Innov-X analyzer can be used to analyze in-situ (directly on the ground), bagged, or prepared soil samples. This attachment summarizes U.S. Environmental Protection Agency (USEPA) Method 6200, which is the standard protocol for field screening. It also provides information on prepared sample testing. Further details on the operation of the XRF device can be found in the instruction manual included with the XRF.

I. Check Standards

It is recommended that a check standard is measured after each standardization and periodically throughout the day. Innov-X provides several National Institute of Standards and Technology (NIST) certified standards for verification. At least one standard should be measured for a minimum of 1 minute. Elemental concentrations for elements of interest plus or minus the error on the reading should be within 20 percent of the standard value.

II. Sample Preparation

A. In-Situ Testing

In-situ testing is performed by pointing the analyzer at the ground. Any grass or large rocks should be cleared away and the analyzer should be held such that the front of the probe head is held flush to the ground. Because dirt can accumulate on the analyzer window, it is recommended that the window be wiped clean after each analysis or a clean layer of plastic be placed between the window and the ground between each use. The window should also be checked to ensure it is not ripped or punctured.

B. Bagged or Prepared Sample Testing

Samples will be collected and homogenized in individual polyethylene bags (Ziploc®-type). When analyzing bagged samples, ensure that sufficient sample exists in the bag to completely cover the window with a sample thickness of a minimum of 0.5 inch.

C. Testing in Soil Mode

After the instrument has been standardized, testing can begin. The red warning light on the top of the instrument will blink, indicating X-rays are being emitted. The screen will display the words “Test in progress” and the time elapsed. The word “Testing” will blink on and off in the lower right-hand corner of the screen.

After a minimum time has elapsed, intermediate results will be displayed on the screen. Until this minimum time has elapsed, the words “WAITING FOR DATA” will appear instead. This minimum time can be set by the user. Each line of the results display shows the name of an element, its calculated concentration, and the error on the measurement. When the measurement is complete, the results screen will open, displaying the final results of the measurement.

D. Results View Menu

The standard screen displays the concentration (in parts per million [ppm]) and error in measurement for detected elements, followed by the list of non-detected elements with the calculated limit of detection for each element for that test.

III. Soil Mode Options

The length of tests is user settable. Users may select a minimum and maximum testing time, as well as choose from a variety of test-end conditions. Four options exist for the test-end criteria in soil mode. Depending on your application, the test can end manually, at a preset testing time, or when the uncertainty in the measurement is within a specified relative standard deviation of the reading. Additionally, an action level can be set for a single element. As soon as the measuring statistics are good enough to ensure that the reading is above, below, or at the action level, the test will end automatically. This allows for very rapid tests for elements that are well above or below an action level.

IV. Basic Operation for the Innov-X Systems Analyzer

All Innov-X Systems Analyzers are shipped with a standard set of reference alloy standards that makes it possible to identify approximately 200 common alloys (35 in FastID). It is recommended that the 316 standardization piece be analyzed first.

A. Install a freshly charged battery in the instrument.

B. Turn on the analyzer by pressing the power switch located on the base of the instrument.

C. Verify that the iPAQ (a type of personal digital assistant [PDA]) is correctly seated on the top of the unit. If the iPAQ is properly connected, the amber light on the upper right side of the iPAQ next to the power button will blink, indicating that the iPAQ is receiving charge from the analyzer. If the iPAQ is not on, turn it on by pressing the power button on the upper right side of the iPAQ.

D. Start the Innov-X Systems Software by selecting the Start Menu from the upper left-hand corner of the iPAQ screen. Select the Innov-X Systems Software from the drop-down menu.

E. A notice will appear reminding the user that this instrument produces ionizing radiation and requires a trained user. Select START to start the Innov-X Systems Software package. Selecting QUIT will exit the Innov-X Software.

F. The Main Menu will open. Tap the name of the Mode to open it. First-time users should use Analytical Mode.

G. There may be a brief pause while the instrument loads the various parameters needed for operation. While this occurs, an icon will appear in the center of the iPAQ screen.

H. Once the analysis mode has been selected, the instrument will go through a 1-minute hardware initiation during which the electronics will stabilize and the detector cooling will be initialized.

I. The message “Standardization Required” will display. Please place a standardization clip over the analyzer window. Then “tap here to standardize” will appear. Standardization is required before testing can begin. Place the standardization clip in front of the analyzer window. Tap the message box. Standardization will take approximately 1 minute; a status bar will be displayed throughout the measurement. Standardization is described in more detail in the instruction manual included with the instrument.

J. When standardization is complete, the resolution of the analyzer will be displayed. Record this value in the field notebook. Then tap “OK” to acknowledge and clear this screen.

K. The analyzer is now ready to take a measurement. The Trigger lock must be unlocked before pulling the trigger.

L. A sample name or sample identifying characteristics can be entered by selecting Edit Test Info. Enter information in text fields, or select items from drop-down menus. Select “OK” to close the Test Info window. The format of this screen may vary depending on user settings.

M. Hold the analyzer to the sample to be analyzed. Make sure the sample is as flush against the analyzing window as is possible. Start the analysis by pulling and holding the trigger. Releasing the trigger will abort the test.

   1. After an analysis is started, the message “Test in Progress” will appear, followed by the number of seconds elapsed during the measurement. For the duration of the test, the red light on top of the instrument will blink, and the “testing” icon will appear in the lower right corner of the iPAQ.

   2. When the measurement is complete, the analysis screen will display the word Calculating. There may be a slight delay while the instrument calculates the results. This will be indicated by the appearance of a “calculating” icon in the lower right-hand corner of the iPAQ screen. Because the FastID calculation is very rapid, this icon is rarely seen; however, there may be a few-second calculation for Analytical Mode.

   3. When the calculations are complete, there will be a slight delay the first time the results screen is opened. An icon will appear in the center of the screen during this delay. This indicates that the results program is loading and re-indexing all saved results.

N. The results screen will display the results. The information displayed on the screen may be changed by selecting one of the options under the View menu.

O. Once the results screen is open, subsequent readings may be started by depressing the trigger.

Attachment 3 (Continued): Standard Protocol and Basic Operation of the Thermo Niton XRF Analyzer

The Thermo Niton Analyzer can be used to analyze in-situ (directly on the ground), bagged, or prepared soil samples. This attachment summarizes USEPA Method 6200, which is the standard protocol for field screening. It also provides information on prepared sample testing. Further details on the operation of the XRF device can be found in the instruction manual included with the XRF.

I. Check Standards

It is recommended that check standards are measured after each standardization and if the instrument is used for the whole day, the instrument should be checked again half-way through the day. Niton provides NIST-certified standards for verification. At least two standards should be measured for a minimum of 15 seconds each. Elemental concentrations for elements of interest plus or minus the error on the reading should be within 20 percent of the standard value.

II. Sample Preparation

A. In-Situ Testing

In-situ testing is performed by pointing the analyzer at the ground. Any grass or large rocks should be cleared away and the analyzer should be held such that the front of the probe head is flush against the ground. Because dirt can accumulate on the analyzer window, it is recommended that the window be wiped clean after each analysis or a clean layer of plastic be placed between the window and the ground between each use. The window should also be checked to ensure it is not ripped or punctured.

B. Bagged or Prepared Sample Testing

Samples will be collected and homogenized in individual polyethylene bags (Ziploc®-type). When analyzing bagged samples, ensure that sufficient sample exists in the bag to completely cover the window with a sample thickness of a minimum of 0.5 inch.

C. Testing In Soil Mode

After the instrument has been standardized, testing can begin. When the trigger is depressed, a red warning light on the back and on each side toward the front of the instrument will blink, indicating X-rays are being emitted. The screen will originally display the words "Starting X-Ray Tube". After a minimum time has elapsed, intermediate results will be displayed on the screen with the time elapsed. Each line of the results display shows the name of an element, its calculated concentration, and the error on the measurement. When the measurement is complete, the final results will be displayed.

D. Results View Menu

The standard screen displays the concentration (in ppm) and error in measurement for detected elements, followed by the list of non-detected elements with the calculated limit of detection for each element for that test.

III. Soil Mode Options

The length of tests is user settable. Users may select a maximum testing time as well as choose from a variety of test-end conditions. Three options exist for the test-end criteria in soil mode. Depending on your application, the test can end manually or at a preset testing time. Additionally, an action level can be set for a single element. As soon as the measuring statistics are good enough to ensure that that the reading is above, below, or at the action level, the test will end automatically. This allows for very rapid tests for elements that are well above or below an action level.

IV. Basic Operation for the Thermo Niton Analyzer

All Thermo Niton Analyzers are shipped with a standard set of reference alloy standards that makes it possible to identify approximately 200 common alloys (35 in FastID).

A. Attach a freshly charged battery onto the handle of the instrument.

B. Turn on the analyzer by pressing the left power switch located below the screen on the instrument.

C. The instrument will count down and then a screen will appear requiring you to touch the screen to continue. Do so.

D. The next screen is a warning to the user that the instrument produces radiation when the lights are flashing. Select YES that you understand this and wish to continue.

E. Next you will need to enter a password. The standard password is 1, 2, 3, 4. Then push “E” for enter.

F. Now the Main Menu should appear. First-time users should tap the “Mode” box to ensure that the instrument is in Standard Bulk Mode. After entering the Mode menu, tap “Bulk Sample Mode” and then “Standard Bulk Mode”.

G. Navigate back to the main menu and tap on the “Utilities” box. Then click on “Calibrate” and then “Calibrate detector”. It is important to calibrate the detector prior to soil testing. The process may take a few minutes while the instrument is calibrating the detector and the sensors involved in receiving the reflected X-rays. During this process, a bar graph will appear on the screen.

H. When calibration is complete, the resolution (Res) of the analyzer will be displayed. Write down this number in your field notes.

I. Next click on “Nav” toward the top of the screen and select “main” from the drop-down menu. This should navigate you back to the main menu.

J. From the main menu, tap the “Test” box and then tap “Data Entry”. The analyzer is now ready to take a measurement.

K. Hold the analyzer to the sample to be analyzed. Make sure the sample is as flush against the analyzing window as is possible. Start the analysis by pulling and holding the trigger. Releasing the trigger will abort the test.

    1. After an analysis is started, the message “Starting X-Ray Tube” will appear, followed by the number of seconds elapsed during the measurement. For the duration of the test, a red light on the back and on each side toward the front of the instrument will blink.

2. When the calculations are complete, there will be a slight delay the first time the results screen is opened.

L. The Results screen will display the results. The information displayed on the screen may be changed by selecting one of the options under the Common Set-up menu.

M. Once the results screen is open, subsequent readings may be started by depressing the trigger.

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Attachment 4

Pre-packed Screen Monitoring Well Installation Procedures

Attachment 4: Pre-packed Screen Monitoring Well Installation Procedures

Prior to commencing work, all underground utilities will be located by the Tennessee One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with ExxonMobil's subsurface drilling policies, each boring location will be hand cleared to a minimum of 5 feet below ground (ft bgs) surface using in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas.

Direct-push drilling is the preferred technique for subsurface sampling because it minimizes the generation of soil cuttings and the introduction of foreign fluids into the probehole. Direct-push techniques are also known to cause less disturbance to the natural formations. A pre-packed screen is an assembly consisting of an inner slotted screen surrounded by a wire mesh sleeve that acts as a support for filter media. Because the filter media is placed around the screen at the surface, pre-packed screens allow more control over the filter pack grain size and eliminate bridging of the filter media. Use of pre-packed screens may make it possible to use finer grained filter pack sand than is used for conventional well filter pack, providing less turbid samples.

I. Temporary Monitoring Well Installation using Pre-Packed Screens

The prepacked screens are constructed in 3- to 5-foot length sections, which have an outside diameter of about 1.5 to 2.0 inches and an inside diameter of 0.75 to 1.0 inch. The screen length will be determined in the field, but will not exceed 10 feet in length. The inner component of the prepacked screens consists of a flush-threaded, 0.5-inch Schedule 40 polyvinyl chloride (PVC) with 0.01-inch slots. The outer component of the screen is stainless steel wire mesh with a pore size of 0.011 inch. The space between the inner slotted pipe and outer wire mesh is filled with 20/40 silica sand.

The specific procedure for installing Geoprobe® pre-packed screen monitoring wells is as follows. Equivalent pre-packed screen materials can also be used.

- The installation begins by advancing a 2.25-inch outside diameter probe rods to depth with a direct-push machine.

- Pre-packed screens are then assembled and installed through the 1.5-inch inside diameter of the probe rods using corresponding 0.75-inch Schedule 40 PVC riser.

- The pre-pack tool string is attached to an expendable anchor point with a locking connector that is threaded to the bottom of the leading screen. Once the connector is locked onto the anchor point, the rod string is slowly retracted until the lower end of the rods is approximately 3 feet above the top prepack. A threaded bottom plug with an expendable point is another way to set the well.

- A minimum 2-foot sand barrier will be installed above the top prepack to avoid contaminating the well screens with bentonite or cement during installation (if the wells are converted to permanent wells). If the formation is stable and does not collapse around the riser as the rod string is retracted, environmental grade 20/40 mesh sand may be installed through the probe rods to provide the minimum 2-foot barrier.

Groundwater samples can be collected with a check valve assembly (with 3/8-inch outside diameter poly tubing), a stainless steel mini-bailer assembly, or a peristaltic pump when appropriate. Groundwater samples collected from temporary wells using pre-packed screens should be considered screening-level data, suitable for obtaining a general understanding of groundwater quality.

II. Conversion of Temporary to Permanent Monitoring Wells

The following steps may be followed to convert a temporary well to a permanent well:

- Granular bentonite or bentonite slurry will be installed in the annulus to form a well seal. A high-pressure grout pump may be used as a tremie cement/bentonite slurry to fill the well annulus.

- The grout mixture should be installed with a tremie tube from the bottom up to accomplish a tight seal without voids.

- These wells will be allowed to equilibrate overnight and groundwater measurements will be collected to determine groundwater flow direction.

Since the Site is underlain by formations having high silt contents, a PVC casing may be used during well installation in order to avoid potential formation collapse. Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least

1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation both on the inner and outer well casings. A typical Geoprobe® overburden monitoring well detail is shown on Figures 4-1 and 4-2.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

III. Conversion of Temporary to Double-Cased Permanent Monitoring Wells

Double-cased monitoring wells will be installed to assess groundwater where the borings penetrate soil and/or groundwater zones potentially containing elevated levels of constituents of interest. An outer casing will be used to minimize the potential for the drilling process to draw or carry contamination down. Hollow-stem auger drilling methods or a Geoprobe® with the ability to advance a longer isolation casing will be used to install the wells. A typical Geoprobe® double-cased monitoring well detail is shown on Figures 4-3 and 4-4.

The specific procedure for installing double-cased Geoprobe® monitoring wells is as follows. Equivalent direct-push techniques can also be used.

- The borehole for the outer casing will be advanced with a large-diameter hollow-stem auger or Geoprobe® device to the required depth. Soil will be continuously sampled using a 2-inch diameter split-spoon sampler and visually classified by the supervising scientist.

- Then, a large-diameter PVC outer casing will be installed through the hollow-stem augers or Geoprobe® device. To complete the installation, the outer casing will be hydraulically pushed approximately 1 foot beyond the bottom of the boring. The annular space of the borehole will then be filled with a cement/bentonite grout mixture using a tremie pipe installed to the bottom of the borehole.

- The cement/bentonite grout in the annulus will be allowed to cure for at least 24 hours before the boring is advanced.

- After the grout has cured for a minimum of 24 hours, the boring will be advanced through the outer casing using a smaller-diameter hollow-stem auger or Geoprobe® device to the required depth.

- During advancement of the boring, soil will be continuously sampled with a 2-inch diameter split-spoon sampler, or 4-foot Macrocore sampler, and will be visually classified by the supervising scientist.

The Geoprobe® well will be installed in accordance with the procedures described in Section I.

Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least 1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation on the outer well casing.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

IV. Development

Development will not be performed within 24 hours of the monitoring well installation. Development will be accomplished by surging and evacuating water by slow pumping. As an alternative to surging and pumping, shallow overburden wells may be developed by using a new, disposable hand bailer to entrain the water and fine-grained solids in and around the well screen and remove these materials. Each well will be developed until turbidity is reduced to 10 nephelometric turbidity units (NTUs) or less. In the event that the wells cannot be developed to 10 NTUs, development will proceed until three consecutive measurements of pH, conductivity, and temperature (taken at 5-minute intervals) agree within 10 percent.

Materials for well development include:

- Appropriate health and safety equipment;
- Appropriate cleaning equipment;
- Bottom-loading bailer;
- Polypropylene rope;
- Plastic sheeting;
- pH, conductivity, and temperature meters;
- Nephelometric turbidity meter;
- Graduated buckets;
- Disposable gloves;
- Drums to collect purge fluids;
- Pump/tubing/foot valve/surge block; and
- Generator.

The procedure for developing a well using the pumping method is outlined below:

When developing a well using the pumping method, new cleaned polypropylene tubing equipped with a foot valve and surge block will be extended to the screened portion of the well. The diameter of the surge block will be within 0.5 inch of the well diameter. The tubing will be connected to a hydrolift-type pumping system that allows up and down movement of the surge block. The tubing will also be manually lifted and lowered within the screened interval. The pumping rate will be about two times the anticipated well purging rate. Surging will be repeated as many times as necessary within the well screen interval until the groundwater is relatively clear. Any tubing will be disposed of between wells; clean, new tubing will be used at each well.

Detailed procedures for groundwater well development are as follows:

1. Use appropriate safety equipment.

2. All equipment entering each monitoring well will be cleaned as specified in Attachment 10.

3. Attach appropriate pump and lower tubing into well.

4. Turn on pump. If well runs dry, shut off pump and allow to recover.

5. Surging by raising and lowering the tubing in the well will be performed several times to pull in fine-grained materials.

6. Steps 4 and 5 will be repeated until groundwater is relatively silt free.

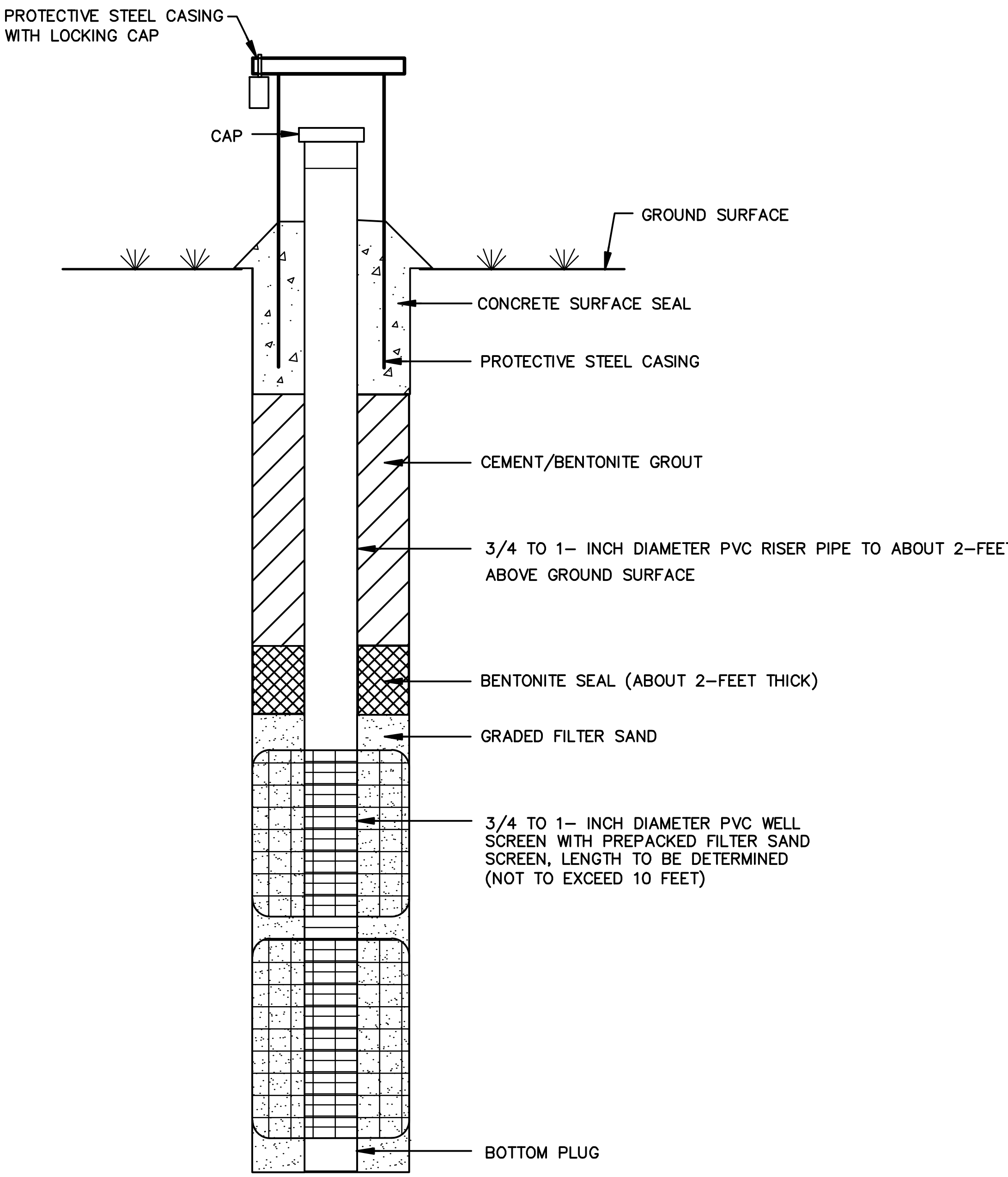
7. Step 6 will be repeated until entire well screen has been developed.

V. Survey

A field survey control program will be conducted using standard instrument survey techniques to document the well location, as well as the ground, inner casing, and outer casing elevations, to the North American Vertical Datum of 1988.

VI. Equipment Cleaning

Downhole equipment will be cleaned with high-pressure steam cleaning equipment using a tap water source. Downhole equipment will be cleaned prior to use on the Site, between each monitoring well location, and at the completion of the drilling prior to leaving the Site as discussed in Attachment 10.



NOT TO SCALE

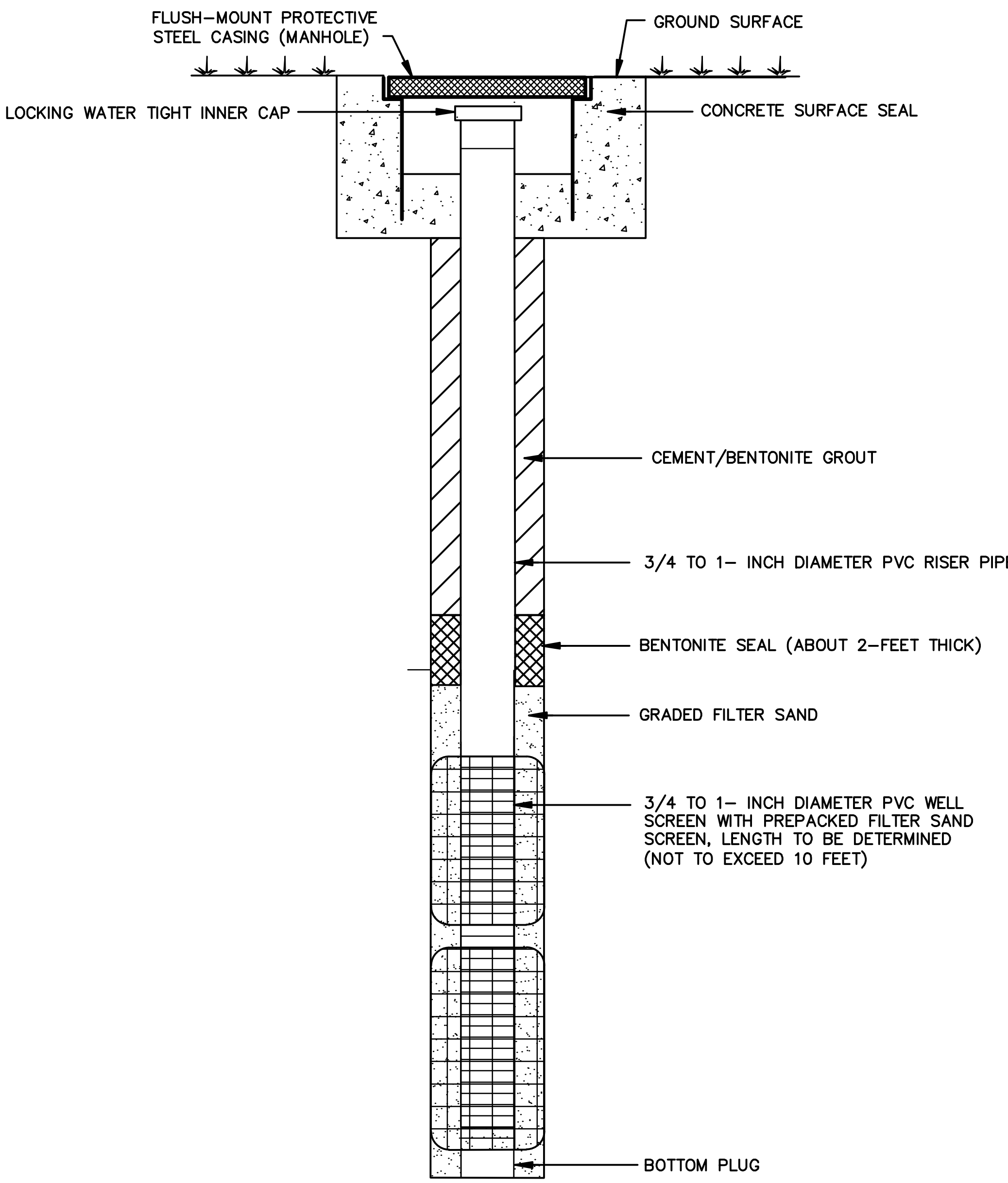
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL GEOPROBE ABOVE-GROUND OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
4-1

CITY:CARY DIV/GROUP:4 4-1 DB:LELLIS/TFATTO LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Cary\ACT\B0085789\1201\00002\DWG\85789D01.DWG LAYOUT: 1 SAVED: 4/16/2012 1:23 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 4/16/2012 1:25 PM BY: ELLIS, LEKOREY
XREFS: IMAGES: PROJECTNAME: ----



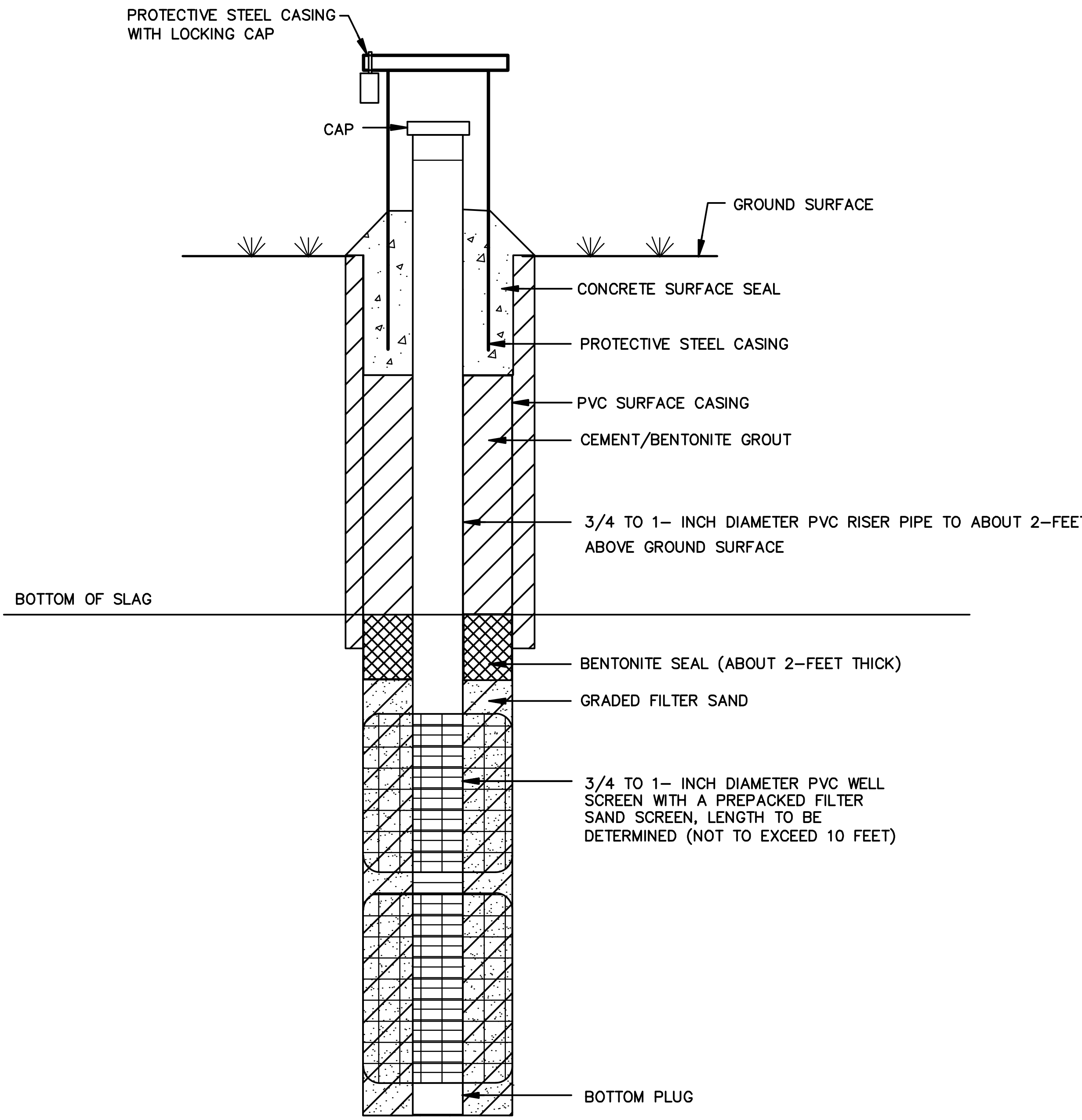
NOT TO SCALE

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL GEOPROBE FLUSH-MOUNT OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
4-2



NOT TO SCALE

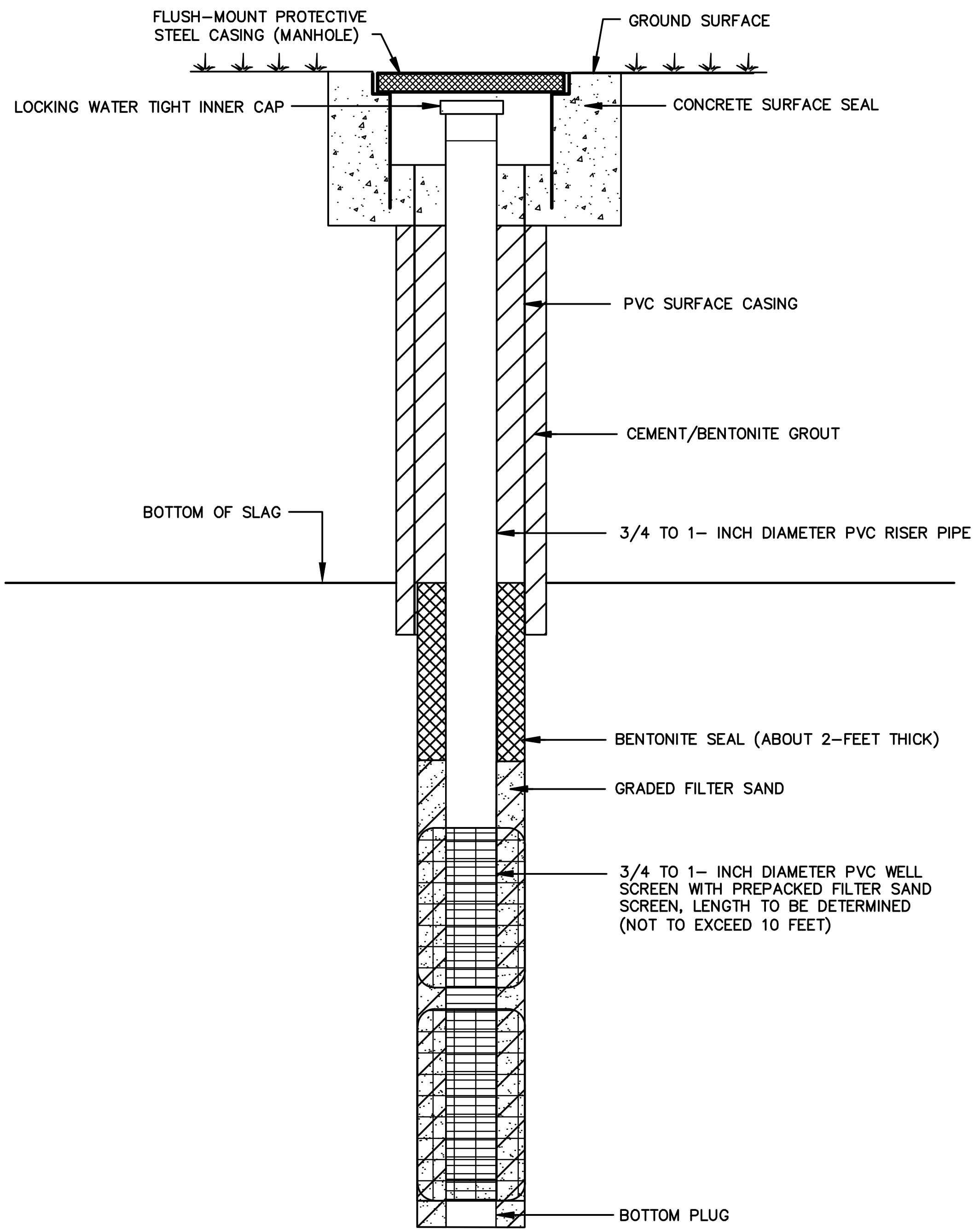
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL GEOPROBE ABOVE-GROUND DOUBLE-CASED OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
4-3

CITY:CARY DIV/GROUP:41 DB:LELLIS/TFATTO LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Cary\ACT\B0085789\1201\00002\DWG\85789D03.DWG LAYOUT: 4-3 SAVED: 4/16/2012 1:23 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 4/16/2012 1:25 PM BY: ELLIS, LEKOREY
XREFS: IMAGES: PROJECTNAME: ----



NOT TO SCALE

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL GEOPROBE FLUSH-MOUNT DOUBLE-CASED OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
4-4

Attachment 5

Traditional Groundwater Monitoring Well Installation and Development Procedures

Attachment 5: Traditional Groundwater Monitoring Well Installation and Development Procedures

Prior to commencing work, all underground utilities will be located by the Tennessee One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with ExxonMobil's subsurface drilling policies, each boring location will be hand cleared to a minimum of 5 feet below ground (ft bgs) surface using in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas.

I. Monitoring Wells in Overburden

Monitoring wells will be installed by placing the screen and casing assembly with bottom cap into the auger string once the screen interval has been selected. At that time, a washed silica sand pack will be placed in the annular space opposite the screen to 1 to 2 feet above the top of the screen. A graded filter sand pack appropriate to the size of the screened soil interval will be used. The upper 0.5 foot of the sand pack will consist of #00 morie sand to impede bentonite infiltrating into the sand pack. Hydrated bentonite will be added to the annulus between the casing and the borehole wall for at least 2 feet. A cement/bentonite grout will then be added above the bentonite during the extraction of the augers to ground surface. For each 94-pound bag of cement, 6 to 7 gallons of water and approximately 7 pounds of granular or powdered bentonite will be added to make the grout mixture. During placement of sand and bentonite, frequent measurements will be made to check the height of the sand pack and thickness of bentonite by a weighted tape measure.

Monitoring wells will be constructed of 2-inch polyvinyl chloride well screen and riser. The well screen will be installed from approximately 2 feet above the water table to just above the anticipated aquitard depth with a maximum screen length of 15 feet. During advancement of the boring, soil will be continuously sampled with a 2-inch diameter split-spoon sampler, or 4-foot Macrocore sampler, and will be visually classified by the supervising scientist.

Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least 1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation both on the inner and outer well casings. A typical overburden monitoring well detail is shown on Figures 5-1 and 5-2.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

II. Development

All monitoring wells will be developed of fine-grained materials that may have collected in the sand filter pack placed around the screen during installation. Development will not be performed within 24 hours of the monitoring well installation of protective casing and concrete pad. Development will be accomplished by surging and evacuating water by slow pumping. As an alternative to surging and pumping, shallow overburden wells may be developed by using a new, disposable hand bailer to entrain the water and fine-grained solids in and around the well screen and remove these materials. Each well will be developed until turbidity is reduced to 10 nephelometric turbidity units (NTUs) or less. In the event that the wells cannot be developed to 10 NTUs, development will proceed until three consecutive measurements of pH, conductivity, and temperature (taken at 5-minute intervals) agree within 10 percent.

Materials for well development include:

- Appropriate health and safety equipment;
- Appropriate cleaning equipment;
- Bottom-loading bailer;
- Polypropylene rope;
- Plastic sheeting;
- pH, conductivity, and temperature meters;
- Nephelometric turbidity meter;
- Graduated buckets;

- Disposable gloves;
- Drums to collect purge fluids;
- Pump/tubing/foot valve/surge block; and
- Generator.

The procedure for developing a well using the pumping method is outlined below:

When developing a well using the pumping method, new cleaned polypropylene tubing equipped with a foot valve and surge block will be extended to the screened portion of the well. The diameter of the surge block will be within 0.5 inch of the well diameter. The tubing will be connected to a hydrolift-type pumping system that allows up and down movement of the surge block. The tubing will also be manually lifted and lowered within the screened interval. The pumping rate will be about two times the anticipated well purging rate. Surging will be repeated as many times as necessary within the well screen interval until the groundwater is relatively clear. Any tubing will be disposed of between wells; clean, new tubing will be used at each well.

Detailed procedures for groundwater well development are as follows:

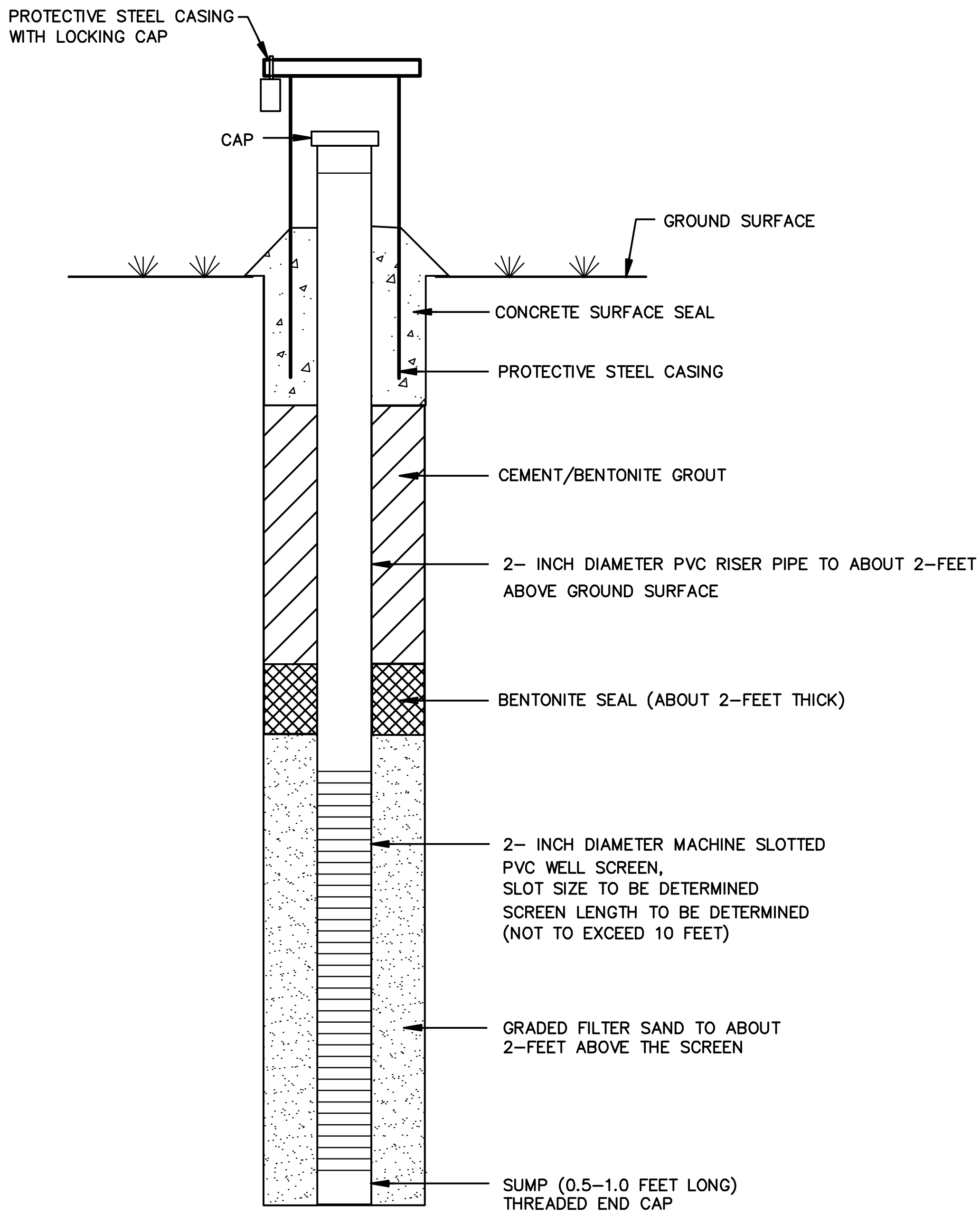
1. Use appropriate safety equipment.
2. All equipment entering each monitoring well will be cleaned as specified in Attachment 10.
3. Attach appropriate pump and lower tubing into well.
4. Turn on pump. If well runs dry, shut off pump and allow to recover.
5. Surging by raising and lowering the tubing in the well will be performed several times to pull in fine-grained materials.
6. Steps 4 and 5 will be repeated until groundwater is relatively silt free.
7. Step 6 will be repeated until entire well screen has been developed.

III. Survey

A field survey control program will be conducted using standard instrument survey techniques to document the well location, as well as the ground, inner casing, and outer casing elevations, to the North American Vertical Datum of 1988.

IV. Equipment Cleaning

Downhole equipment will be cleaned with high-pressure steam cleaning equipment, flushing, and or manual cleaning using a tap water source. Downhole equipment will be cleaned prior to use on the Site, between each monitoring well location, and at the completion of the drilling prior to leaving the Site as discussed in Attachment 10.



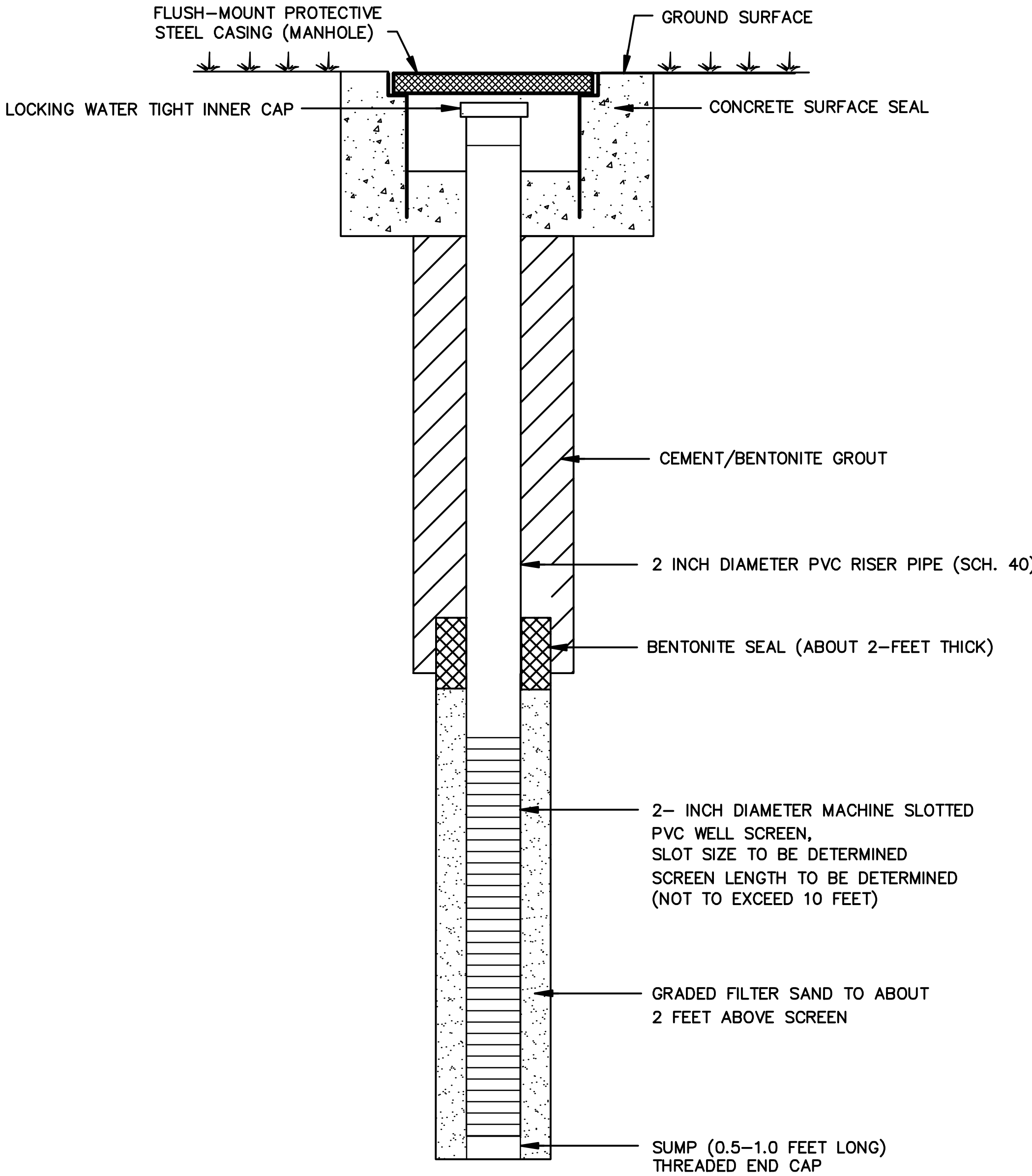
NOT TO SCALE

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL ABOVE-GROUND OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
5-1



NOT TO SCALE

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL FLUSH-MOUNT OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
5-2

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G:\ENVCAD\Cary\ACT\B0085789\1201\00002\DWG\85789D06.DWG LAYOUT: 5-2 SAVED: 4/16/2012 1:23 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 4/16/2012 1:26 PM BY: ELLIS, LEKOREY
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Attachment 6

Double-Cased Groundwater Monitoring Well Installation and Development Procedures

Attachment 6: Double-Cased Groundwater Monitoring Well Installation and Development Procedures

Prior to commencing work, all underground utilities will be located by the Tennessee One Call Center, by field personnel with appropriate devices, and/or by a private utility locator. Also, consistent with ExxonMobil's subsurface drilling policies, each boring location will be hand cleared to a minimum of 5 feet below ground (ft bgs) surface using in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas.

I. Monitoring Wells in Unconsolidated Sand

Double-cased monitoring wells will be installed to assess groundwater where the borings penetrate soil and/or groundwater zones potentially containing elevated levels of constituents of interest. An outer casing will be used to minimize the potential for the drilling process to draw or carry contamination down. Hollow-stem auger drilling methods will be used to install the wells. A typical overburden double-cased monitoring well detail is shown on Figures 6-1 and 6-2.

The specific procedure for installing double-cased monitoring wells is as follows:

- The borehole for the outer casing will be advanced with a nominal 8¼-inch or 12¼-inch inner-diameter hollow-stem auger to the required depth. Soil will be continuously sampled using a 2-inch diameter split-spoon sampler and visually classified by the supervising scientist.

- Then, a 6-inch or 10-inch inner-diameter polyvinyl chloride (PVC) outer casing will be installed through the 8¼-inch or 12¼-inch inner-diameter hollow-stem auger. To complete the installation, the outer casing will be hydraulically pushed approximately 1 foot beyond the bottom of the boring. The annular space of the borehole will then be filled with cement/bentonite grout mixture using a tremie pipe installed to the bottom of the borehole.

- The cement/bentonite grout in the annulus will be allowed to cure for at least 24 hours before the boring is advanced.

- After the grout has cured for a minimum of 24 hours, the boring will be advanced through the outer casing using 4¼-inch inner-diameter hollow-stem augers to the required depth.

- During advancement of the boring, soil will be continuously sampled with a 2-inch diameter split-spoon sampler, or 4-foot Macrocore sampler, and will be visually classified by the supervising scientist.

Monitoring wells will then be installed by placing the screen and casing assembly with bottom cap into the borehole once the screen interval has been selected. At that time, a washed silica sand pack will be placed in the annular space opposite the screen to 1 to 2 feet above the top of the screen. A graded filter sand pack appropriate to the size of the screened soil interval will be used. The upper 0.5 foot of the sand pack will consist of #00 morie sand to impede bentonite infiltrating into the sand pack. Bentonite will be added to the annulus between the casing and the borehole wall for at least 2 feet. A cement/bentonite grout will then be added above the bentonite to ground surface. For each 94-pound bag of cement, 6 to 7 gallons of water and approximately 7 pounds of granular or powdered bentonite will be added to make the grout mixture. During placement of sand and bentonite, frequent measurements will be made to check the height of the sand pack and thickness of bentonite by a weighted tape measure. Monitoring wells will be constructed of 2-inch Schedule 40 PVC riser and 2-inch Schedule 40 well screen.

Wells will be completed with a flush-mount (curb box) cover when installed in areas exposed to vehicle access or in residential areas. In areas not exposed to vehicle access, a vented protective steel casing will be located over the riser casing extending at least 1.5 feet below grade and 2 to 3 feet above grade secured by a neat concrete seal. The concrete seal will be flush with the ground surface and will extend approximately 1.5 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently to drain water away from the well. Monitoring wells will be labeled with the appropriate designation on the outer well casing.

The supervising geologist will specify the monitoring well designs to the drilling contractor before installation.

The supervising geologist is responsible for recording the exact construction details as relayed by the drilling contractor and actual measurements. Both the supervising geologist and drilling contractor are responsible for tabulating all materials used, such as casing footage and screen or bags of bentonite, cement, and sand.

II. Development

All monitoring wells will be developed of fine-grained materials that may have collected in the sand filter pack placed around the screen during installation. Development will not be performed within 24 hours of the monitoring well installation. Development will be accomplished by surging and evacuating water by slow pumping. As an alternative to surging and pumping, shallow overburden wells may be developed by using a new, disposable hand bailer to entrain the water and fine-grained solids in and around the well screen and remove these materials. Each well will be developed until turbidity is reduced to 10 nephelometric turbidity units (NTUs) or less. In the event that the wells cannot be developed to 10 NTUs, development will proceed until three consecutive measurements of pH, conductivity, and temperature (taken at 5-minute intervals) agree within 10 percent.

Materials for well development include:

- Appropriate health and safety equipment;
- Appropriate cleaning equipment;
- Bottom loading bailer;
- Polypropylene rope;
- Plastic sheeting;
- pH, conductivity, and temperature meters;
- Nephelometric turbidity meter;
- Graduated buckets;
- Disposable gloves;
- Drums to collect purge fluids;
- Pump/tubing/foot valve/surge block; and
- Generator.

The procedure for developing a well using the pumping method is outlined below:

When developing a well using the pumping method, new cleaned polypropylene tubing equipped with a foot valve and surge block will be extended to the screened portion of the well. The diameter of the surge block will be within 0.5 inch of the well diameter. The tubing will be connected to a hydrolift-type pumping system that allows up and down movement of the surge block. The tubing will also be manually lifted and lowered within the screened interval. The pumping rate will be about two times the anticipated well purging rate. Surging will be repeated as many times as necessary within the well screen interval until the groundwater is relatively clear. Any tubing will be disposed of between wells; clean, new tubing will be used at each well.

Detailed procedures for groundwater well development are as follows:

1. Use appropriate safety equipment.

2. All equipment entering each monitoring well will be cleaned as specified in Attachment 10.

3. Attach appropriate pump and lower tubing into well.

4. Turn on pump. If well runs dry, shut off pump and allow to recover.

5. Surging by raising and lowering the tubing in the well will be performed several times to pull in fine-grained materials.

6. Steps 4 and 5 will be repeated until groundwater is relatively silt free.

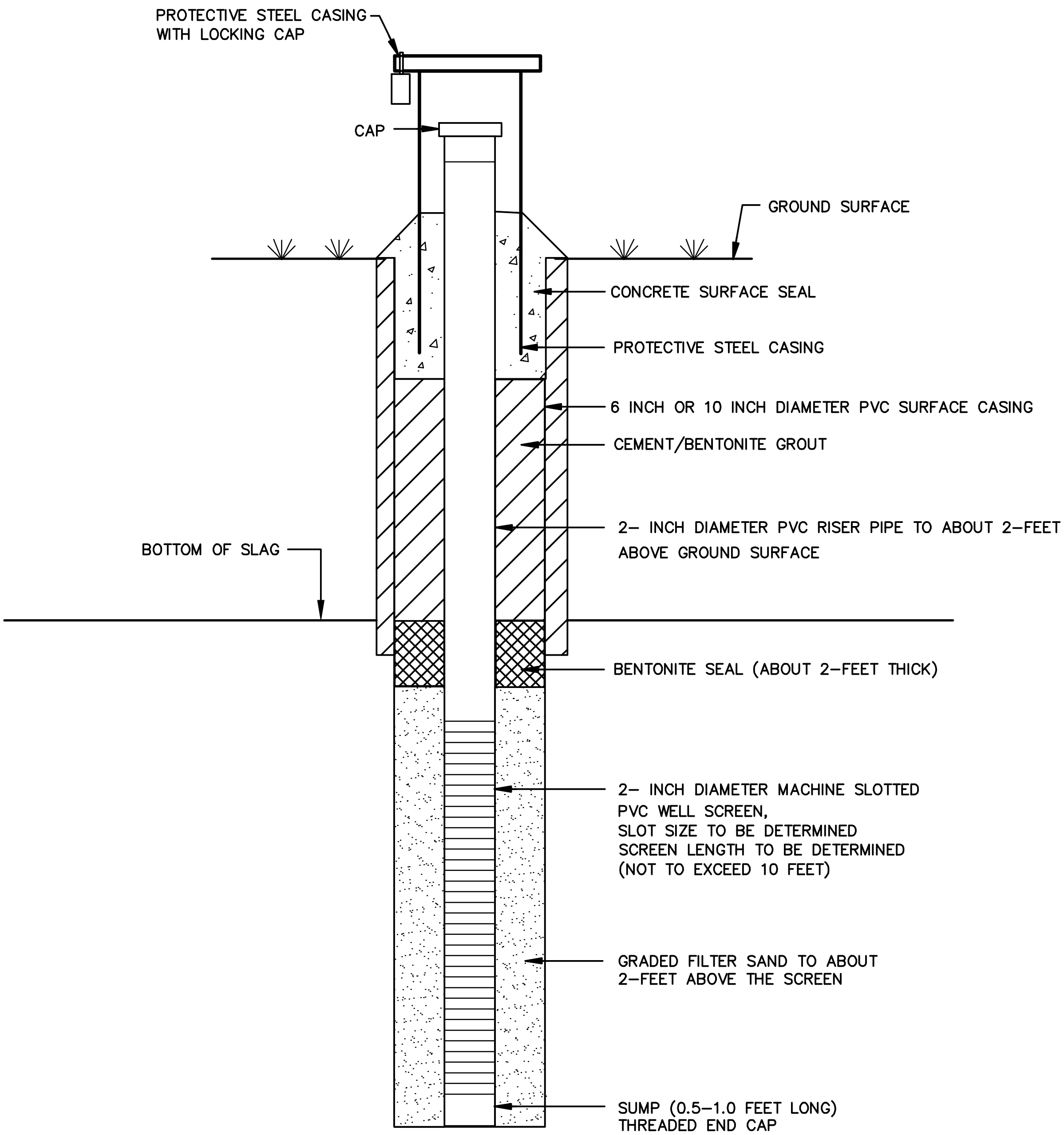
7. Step 6 will be repeated until entire well screen has been developed.

III. Survey

A field survey control program will be conducted using standard instrument survey techniques to document the well location, as well as the ground, inner casing, and outer casing elevations, to the North American Vertical Datum of 1988.

IV. Equipment Cleaning

Downhole equipment will be cleaned with high-pressure steam cleaning equipment, flushing, and/or manual cleaning using a tap water source. Downhole equipment will be cleaned prior to use on the Site, between each monitoring well location, and at the completion of the drilling prior to leaving the Site as discussed in Attachment 10.



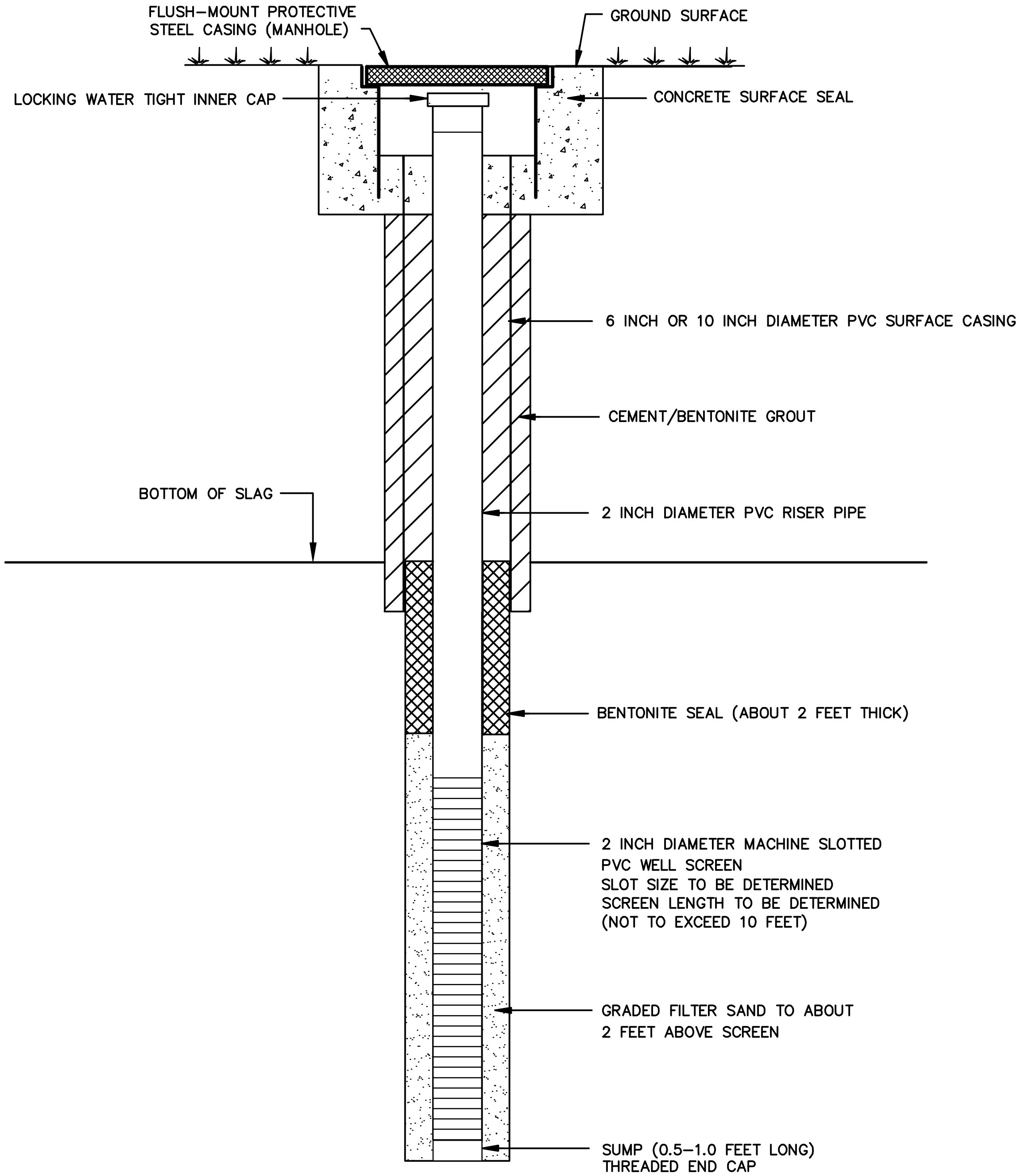
NOT TO SCALE

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL ABOVE-GROUND DOUBLE-CASED OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

ARCADIS

FIGURE
6-1



NOT TO SCALE

EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MEMPHIS, SHELBY COUNTY, TENNESSEE
FIELD SAMPLING PLAN

TYPICAL FLUSH-MOUNT DOUBLE-CASED OVERBURDEN MONITORING WELL CONSTRUCTION DETAIL

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FIGURE
6-2

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Attachment 7

Groundwater Sample Collection Procedures

Attachment 7: Groundwater Sample Collection Procedures

I. Introduction

Groundwater samples will be collected using the low-flow (minimal drawdown) technique (Puls and Barcelona 1996) for newly installed monitoring wells. The use of low-flow purging and sampling will minimize the stresses (pressure gradients, drawdown, heating, and turbulence) associated with more conventional purging techniques, reduce mixing of stagnant casing water with formation water, and facilitate the direct withdrawal of groundwater from the formation surrounding the well screen.

For HydroPunch™ sampling, refer to the Standard Operating Procedure (SOP) provided at the end of this attachment.

No monitoring wells will be sampled until well development has been performed, and sampling will be conducted no sooner than 24 hours following well development. Any synoptic water level measurement events will be completed under static groundwater conditions, prior to the initiation of purging and sampling activities. When one round of water levels is taken to generate water elevation data, the water levels will be taken prior to sampling or other activities.

II. Materials

The following materials, as required, shall be available during groundwater sampling:

- Peristaltic or bladder pump for purging and sampling;
- Sample tubing;
- Power source (i.e., generator);
- Photoionization detector (PID);
- Appropriate health and safety equipment as specified in the Health and Safety Plan (HASP);
- Plastic sheeting (for each sampling location);
- Five-gallon buckets for temporary containment of purge water;
- Dedicated or disposable bailers;
- Field filters (if necessary);

- New disposable polypropylene rope;
- Clear glass or plastic measuring cup graduated in milliliters;
- Buckets to measure purge water;
- Water level probe;
- Portable electronic meter(s) capable of measuring pH, conductivity, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), salinity, and/or turbidity;
- Flow-through cell to be used in the measurement of field parameters;
- Appropriate water sample containers;
- Appropriate blanks (trip blank supplied by the laboratory);
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials;
- Groundwater sampling logs;
- Chain-of-custody forms;
- Indelible ink pens;
- Site map with well locations and groundwater contours maps; and
- Keys to wells.

III. Procedures

Monitoring well sampling procedures are as follows:

A. Review materials checklist (Part II) to ensure the appropriate equipment has been acquired.

B. Use safety equipment, as required in the HASP.

C. Prior to sampling any monitoring well, collect depth-to-water and PID headspace screening measurements from all Site monitoring wells as follows:

   1. Measure and record the background PID reading.

   2. Unlock and open the well cover while standing upwind of the well. Remove the well cap and insert PID probe in the breathing zone above the well

casing (following instructions in the HASP). Record the maximum PID reading obtained over a 30-second monitoring period.

3. Remove and replace rusted or broken well caps and locks as necessary.

4. Obtain and record depth-to-water and total well depth measurements using an electronic water level indicator (sounder); depths will be measured and recorded to the nearest 0.01 foot.

5. Clean the water level indicator after each use as specified in Attachment 10.

D. Determine a well sampling order, generally from historically least to historically most impacted, or if the wells are being sampled for the first time, use PID headspace measurements or distance from the source area to gauge the relative levels of impact at the various monitoring wells.

E. Begin purging and sampling activities. Identify the site and well being sampled in the field log, along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized and other pertinent data.

F. Place the plastic sheeting adjacent to the well to use as a clean work area.

G. Set out on plastic sheeting the decontaminated and/or disposable sampling device and meters.

H. Label all sample containers with the following information (at a minimum):

1. Site name;

2. Sample location / ID;

3. Date and time of sampling;

4. Analyses requested;

5. Type of preservative (if any); and

6. Initials of sampling personnel.

I. Pump, safety cable, and tubing will be lowered slowly into the monitoring well to a depth corresponding to the center of the saturated screen section of the well. Any internal combustion power sources should be placed downwind of the monitoring well at a distance sufficient to prevent the migration of engine exhaust into the sampling area.

   Measure the water level again with the pump in the monitoring well before starting the pump. Start pumping the well at 200 to 500 milliliters per minute. Ideally, the pump rate should cause little or no water level drawdown in the well. Although a maximum acceptable drawdown of 0.3 foot is commonly used, the acceptable level of drawdown will be determined in the field on a Site-specific and well-specific basis. In general, for wells screened below the water table, drawdown will be acceptable as long as the water level can be stabilized at a constant pumping rate, at a level above the top of the well screen. For wells screened across the water table, drawdown will be acceptable if the water level can be stabilized at a constant pumping rate, at a level above the intake of the pump. The water level should be monitored every 3 to 5 minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken or entrainment of air in the sample. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to minimize drawdown.

   If minimal draw down cannot be maintained, water should be purged from the well at the minimum sustainable pumping rate. If the indicator parameters do not stabilize before the water level reaches the pump intake, then purging should be interrupted and the water level allowed to recover before groundwater samples are collected.

J. During monitoring well purging, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, DO, and ORP every 3 to 5 minutes (or as appropriate) using a portable electronic meter(s). The well is considered stabilized and ready for sample collection as soon as the indicator parameters meeting the following criteria for three consecutive readings (taken over a minimum period of 15 minutes):

   1. pH measurements remain stable within 0.1 standard unit;

   2. Specific conductivity varies by no more than 3 percent;

3. ORP remains stable within 10 millivolts;

4. DO varies no more than 10 percent; and

5. A constant non-turbid discharge (<10 nephelometric turbidity units) is achieved, or turbidity over three consecutive readings varies no more than 10 percent.

Measurements for DO and ORP must be obtained using a flow-through cell; however, other parameters may be taken in a clean container such as a glass beaker if individual meters are being used to obtain the field parameter measurements.

K. When conventional volumetric purging is used, an attempt should be made to purge at least three but no greater than five well volumes of water prior to sampling. Monitoring of field parameters should be conducted at a frequency of at least one measurement per well volume. If three well volumes cannot be removed before the water level reaches the pump intake, then the purging should be interrupted and the well water level allowed to recover (at least 75 percent) prior to sample collection. Sampling should be conducted as soon as possible (no longer than 24 hours) after cessation of purging.

L. After purging has been completed, obtain the groundwater sample needed for analysis directly from the sampling device in the appropriate container and tightly screw on the caps. If samples are to be field-filtered, connect field-filter sampling device. Allow approximately three sample volumes to flow through the filter before collecting the groundwater sample.

M. Make sure that all samples are labeled as indicated in the Field Sampling Plan. Secure the samples with packing material and store at 4 degrees Celsius on wet ice in an insulated transport container provided by the laboratory.

N. After all sampling containers have been filled, collect an additional, post-sampling set of field parameter measurements, and record these measurements along with the color, appearance, and odor of the sample on the field log.

O. Record the time sampling procedures were completed on the field logs.

P. Place all disposable sampling materials (plastic sheeting, disposable bailers, and health and safety equipment) in appropriately labeled containers. Go to the next well and repeat Step E through Step P until all wells are sampled.

Q. Complete the procedures for packaging, shipping, and handling with associated chain-of-custody forms.

IV. References

Puls, R.W., and M.J. Barcelona. 1996. Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

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Groundwater Sampling Using HydroPunch™

Rev. #: 01

Rev Date: March 3, 2009

Approval Signatures

Prepared by: Andrew Kanik Date: 3/3/09

Reviewed by: Michael J Gefell Date: 3/3/09
(Technical Expert)

I. Scope and Application

This document describes procedures for collecting discrete-depth groundwater samples using the HydroPunch™ sampling device (QED Environmental Services, Inc.), or equivalent, during drilling in unconsolidated materials. HydroPunch™ can be used to collect a single sample from a selected depth, or multiple samples from a single borehole to produce a profile of groundwater quality data versus depth. The HydroPunch™ sampler is typically driven through open-ended drill casing or hollow-stem augers.

HydroPunch™ consists of a drive point, a stainless steel screen section, a sample reservoir integral within the tool body, and assorted O-rings and check valves to create watertight seals within the various components. Two models of HydroPunch™ have been developed, having slightly different designs and/or component parts as shown on the attached HydroPunch™ schematic drawings. All components are made of stainless steel, Teflon, or other relatively inert materials. The tool can be disassembled easily for cleaning between samples.

Although this document refers to groundwater sample collection, HydroPunch™ is also capable of obtaining samples of light or dense non-aqueous phase liquid (LNAPL or DNAPL, respectively), if present at sufficient saturation and pressure head at the depth of the ampler during deployment.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities using HydroPunch™ should have a minimum of 2 years of previous groundwater sampling experience and current health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and CPR, as needed. Field personnel will also be compliant with client-specific training requirements. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and posses the required skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following materials are required for the collection of discrete-depth groundwater samples using HydroPunch™.

- HydroPunch™ sampling device provided by drilling subcontractor

- Drill casing or augers having an effective inside diameter of at least 1.25 inches (to be provided by drilling subcontractor)
- Electronic water-level probe
- Groundwater sample containers provided by the testing laboratory
- Health and safety monitoring equipment and personal protective equipment
- Materials for decontamination of the sampler between samples

IV. Cautions

Because the HydroPunch™ sampler is a groundwater sampling device, it must be used in saturated soils. Positive hydraulic head is required to fill the sampler, and the sampler may fill slowly or not at all at depths just below the water table. HydroPunch™ I and HydroPunch™ II in the "groundwater mode" cannot be used at sampling depths less than 5 feet below the water table. HydroPunch™ II in the "hydrocarbon mode" is preferred for sampling at the water table.

Some types of geologic materials may not allow effective use of the HydroPunch™ sampler, even at significant depth below the water table. For example, extremely dense soils or those containing cobbles or boulders may resist penetration of the sampler, precluding its use. Low permeability soil such as silt and clay may not produce groundwater at a sufficient rate to fill the HydroPunch™ sampler within a practicable timeframe. For these types of situations, an alternative approach should be considered, such as collecting a sample of saturated soil for analysis.

Groundwater samples collected using HydroPunch™ should be considered screening-level data, suitable for obtaining a general understanding of groundwater quality and selecting depths for monitoring well screens. Samples obtained using HydroPunch™ are commonly more turbid than those produced from installed, developed monitoring wells. Higher turbidity could affect sample quality if samples are to be analyzed for sorptive analytes such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides or metals. For these types of analytes, unfiltered HydroPunch™ samples could produce concentrations that are higher than those of sediment-free aquifer water. Field or laboratory filtering of the samples obtained for these types of constituents should be considered. For less-sorptive analytes (volatile organic compounds, anions such as chloride, etc.), sample turbidity is unlikely to adversely impact the direct usability of unfiltered samples.

V. Health and Safety Considerations

- Sample collection will be performed using procedures consistent with the project Health and Safety Plan.
- Appropriate personal protective equipment must be worn by ARCADIS field personnel

VI. Procedure

The following steps will be followed during the collection of discrete-depth groundwater Samples using HydroPunch™:

1. Select the desired groundwater sampling depth.
2. The drilling subcontractor will advance the borehole to approximately 2 feet above the depth from which a discrete water sample is to be obtained.
3. The drilling subcontractor will disassemble the HydroPunch™ sampling device according to the manufacturer's instructions to allow the sampler to be decontaminated. The sampler should be completely disassembled, including O-rings and/or check valves.
4. Decontaminate the sampler as appropriate for the range of groundwater analytes to be sampled for, by washing with laboratory-grade detergent and potable water wash, followed by solvent rinse (if sampling for organics) and final rinse with deionized or distilled water. Check the condition of the O-rings during each cleaning, and replace if necessary.
5. The drilling subcontractor will reassemble the decontaminated HydroPunch™ sampling device according to the manufacturer's instructions and lower the device to the bottom of the borehole.
6. The drilling subcontractor will push or drive the HydroPunch™ 5 feet below the bottom of the casing or augers, then retract the sampler 3 feet upward. Subsurface friction will retain the drive point in place, exposing the screen and allowing groundwater to enter the sampling tool.
7. Allow sufficient time to allow the sampler to fill with water. Typically 30 minutes is sufficient, except in low permeability materials.
8. Collect a groundwater sample by:

- Retracting the sampler to ground surface – the drilling subcontractor will then open the sampler allowing collection of the groundwater sample [if using the HydroPunch™ I or else the HydroPunch™ II in groundwater mode (see Attachment A)]

- Lowering a bailer or a peristaltic or inertia pump tube through the rods and body of the sampler, and retrieving the bailer or operating the pump to collect the groundwater sample [if using the HydroPunch™ II in hydrocarbon mode (see Attachment A)]

9. Perform field filtering of samples if required by the work plan, FSP and/or QAPP.

10. Obtain field water quality measurements if required by the work plan, FSP and/or QAPP.

11. Label the sample containers at the time of sampling with the following information.

    - Project name and number
    - Sample location
    - Sample number
    - Date and time of collection
    - Sampler initials
    - Analyses required

12. Preserve, store, handle, and ship samples to the analytical laboratory under chain of custody procedures as described in by the work plan, FSP and/or QAPP.

VII. Waste Management

Investigation-derived waste will be managed as described in the Investigation-Derived Waste Handling and Storage SOP.

VIII. Data Recording and Management

Borehole identification, sample depth, sample date and time will be recorded in the field notebook, the boring log, and/or the personal digital assistant (PDA). The sample will also be identified on an appropriate chain of custody form, as appropriate for submittal to an analytical laboratory for analysis, if required. Consider digital photography to record unusual field conditions or to document compliance.

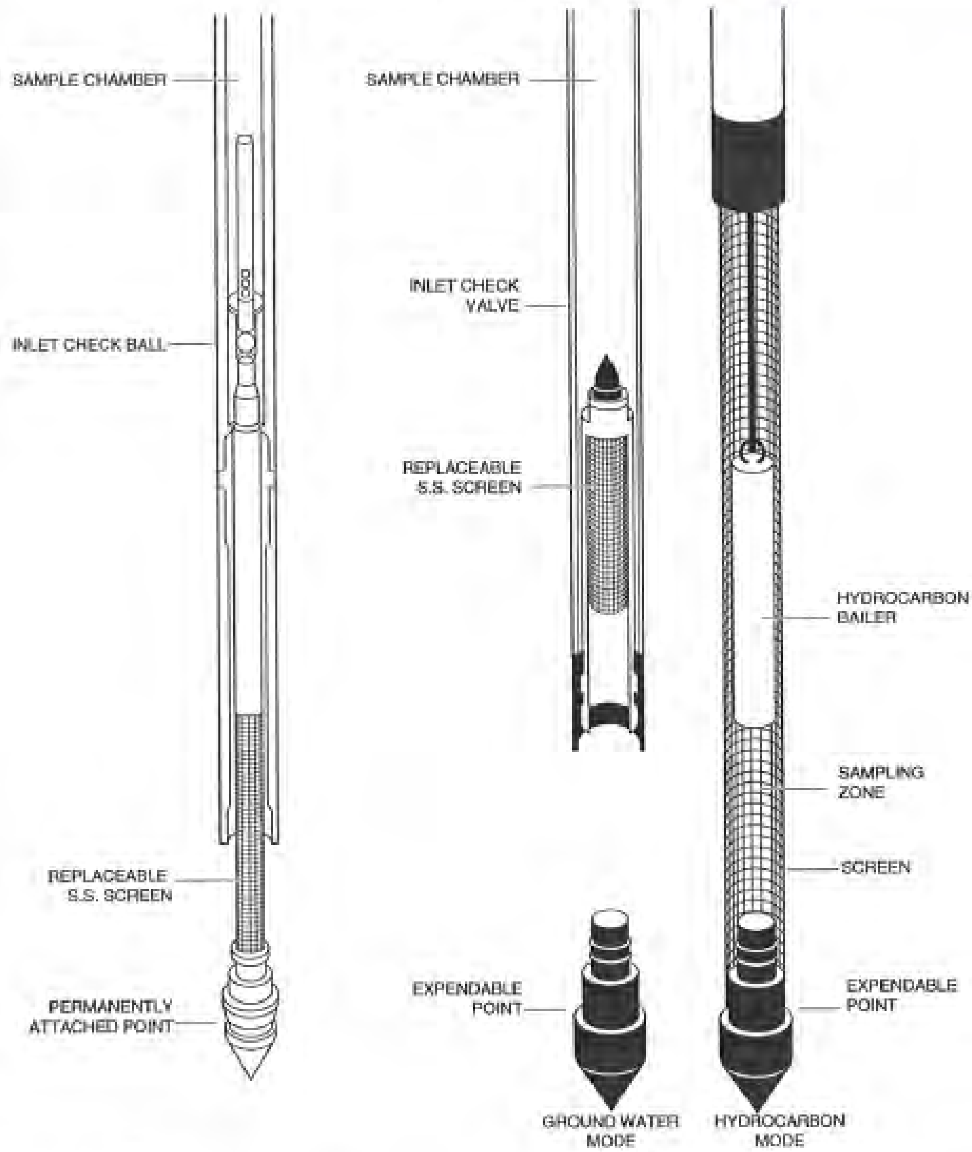
IX. Quality Assurance

The HydroPunch™ sampling device will be decontaminated as appropriate for the list of analytical parameters for which the groundwater samples are collected.

X. References

No references are required to accompany this SOP.

Attachment A - Hydropunch® Schematics



HydroPunch® I

- Collects ground water samples only (not floating layer)
- Permanently-attached drive cone and screen (leaves nothing in the ground)
- Can be used with cone penetrometer or drill rig

HydroPunch® II

- Collects floating layer and ground water
- Replaceable cones and screens are left in ground (note: screens may be retrievable)
- Stronger for tough duty; used with drill ring

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Attachment 8

Specific Capacity Testing Procedures

Attachment 8: Specific Capacity Testing Procedures

I. Introduction

Specific capacity testing is a field method used to estimate the transmissivity of a saturated geologic medium surrounding the screened or open interval of a well. A specific capacity test involves pumping groundwater from a well at a constant rate and quantifying the pumping rate and the magnitude of drawdown inside of the tested well after a known duration of pumping. Specific capacity tests are also referred to as single well pumping tests or constant rate tests.

The transmissivity is calculated based on the observed test pumping rates, the drawdown measured immediately before the end of pumping, the pumping duration that preceded the drawdown measurement, the effective radius of the well, and the estimated storativity of the formation. If the thickness of the effective water bearing zone transmitting ground-water to the well intake is assumed to be approximately equal to the length of the intake, the hydraulic conductivity can be estimated by dividing the transmissivity by the length of the intake.

II. Materials

The equipment needed for specific capacity testing includes:

- Health and safety equipment (as required in the Site Health and Safety Plan);
- Cleaning equipment as specified in Attachment 10;
- Pump (preferably submersible) capable of pumping at a controlled rate between a fraction of one gallon per minute and several gallons per minute (gpm), equipped with discharge line;
- Power source for the pump;
- Calibrated in-line totalizing flow meter or two calibrated buckets;
- Stopwatch; and
- Electronic water-level indicator.

III. Pre-Test Set-Up

Prior to the installation of the pump into the well to be tested, the static water level inside the well is measured to the nearest 0.01 feet relative to a specified datum at the top of the well using the electronic water-level indicator. The water level and the time of measurement are recorded in the field notebook. The water level is measured again several minutes after the initial measurement. This measurement and time are recorded. This procedure is repeated until two consecutive measurements are identical, indicating approximately static conditions. The static depth to water is recorded.

The pump is installed into the well to at least 10 feet below the static water level, or within approximately 1 foot of the bottom of the well if the initial water column in the well is less than 11 feet. The depth of the pump intake below the static water level (indicating the length of the pre-test water column above the pump) is recorded. After the pump is installed, but prior to pumping, the water level in the well is monitored until it has returned to within 0.01 feet of the static water level.

IV. Test Procedures

The specific capacity test is performed as follows:

1. Hold the water level probe in the well just above the static water level. If an in-line totalizing flow meter is used, record the pre-test volume measurement in the field notebook. If no in-line flow meter is available, place the end on the discharge line in one of the two calibrated buckets. Record the total volumetric capacity of each bucket.

2. Simultaneously start the pump and stopwatch. Record the start time.

3. Immediately begin monitoring the water level in the well. If the water level inside the test well declines rapidly, quickly reduce the pumping rate to a slower, constant rate. To avoid pumping the well "dry" during the test, the drawdown after one minute of pumping should be less than or equal to 20% of the height of the pre-pumping water column above the pump. All pumping rate adjustments should be completed within 1 or 2 minutes of the start of pumping, after which no adjustment should be made other than minor adjustments that may be necessary to maintain a steady pumping rate.

4. Continue to pump for at least 20 minutes, recording the water level in the well approximately every 5 to 10 minutes throughout the test. If an in-line flow meter is used, record the volume measurement on the totalizer gauge approximately every 2 minutes during the test. If calibrated buckets are used to measure the pumping rate, record the time at which the bucket reaches the known volumetric capacity of the bucket. Transfer the discharge line to the other (empty) calibrated bucket and record the time when it becomes full. Repeat this procedure for the duration of the test.

5. The specific capacity test is complete after at least 20 minutes of pumping have elapsed. A longer pumping period is not necessary to estimate transmissivity from the test. However, increasing the length of the test may further increase the reliability of the resulting transmissivity estimate. Immediately before termination of pumping, record the final water level measurement plus the time of the measurement.

6. Calculate and record the total volume of groundwater removed from the well during the test and the total duration of the test. Divide the total volume (in gallons) by the total pumping duration (in minutes) to calculate and record the average test pumping rate (in gpm).

V. Specific Capacity Test Data Reduction

Data from a specific capacity test are reduced to a transmissivity estimate for water-bearing formation surrounding the intake of the tested well by solving for the value of transmissivity in the equation (Walton 1962):

$$Q/s = T / [264 \log(Tt/2693rw2S) - 65.5]$$

where

where	Q/s	=	specific capacity of the well in gpm per foot
	Q	=	average test pumping rate in gpm
	s	=	drawdown measured inside of the tested well after a known duration of pumping (t)
	T	=	transmissivity of the water-bearing zone surrounding the intake of the tested well
	S	=	estimated storativity of the aquifer
	rw	=	effective radius of the well

t = time in minutes between the start of pumping and the time when the drawdown was measured.

The value of T can be solved iteratively using a specific capacity test data reduction spreadsheet program (e.g., QSTRANS) developed by Blasland, Bouck & Lee, Inc. (BBL, now ARCADIS). If the well screen is surrounded by a sand pack that may be assumed to be substantially more permeable than the formation, the effective radius of the well is taken to be that of the borehole.

The value of S may be estimated without introducing serious error into the results. For confined aquifers, S should be estimated as 0.0001. For unconfined aquifers, the short-term storativity may be comparable to that of a confined aquifer. Only after a protracted pumping duration (several hours or more) does the storativity begin to approximately the aquifer specific yield of approximately 0.2 to 0.3 (Nwankwor et al., 1985). In the calculation of transmissivity from a specific capacity test of less than several hours duration, therefore, an estimated storativity value of 0.01 can be used.

To obtain an estimate of the hydraulic conductivity of the water-bearing zone that transmits groundwater to the well, the calculated transmissivity value may be divided by the estimated thickness of the water-bearing zone. In a stratified formation in which the horizontal hydraulic conductivity may be expected to greatly exceed the vertical hydraulic conductivity, the thickness of the water-bearing zone may be estimated as the length of the well intake to obtain an estimate of the hydraulic conductivity immediately surrounding the well intake.

It should be noted that the Walton (1962) specific-capacity data analysis method is based on the modified non-equilibrium equation. According to Kruseman and deRidder (1990), these methods are useful provided that:

$u \leq 0.15$

where u = r^2 S/4Tt

r = effective well radius

S = storativity

T = transmissivity of the test zone (formation interval adjacent to saturated sandpack)

t = the pumping duration

Following data analysis, the value of u should be calculated to confirm that the above condition is satisfied. If u > 0.15, then a different hydraulic conductivity test method should be employed.

In addition, in circumstances when the pumping rate is low (e.g., less than 1 gpm) and the drawdown is high or occurs within the sandpack, the water removed from well and sandpack storage should be calculated and subtracted from the pumped volume to estimate the volume of water produced by the formation. The volume of water produced by the formation should be divided by the pumping duration to obtain an effective average test pumping rate for use in calculating T and K.

VI. References

Kruseman, G.P., and N.A. de Ridder, 1990. Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, Second Edition, Publication 47, pp 377

Nwankwor, G.I., Cherry, J.A., and R.W. Gillham, 1985. A comparative study of specific yield determinations for a shallow sand aquifer, Ground Water, Vol. 22, No. 6, pp. 764-772.

Walton, W.C., 1962. Selected Analytical Methods for Well and Aquifer Evaluation, Illinois State Water Survey Bulletin 19.

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Attachment 9

Groundwater Elevation Measurement Procedures

Attachment 9: Groundwater Elevation Measurement Procedures

I. Introduction

Water levels will be measured using an electronic water level indicator (sounder), steel tape, or measuring tape at established reference points (top of casing, etc.). Reference points will be surveyed to determine their elevations relative to mean sea level.

II. Materials

The following materials will be available, as required, during groundwater elevation measurements.

- Appropriate health and safety equipment as specified in the Health and Safety Plan (HASP);
- Laboratory type soap (Alconox® or equivalent);
- Electronic water level indicator (sounder);
- Analyte-free water; and
- Indelible ink pen.

III. Gauging Procedures

A detailed procedure for obtaining water levels will be as follows. All field notations on logs will be treated as secured documentation and indelible ink will be used.

A. Identify site and well number in field notebook along with date, time, personnel, and weather conditions.

B. Use safety equipment as specified in the HASP.

C. Clean the water-level indicator as specified in Attachment 10. Contain rinse water in a portable container that will be transferred to an on-site container.

D. Unlock and open the well cover while standing upwind from the well.

E. Locate a measuring reference point on the well casing. If one is not found, create a reference point by notching the inner casing (or outer if an inner casing is not present) with a hacksaw. All downhole measurements will be taken from one reference point. Document the creation of any new reference point or alteration of the existing reference point.

F. Measure to the nearest 0.01 foot and record the height of the inner and outer casing (for wells only) from reference point to ground level.

G. Lower the water level indicator probe down through the water column until it touches the bottom of the well. Record the depth of the well at that location. Make water level measurements as the probe is drawn back up through the water column. Double-check all measurements and record depths to the nearest 0.01 foot.

H. Clean the instrument(s) as specified in Attachment 10.

I. Compare the depth of the well to previous records.

J. Lock the well when all activities are completed.

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Attachment 10

Equipment Cleaning Procedures

Attachment 10: Equipment Cleaning Procedures

I. Introduction

Equipment cleaning areas will be located within or adjacent to a specific area, as designated by the supervising geologist. The procedure applies only to non-dedicated, non-disposable sampling equipment that is intended for re-use.

II. Materials

The following materials, as required, shall be available during equipment cleaning:

- Personal protective equipment (PPE) (as required in the Health and Safety Plan [HASP]);
- Tap water (provided by a municipal water supply);
- Non-phosphate laboratory soap (Alconox® or equivalent);
- Pesticide grade isopropanol (as necessary);
- Nitric acid (as necessary);
- Deionized water;
- Organic/analyte free water;
- High pressure water/steam cleaning unit;
- Wash basins;
- Plastic containers for the collection of rinsate;
- Brushes;
- Polyethylene sheeting;
- Aluminum foil;
- Pre cleaned plastic overpack drum or garbage can for cleaning submersible pump;
- Large heavy duty garbage bags;
- Spray bottles; and
- Disposable gloves.

III. Handling and Storage of Equipment

A. Cleaning Equipment

All storage and application containers (spray bottles) will be constructed of proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap must be kept in its original container or clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.
- Solvent must be stored in the unopened original containers until used and will be applied using Teflon® or polyethylene squeeze bottles.
- Tap water may be kept in clean tanks, hand-pressure sprayers, squeeze bottles, or applied directly from a hose.
- Deionized water must be stored in clean glass, stainless steel, or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.
- Organic/analyte free water must be stored in clean glass, Teflon®, or stainless steel containers prior to use. It may be applied using Teflon® squeeze bottles.

B. Cleaned Sampling Equipment

After field cleaning, equipment should be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment should be moved away (preferably upwind) from the cleaning area to prevent re-contamination. If the equipment is not to be immediately re-used, it should be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

IV. Safety Procedures During Equipment Cleaning

A. Personnel will wear the following PPE when cleaning smaller sampling equipment (e.g., split-spoon sampler, trowels);

- Safety glasses, goggles, or a splash shield; and
- Disposable gloves/Tyvek sleeves®.

B. Personnel will wear the following additional PPE when cleaning larger equipment (e.g., drilling rigs) with a high pressure water/steam cleaning unit:

- Safety glasses, goggles, or a splash shield;
- Disposable gloves; and
- Disposable Tyvek® coveralls and chemical-resistant overboots may also be worn during steam cleaning as specified in the HASP.

C. All solvent rinsing will be conducted in an adequately ventilated area.

D. All solvents transported into the field will be stored and packaged in appropriate containers with care taken to avoid exposure to extreme heat.

E. Solvent handling will be consistent with the manufacturer's Material Safety Data Sheets.

F. No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

V. Cleaning Procedures

A. Decontamination Pad

At the discretion of the supervising scientist, a decontamination pad may be constructed for steam cleaning of drill rigs (including augers), Geoprobe® equipment, and other heavy equipment that may come into contact with environmental samples. If one is required, the decontamination pad will be constructed in an area known or believed to be free of contamination. Existing structures (i.e., concrete pads and/or diked areas) will be used as decontamination pads to the extent possible, but if no such structures exist or if they are suspected to be contaminated, then a pad will be constructed using a double thickness of 10-mil plastic sheeting, secured to the ground on three sides with heavy timbers. The pad will be designed and constructed to minimize leakage and sloped to channel rinse water toward a sump in one corner of the pad, from which the rinse water can be pumped and containerized. The pad should be of sufficient size to capture any overspray from the steam cleaning operation. Water used to make steam may be stored in a pre-cleaned container and will be applied at a pressure of at least 2,000 pounds per square inch and a temperature of at least 200 degrees Fahrenheit. Due to potential material incompatibility and safety issues, solvents will not be used in conjunction with a decontamination pad, unless they can be captured and containerized in a safe manner. Any decontamination pad constructed during field activities will be dismantled and the area restored to its original condition after the completion of sampling activities.

B. Heavy Equipment

Items such as drill rigs, well casings, auger flights, and backhoes could contain potential sources of interference to environmental samples. The sampling equipment may have come in contact with the materials adjacent to the matrix being sampled or media may be attached to the actual sampling equipment. Heavy equipment may also retain constituents from other sources such as roadways or storage areas or material from previous job sites that were not adequately removed. For these reasons, it is important that these items be cleaned prior to use during the investigation.

Two methods are used for cleaning heavy equipment:

- Steam cleaning; and
- Manual scrubbing.

Steam cleaning can remove visible debris. Because steam cleaners provide a high-pressure medium, they are very effective for solids removal. They are also easy to handle and generate low volumes of wash solutions.

Manual scrubbing of equipment is accomplished using brushes and an Alconox®/water solution. This procedure can be as effective as steam cleaning and is preferred in situations where steam cleaning fails to remove visible materials. Disadvantages to manual scrubbing are that it is labor intensive and generates large volumes of wash and rinse solutions.

The working end of the drill rig will be thoroughly steam cleaned or manually scrubbed upon arrival. Drill rig items such as auger flights, drill rods, and drill bits will be cleaned before changing sample locations.

All equipment such as drill rigs, backhoes, and other mobile equipment will receive an initial cleaning prior to use. The frequency of subsequent cleaning at the project area depends on equipment usage in relation to environmental sample collection. In addition, all heavy equipment will be inspected for leaks, drips, broken lines, etc., prior to use at the Site.

C. Reusable Sampling Equipment

The following procedures will be used for sampling equipment (split spoons, drive shoes, scoops/spoons, bucket augers, trowels, mixing bowls, etc.) used to collect routine samples undergoing trace inorganic constituent analyses:

- Clean with tap water and soap (Alconox®) using a brush if necessary to remove particulate matter and surface films. Equipment may be steam cleaned (soap and high-pressure hot water) as an alternative to brushing. All steam cleaning should be conducted within a decontamination pad, with smaller sampling equipment placed on racks or sawhorses at least 2 feet above the floor of the decontamination pad. Polyvinyl chloride (PVC) or plastic items will not be steam cleaned.

- Rinse thoroughly with tap water.

- Rinse thoroughly with analyte free water.

- Rinse thoroughly with solvent (nitric acid). PVC and plastic items will not be rinsed with solvent.

- Rinse thoroughly with organic/analyte free water.

- Remove the equipment from the decontamination area and cover with plastic. Equipment stored overnight should be wrapped in aluminum foil and covered with clean, unused plastic.

D. Water Level Indicators, Interface Probes, and Tapes

Water level indicators (sounders), oil-water interface probes, and measuring tapes will be cleaned used an abbreviated procedure:

- Wash with soap and tap water.

- Rinse with tap water.
- Rinse with analyte free water.

E. Instruments / Equipment Used to Collect and Measure Samples for Analysis of "Classical" Parameters

"Classical" parameters include pH, conductivity, temperature, oxidation-reduction potential, dissolved oxygen, turbidity, salinity, oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc. Instruments and equipment used to collect and measure samples for these parameters may be cleaned/rinsed with the fresh sample or with analyte-free water between sampling locations. This method will not be acceptable for equipment used to collect samples for analysis of trace inorganic constituents.

F. Pumps

If submersible pumps are used to evacuate groundwater in wells, they will be cleaned and flushed between uses. This cleaning process will consist of an external detergent wash and tap water rinse, or a steam cleaning of pump casing, hose, and cables followed by flushing with tap water through the pump. This flushing will be performed with the use of a clean plastic overpack drum or plastic garbage can filled with tap water. The pump will run long enough to flush water sufficiently through the pump housing and hose. Extreme care should be taken to avoid contact with the pump casing and water in the drum while the pump is running to avoid electric shock. The pump and hose will be placed on clean polyethylene sheeting to avoid contact with the ground surface.

As an alternative, pumps may also be disassembled and manually cleaned using the procedures described in Section C of this attachment. This alternative procedure is not acceptable for tubing, which must be decontaminated using the flushing method described above. Dedicated and/or disposable tubing should be used if possible, and the re-use of tubing should be avoided.

VI. Disposal Methods

Water generated during cleaning procedures will be collected and transferred to a central container for interim storage.

PPE, such as gloves, disposable clothing, and other disposable equipment resulting from personnel cleaning procedures, will be placed in plastic bags. These bags will be transferred into appropriately labeled containers and stored in a designated area. The contents will be disposed of in accordance with applicable rules and regulations.

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Attachment 11

Sample Packing, Handling, and Shipping Procedures

Attachment 11: Sample Packing, Handling, and Shipping Procedures

I. Handling

A. Place a sample label containing the following information, written in indelible ink, on each sample container:

- Sample type (soil/sediment, groundwater, biota);
- Project name;
- Sample identification code and other sample identification information, if applicable;
- Analysis required;
- Date;
- Time sampled;
- Sampler;
- Sample type (composite or grab); and
- Preservative added, if applicable.

B. Check the caps on the sample containers to ensure that they are tightly sealed.

C. Initiate chain-of-custody protocol by designated sampling personnel responsible for sample custody (after sampling or prior to sample packing). Record each sample, including quality assurance/quality control (QA/QC) samples on the chain-of-custody form. Note: If the designated sampling person relinquishes the samples to other sampling or field personnel for packing or other purposes, the samplers will complete the chain-of-custody prior to this transfer. The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer.

II. Packing

A. Using tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport.

B. Place each sample container or package in individual polyethylene bags (Ziploc®-type) and seal.

C. Place one to two inches of packing material at the bottom of the cooler as a cushioning material.

D. Place the sealed sample containers and package upright in the cooler, inside a trash bag.

E. Repackage ice (if required) in small Ziploc®-type plastic bags and place loosely in the cooler. Do not pack ice so tightly that it may prevent addition of sufficient cushioning material.

F. Fill the remaining space in the cooler with packing material.

G. Place the completed chain-of-custody forms in a large Ziploc®-type bag and tape the forms to the inside of the cooler lid.

H. Close the lid of the cooler and fasten with tape.

I. Wrap strapping tape around both ends of the cooler at least twice.

J. Mark the cooler on the outside with the following information: shipping address, return address, "Fragile" labels on the top and on one side, and arrows indicating "This Side Up" on two adjacent sides.

K. Place signed and initialed custody seal tape over front right and back left of the cooler lid and cover with clear plastic tape.

III. Shipping

A. All samples will be delivered by an express carrier, or other appropriate means, to the laboratory as soon as possible, ideally within 24 hours of the time of sample collection.

B. The following chain-of-custody procedures will apply to sample shipping.

C. Relinquish the sample containers to the laboratory via express carrier. The signed and dated forms must be included in the cooler. The express carrier will not be required to sign the chain-of-custody forms. The sampler should retain the express carrier receipt or bill of lading; this document serves as an extension of the chain-of-custody during shipment.

D. When the samples are received by the laboratory, the laboratory personnel shall complete the chain-of-custody forms by recording receipt of samples, measuring and recording the internal temperature of the shipping container, and comparing the sample identification numbers on the containers to the chain-of-custody form.

Attachment 12

Handling Investigation-Derived Wastes (IDW)

Attachment 12: Handling Investigation-Derived Wastes (IDW)

I. Introduction

IDW will be generated during drilling, sampling, and decontamination procedures. IDW may include soil, groundwater, decontamination liquids, personal protective equipment (PPE), and disposable sampling materials. All IDW will be collected at the point of generation and taken to a storage area on site. Soil and water will be tested to determine proper disposition. PPE and disposable sampling equipment will be containerized in drums prior to disposal with the containerized soil.

II. Materials

The following materials and equipment will be available, as needed, for handling investigation derived wastes:

- Plastic bags;
- 55-gallon drums; and
- Labels.

III. In the Field (Well Head, Soil Boring, etc.)

IDW will be handled at the point of generation according to the following procedure:

A. Collect soil cuttings, groundwater, and decontamination liquids in 55-gallon drums.

B. Label the drum with the following information:

- Sequential drum number for future identification;
- Sample location ID;
- Date;
- Description of the contents;
- Drilling contractor; and

- Sampling contractor.

C. Record the drum ID number, sample location, date, contents, drilling contractor (if applicable) in the field notebook.

D. Notify Site personnel of the number and location of drums to be transported to the temporary storage area on site.

IV. Sampling for Waste Characterization

IDW will be inventoried (and sampled, as necessary) to determine the appropriate disposition according to the following procedure:

A. Inventory the drums of IDW against the field records to ensure that all drums of IDW are accounted for.

B. Collect representative samples of the contents of selected, representative drums of IDW. If samples collected in the field can be used, this step may be omitted.

C. Submit samples for laboratory analyses for waste characterization parameters as appropriate for the constituents of concern in the area that the IDW was generated, with consideration given to any additional analyses required by potential treatment and/or disposal facilities.

D. Determine the recommended method(s) of treatment and/or disposal.

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Appendix B

Quality Assurance Project Plan

Infrastructure · Water · Environment · Buildings

Imagine the result

ExxonMobil Environmental Services Company

Quality Assurance Project Plan

Former Virginia-Carolina Chemical Corporation
Memphis Site, Memphis, Tennessee

May 2012

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Quality Assurance Project Plan

Former Virginia-Carolina Chemical Corporation Memphis Site, Memphis, Tennessee

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Table of Contents

Table of Contents

Tables

Figure

Attachment

1. Project Description

1.1 Introduction

This Quality Assurance Project Plan (QAPP) provides guidance for ARCADIS' data collection in support of the Site characterization at the former Virginia-Carolina Chemical Corporation (VCC) Memphis Site located in Memphis, Shelby County, Tennessee.

A description of the Site, along with a Site history and a summary and interpretation of previous investigations, is provided in the *Site Delineation Work Plan, Former Virginia-Carolina Chemical Corporation Memphis Site, Memphis, Tennessee* (Work Plan), to which this QAPP is an appendix. This QAPP, along with the Field Sampling Plan (FSP) (also appended to the Work Plan) are intended to guide all sampling and measurement activities conducted during the implementation of the Site characterization field activities. The FSP and this QAPP are integrated and cross-referenced, where applicable, to minimize redundancy.

This QAPP was prepared in a manner consistent with the following documents, where applicable:

- Test Methods for Evaluating Solid Waste (SW-846) (U.S. Environmental Protection Agency [USEPA] 1996; and

- Field Branches Quality System and Technical Procedures, USEPA Region 4 (USEPA 2012).

Information contained in this QAPP has been organized into the following sections:

Section	Content
1	Project Description
2	Project Organization and Responsibilities
3	Quality Assurance Objectives for Measurement Data
4	Field Procedures
5	Sample and Document Custody
6	Calibration Procedures
7	Analytical Procedures
8	Data Reduction, Review, and Reporting

Section	Content
9	Data Management
10	Field and Laboratory Quality Control Checks
11	Performance and System Audits
12	Preventive Maintenance
13	Data Assessment Procedures
14	Corrective Action
15	Quality Assurance Reports
16	References

Details are provided in the subsequent sections. This document also contains pertinent information from the Work Plan and the FSP related to the measurement and evaluation of analytical data.

1.2 Site Description and History

The description and history of the Site are presented in the Work Plan, to which this QAPP is an appendix.

1.3 Data Quality Objectives

The data quality objectives (DQO) process, as described in *Guidance for Quality Assurance Project Plans* (USEPA 2002), is intended to provide a "logical framework" for planning field investigations. The following sections address, in turn, each of the seven sequential steps in the QAPP DQO process.

Step 1: State the Problem

Based on historical knowledge of phosphate fertilizer plant byproducts and observations made during the Site reconnaissance, the presence of arsenic and lead are anticipated in soil. It has been reported that arsenic and lead have the potential to adversely affect human health and the environment. The sampling and analysis program is intended to generate data to evaluate potential remedial alternatives.

Step 2: Identify the Goal of the Study

The initial use of the data is descriptive (distribution and concentration), and there is no decision point for this descriptive application. The decision in this case is to determine whether or not future actions are required for the Site based on the distribution and concentrations of arsenic and lead present in soil and groundwater.

Step 3: Identify Information Inputs

Decision inputs incorporate both concentration and distribution of arsenic and lead in Site media. A fundamental basis for decision-making is that a sufficient number of data points of acceptable quality are available from the investigation to support the decision. Thus, the necessary inputs for the decision are: 1) the proportion of non-rejected (usable) data points; and 2) the quantity of data needed to evaluate whether a removal action is required for the Site.

The data will be evaluated for completeness, general conformance with requirements of this QAPP, and consistency among datasets and with historical data, as appropriate.

Step 4: Define the Boundaries of the Study

The Site includes the area encompassed by the property boundaries of the former VCC-Memphis Site and adjacent properties that may be identified during the delineation activities.

Step 5: Develop the Analytic Approach

The decision on whether data can be used to evaluate the need for future actions will be based on the validation results. Following validation, the data will be flagged, as appropriate, and any use restrictions noted. The sampling plan has been devised so that the loss of any single data point will not hinder description of the distribution of arsenic and lead or the evaluation of the need for future actions. Given this, a reasonable decision rule would be that 90 percent of the data points not be rejected and deemed unusable.

Step 6: Specify Performance or Acceptance Criteria

Specifications for this step call for: 1) giving forethought to corrective actions to improve data usability; and 2) understanding the representative nature of the sampling design. This QAPP has been designed to meet both specifications for this step. The sampling and analysis program has been developed based on observations made during the Site reconnaissance and knowledge of present and historical Site conditions. Corrective actions are described elsewhere in the document and in the appended documents. The representative nature of the sampling design has been assured by discussions among professionals familiar with the Site and the appropriate government agencies.

Step 7: Develop the Detailed Plan for Obtaining Data

The overall quality assurance objective is to develop and implement procedures for field sampling, chain of custody (COC), laboratory analysis, and reporting that will provide results which will support the evaluation of the need for a removal action. Specific procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, data reporting, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP.

A summary of the DQOs for the sampling investigation efforts is presented in the subsequent section. The summary consists of stated DQOs relative to data uses, data types, data quantity, sampling and analytical methods, and data measurement performance criteria.

1.3.1 General

DQOs are statements, in either qualitative or quantitative terms, regarding the appropriate data quality for an investigation. DQOs are typically determined through an iterative process and are refined as additional information becomes available; they are initially established based on the intended end use of the data to be obtained. General project DQOs for the Site characterization and delineation are summarized in this section, with detailed information provided throughout the QAPP, FSP, and the Site Delineation Work Plan. Generally, the data generated during the Site characterization will be used to evaluate Site media in the area of suspected releases. To obtain information necessary to meet the objectives stated above, the field investigation will include soil and groundwater data collection.

Preliminary DQOs were identified during Site characterization scoping. These DQOs were then incorporated into the QAPP to provide that the data generated during field investigations are of adequate quality and sufficient quantity to form a sound basis for decision-making purposes relative to the above objectives. DQOs have been specified for each data collection activity or investigation at the Site. The DQOs presented herein address investigation efforts only and do not cover health and safety issues, which are addressed in detail in the Health and Safety Plan (HASP) for this project, a component of the overall Work Plan.

A DQO summary for each of the investigation efforts is presented below. The summary consists of stated DQOs relative to the following items:

- Data uses;
- Data types;
- Data quality;
- Data quantity;
- Sampling and analytical methods; and
- Data precision, accuracy, representativeness, completeness, and comparability (PARCC parameters).

A wide range of data quality is achieved through the use of various analytical methods. There are three analytical categories that address various data uses and the quality assurance/quality control (QA/QC) effort and methods required to achieve the desired level of quality. These categories are:

Screening Data: Screening data afford a quick assessment of Site characteristics or conditions. This objective for data quality is available for data collection activities that involve rapid, non-rigorous methods of analysis and QA. This objective is generally applied to physical and/or chemical properties of samples, degree of contamination relative to concentration differences, and preliminary health and safety assessment.

Screening Data with Definitive Confirmation: Screening data provide rapid identification and quantitation; however, because screening generally involves the use of less precise methods of analysis with less rigorous sample preparation, the quantitation may be relatively imprecise. Generally, at least 10 percent of the data are confirmed using analytical methods and QA/QC procedures and criteria associated with definitive data. This objective can also be used to verify less rigorous laboratory-based methods. This objective of data quality is available for data collection activities that require qualitative and/or quantitative verification of a select portion of sample findings.

Definitive Data: Definitive data are generated using rigorous analytical methods, such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the Site or at an off-site location, as long as the QA/QC requirements are satisfied. For data to be definitive, either analytical or total measurement error must be determined. Definitive data are used for Site characterization, environmental monitoring, confirmation of field data, and to support engineering studies. Definitive data are used to confirm lower level data and to obtain highly documented data.

It is anticipated that both the screening and definitive data categories will be used during the investigation. Field screening data (e.g., X-Ray Fluorescence Spectrum Analysis [XRF analysis]) will be obtained during soil sampling to provide real-time quantitative data that will assist in determining the need for additional sampling. All remaining parameters will be determined using definitive techniques.

For the purposes of the Site characterization, four levels of data reporting have been defined. They are as follows:

Level 1 - Minimal Reporting: Minimal or "results only" reporting is used for analyses that, either due to their nature (e.g., field monitoring) or the intended data use (e.g., preliminary screening), do not generate or require extensive supporting documentation.

Level 2 - Limited Reporting: Limited reporting is used when some additional QC information is required. The documentation includes sample analytical results as well as summarized QC sample results.

Level 3 - Expanded Reporting: Modified reporting is used for analyses that are performed following standard USEPA-approved methods and QA/QC protocols and that, based on the intended data use, require some supporting documentation but not, however, full "Contract Laboratory Program (CLP)-type" reporting.

Level 4 - Full Reporting: Full "CLP-type" reporting is used for those analyses that, based on the intended data use, require full documentation.

The reporting levels for the individual sampling efforts described herein are presented in the following sections.

1.3.2 Soil Data Collection

Data Uses

The on-site soil investigation is designed to generate data to investigate the presence of Site-related constituents in surface and subsurface soils at the Site. The data obtained will be used primarily to characterize the nature of the constituents in the surface and subsurface soil at the Site.

Data Types

Soil samples from the Site will be analyzed for one or more of the following analytes: metals (arsenic and lead), pH, and toxicity characteristic leaching procedure (TCLP) metals for designated samples (see the Work Plan and FSP for details). The soil samples will be field screened via XRF analysis to provide real-time arsenic and lead concentrations. The rationale for selecting the specific chemical parameters is discussed in detail in the Work Plan.

Data Quality

Definitive data will be generated for all chemical constituents. For these parameters, SW-846 analytical methods are used. Reporting limits are presented in Section 3 of this QAPP. Reporting for TCLP metals and pH will be Level 2 and all other analyses will be Level 4.

Data Quantity

The soil investigation will involve collecting environmental soil samples and associated QC samples. The anticipated number of soil samples to be collected from each site, the number of QC samples, and the constituents to be analyzed are presented in Section 3 of this QAPP.

Sampling and Analytical Methods

The soil sampling procedures are provided in the FSP. The laboratory analytical methods for the chemical constituents are presented in Section 3 of this QAPP.

PARCC Parameters

Precision and accuracy QC limits for chemical constituents, which are used during data validation to assess analytical performance, are presented in Section 13. When possible, these limits reflect the laboratory's control limits, although as noted on the table, published guidance limits are identified in some situations. Published method accuracy limits are used to provide the required analytical control.

Data representativeness is addressed by the sample quantities and locations identified in the Work Plan and the FSP. Data comparability is intended to be achieved through the use of standard USEPA-approved methods. Data completeness will be assessed at the conclusion of the Site characterization, as discussed in Section 13.

1.3.3 Groundwater Data Collection

Data Uses

The groundwater investigation is designed to generate water quality data to support the delineation of plume(s) that may be associated with past Site operations. The data obtained will be used primarily to characterize the nature and extent of the constituents in the groundwater.

Data Types

Groundwater samples from the Site will be analyzed for one or more of the following analytes: Resource Conservation and Recovery Act metals. The rationale for selecting the specific chemical parameters is discussed in detail in the Work Plan. Water quality data will also consist of field parameters, including turbidity, pH, temperature, dissolved oxygen, and specific conductance.

Data Quality

Definitive data will be generated for all laboratory-determined chemical constituents. For these parameters, standard analytical methods and their associated detection levels are used. Reporting limits are presented in Section 3. Reporting will be Level 4 for all laboratory analyses. Screening data will be generated for all field-measured parameters (e.g., field parameters, including dissolved oxygen) because this information will supplement the water quality data.

Data Quantity

The groundwater investigation will involve collecting groundwater samples from Hydropunch™ sampling points and possibly permanent monitoring wells installed as part of the Site characterization for field and laboratory analyses. The anticipated quantity of groundwater analytical data, including QA/QC samples that will be collected during the Site characterization, is summarized in Section 3.

Sampling and Analytical Methods

Procedures for measuring field parameters and collecting groundwater samples are provided in the FSP. The laboratory analytical methods for the chemical constituents are presented in Section 3.

PARCC Parameters

Precision and accuracy QC limits for chemical constituents, which are used during data validation to assess analytical performance, are presented in Section 13. When possible, these limits reflect the laboratory's control limits, although as noted in Section 13, published guidance limits are identified in some situations. Published method accuracy limits are used to provide the required analytical control.

Data representativeness is addressed by the sample quantities and locations identified in the Work Plan. Data comparability is intended to be achieved through the use of standard USEPA-approved methods. Data completeness will be assessed at the conclusion of the Site characterization as discussed in Section 13.

2. Project Organization and Responsibilities

The essential organizations involved in this project and their responsibilities are described in the Work Plan, to which this QAPP is an appendix.

3. Quality Assurance Objectives for Measurement Data

3.1 Selection of Measurement Parameters, Laboratory Methods, and Field Testing Methods

3.1.1 Field Parameters and Methods

All applicable field parameter measurement procedures are described in the FSP.

3.1.2 Laboratory Parameters and Methods

Laboratory analyses of soil and groundwater samples will be performed as described in the Work Plan and the FSP. The analytical parameters selected for each media are described in the Work Plan. Table 3-1 lists by matrix the anticipated analyses to be performed along with the required field QC sample frequencies. Table 3-2 presents the chemical constituents slated for analysis, organized according to sample matrix and selected analytical methods. Method reporting limits are also included. Unless otherwise specified, the QA/QC criteria and reporting limits in the laboratory Quality Assurance Manual (QAM) (Attachment A) will be used.

3.2 Quality Assurance Objectives and Criteria

The overall QA objective for this Site characterization is to develop and implement procedures for sampling, COC, laboratory analysis, instrument calibration, data reduction and reporting, internal QC, audits, preventive maintenance, and corrective action such that valid data will be generated for Site evaluation purposes. These procedures are presented or referenced in subsequent sections of the QAPP. Specific QC checks are discussed in Section 10 of this QAPP.

Quality assurance objectives are generally defined in terms of five parameters:

1. Representativeness;
2. Comparability;
3. Completeness;
4. Precision; and
5. Accuracy.

Each parameter is defined below. Specific objectives for this Site characterization are set forth in other sections of this QAPP as referenced below.

3.2.1 Representativeness

Representativeness is the degree to which sample data accurately and precisely represent Site conditions and is dependent on sampling and analytical variability and the variability (or homogeneity) of the Site itself. The Site characterization has been designed to assess the presence of the chemical constituents and supplemental parameters at the time of sampling. The Work Plan presents the rationale for sample quantities and locations. The FSP and this QAPP present field sampling methodologies and laboratory analytical methodologies, respectively. The use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to provide representative data. Further discussion of QC checks is presented in Section 10 of this QAPP.

3.2.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between data collected during different phases will be maintained through consistent use of the sampling and analytical methodologies set forth in the QAPP and the FSP, through stringent application of established QA/QC procedures, and through utilization of appropriately trained personnel.

3.2.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results, as discussed in Section 13 of this QAPP.

3.2.4 Precision

Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the Site characterization. To maximize precision, sampling and analytical procedures will be strictly followed; work for this Site characterization will adhere to established protocols presented in the QAPP and FSP. Checks for analytical precision will include the analysis of matrix spike/matrix spike duplicate (MS/MSD) pairs, laboratory QA/QC checks, and field duplicates. Field-measurement precision will be monitored by obtaining duplicate field measurements. Further discussion of precision QC checks is provided in Sections 10 and 13 of this QAPP.

3.2.5 Accuracy

Accuracy is a measure of how close a measured result is to the true value. Recovery of reference standards, MS, laboratory control standards, and surrogate standards will be used to assess the accuracy of the analytical data. Further discussion of these QC samples is provided in Sections 10 and 13 of this QAPP.

4. Field Procedures

All samples will be collected using the procedures described in the FSP. In addition, the FSP contains the procedures for installing soil borings; collecting soil samples; performing XRF field screening of soil samples; Hydropunch™ temporary sampling point and groundwater monitoring well installation and development; collecting groundwater samples; measuring groundwater elevations; equipment cleaning; handling investigation-derived waste; and handling, packing, and shipping of Site characterization samples. Table 4-1 presents sample container, preservation, and holding time requirements.

5. Sample and Document Custody

5.1 Field Procedures

The objective of field sample custody is to ensure that samples are not tampered with from the time of collection through transport to the analytical laboratory. Persons will have "custody of samples" when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel. Both discussions of sample custody and directions for the field use of COC forms are provided in the FSP.

5.2 Laboratory Procedures

5.2.1 General

Upon sample receipt, laboratory personnel will take responsibility for sample custody by signing each COC form in the designated space. The original field COC form will accompany all samples requiring laboratory analysis. The laboratory will follow the COC procedures described in the Laboratory QAM (Attachment A). Requirements that pertain specifically to USEPA contracts (e.g., USEPA Traffic Reports) are not relevant to this project. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for documenting and maintaining sample integrity at all stages of sample processing.

5.2.2 Sample Receipt and Storage

Immediately upon sample receipt, the laboratory sample custodian will verify the package seal, open the package, check the cooler temperature, and compare the contents against the field COC. At this time, the laboratory sample custodian will also be responsible for logging the samples in, assigning a unique laboratory identification number to each, and labeling the sample bottle with the laboratory identification number. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory logbook. Once samples are logged in, the samples will be promptly transferred to a thermometer-controlled refrigerator.

The pH of aqueous samples will be analyzed at login or at method level. The pH of samples will be checked in a manner to not jeopardize the integrity of the sample aliquot. If a sample container is broken, is in an inappropriate container, has not been preserved by appropriate means, or if any discrepancy between the samples received and the COC documentation is found, ARCADIS' Quality Assurance Manager will be notified immediately for resolution of the problem(s) prior to analysis.

5.2.3 Sample Analysis

Analysis of an acceptable sample will be initiated by a worksheet that will contain pertinent information for analysis. The routing sheet will be forwarded to the analyst, and the sample will be moved into an appropriate storage location to await analysis. The document control officer will file COC forms in the project file.

Samples will be organized into sample delivery groups (SDGs) by the laboratory according to sample receipt and the COC. An SDG may contain more than 20 field samples (field duplicates, rinsate blanks, and trip blanks are considered field samples for the purposes of SDG assignment); however, all QC batches will be run on a maximum of 20 samples per batch. Due to holding time issues, the laboratory will need to analyze samples based on receipt, holding time, and analytical due date. If reanalysis of a sample is required, it may be re-run separately from the original SDG; however, the resulting data will be reported with the original SDG.

Every SDG must include a minimum of one method blank and one MS/MSD (or MS/laboratory duplicate) pair; each SDG will, therefore, be self-contained for all of the required QC samples. Samples to be used for MS/MSDs will be noted on the COC. The laboratory must make every effort to extract and analyze all samples including QC samples within an SDG together. These rules for analysis will provide that the QC samples for an SDG are applicable to the field samples of the same SDG and that the best possible comparisons may be made.

Information regarding the sample, analytical procedures performed, and the results of the testing will be recorded in a laboratory notebook by the analyst. These notes will be dated and identify the analyst, the instrument used, and the instrument conditions.

5.2.4 Laboratory Project Files

During the Site characterization, the laboratory will establish a file for all pertinent data. These files will include the COC forms, raw data, chromatograms (required for all constituents analyzed by chromatography), and sample preparation information. The laboratories will retain project records for 5 years.

5.2.5 Sample Storage Following Analysis

Once an analysis is complete, the unused portion of a sample and all identifying tags and laboratory records will be maintained by the laboratory conducting the analyses. Samples will be retained at the laboratory for a period of 60 days. Samples requiring a longer retention period must be agreed upon before samples arrive. If a sample is going to be retained longer than 60 days, this retention notice needs to be noted on the COC.

5.3 Project File

Site characterization documentation will be placed in a single project file at the ARCADIS office in Raleigh, North Carolina. Each client project is assigned a file/job number. Each file is then broken down into the following subfiles:

- Agreements (filed chronologically);
- Correspondence (filed chronologically);
- Memos (filed chronologically); and
- Notes and Data (filed by topic).

Originals, when possible, are placed in the files. These are the central files and will serve as the Site-specific files for the investigations.

Analytical reports (including QA reports) and laboratory documentation (when received) will be filed in the Miscellaneous file. Field data will be filed with Field Logs and Notes. Filed materials may be removed and signed out by personnel on a temporary basis only.

6. Calibration Procedures

6.1 Field Equipment Calibration Procedures and Frequency

Specific procedures for performing and documenting calibration and maintenance for the XRF field screening equipment for measuring arsenic and lead are provided in the FSP. Calibration checks will be performed at least daily when the instrument is in use. Calibration requirements for other field measurements are listed in Table 6-1.

6.2 Laboratory Equipment Calibration Procedures and Frequency

Instrument calibration will follow the specifications provided by the instrument manufacturer or specific analytical method used. Initial and continuing calibrations will be performed according to the requirements of SW-846.

7. Analytical Procedures

7.1 Field Analytical Procedures

Field analytical procedures will include the screening level measurement of arsenic and lead. Specific field measurement protocols are provided in the FSP.

7.2 Laboratory Analytical Procedures

Laboratory analytical requirements presented in the subsections below include a general summary of requirements, specific information related to each sample medium to be analyzed, and details of the methods to be used for this project. Current SW-846 methods will be used for all applicable parameters (e.g., metals) and sample media (soil and groundwater).

7.2.1 General

The tables listed below summarize the general analytical requirements:

Table	Title
3-1	Environmental and Quality Control Sample Analyses
3-2	Parameters, Methods, and Reporting Limits
4-1	Sample Containers, Preservation, and Holding Times

The primary sources for methods used in this investigation are provided in the following documents:

- Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Update 3, USEPA (2007).

7.2.2 Chemical Constituents

Inorganic analyses will be performed by SW-846 methods and will be reported as complete data validation packages using “CLP-like” forms. Additional analyses (i.e., pH, TCLP) will be reported to the reporting limits identified in Table 3-2 using Level 2 deliverables (see Section 8.2.3).

8. Data Reduction, Review, and Reporting

After field and laboratory data are obtained, these data will be subject to:

- Validation;
- Reduction, via mathematical manipulation or otherwise, into meaningful and useful forms; and
- Organization, interpretation, and reporting.

8.1 Field Data Reduction, Review, and Reporting

8.1.1 Field Data Reduction

Information that is collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks, data sheets, and/or forms. Such data will be reviewed by the appropriate Task Manager for adherence to the FSP and consistency. Any concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and, as necessary, incorporated into the data evaluation process.

8.1.2 Field Data Review

Field data calculations, transfers, and interpretations will be performed by field personnel and reviewed for accuracy by the appropriate Task Manager and the Quality Assurance Manager. All logs and documents will be checked for:

- General completeness;
- Readability;
- Appropriate procedures usage;
- Appropriate instrument calibration and maintenance;
- Reasonableness in comparison to present and past data collected;
- Correct sample locations; and
- Correct calculations and interpretations.

8.1.3 Field Data Reporting

Where appropriate, field data forms and calculations will be processed and included in appendices to the report. The original field logs, documents, and data reductions will be kept in the project file at the ARCADIS office in Raleigh, North Carolina, for a minimum of 3 years.

8.2 Laboratory Data Reduction, Review, and Reporting

8.2.1 Laboratory Data Reduction

Laboratory analytical data will be transferred from the instrument to the computer or the data reporting form (as applicable) by the analyst. Calculations of sample concentrations are performed using the calculation procedures specified by the analytical method used including, as applicable, use of regression analysis, response factors, and dilution factors. Soil values will be reported on a dry weight basis. Unless otherwise specified, values will be reported uncorrected for blank contamination.

8.2.2 Laboratory Data Review

Raw data will be examined to assess compliance with QC guidelines. Surrogate, MS/MSDs, and QC check sample recoveries will be reviewed, in addition to checking samples for possible contamination or interferences. Concentrations will be checked to verify that the systems are not saturated; if necessary, dilutions will be performed.

Any deviations from the guidelines will call for corrective action. Those deviations determined to be caused by factors outside the laboratory's control, such as matrix interference, will be noted with an explanation in the report narrative. Calculations will be checked and the report reviewed for errors and oversights. Reports will be validated by the Quality Assurance Manager or his/her appropriately trained designee prior to release.

Once a report is complete, it will be reviewed for discrepancies, errors, or omissions. The data will then be submitted to the laboratory Quality Assurance Manager or his/her appropriately trained designee for review. The Quality Assurance Manager or his/her appropriately trained designee will review the package, see that any necessary corrections are made, and give the package to the Project Manager or his/her appropriately trained designee, who will review it for completeness and compliance. A copy of the package will be filed in the project file. The mailed package(s) will be sealed in an appropriate shipping container with a custody seal and logged into a document-mailing log.

8.2.3 Laboratory Data Reporting

The laboratory is responsible for reporting sample data both in tabular form, in data packages containing “CLP-like” deliverables, and well as electronically (see Section 9). A “CLP-like” deliverable refers to full data package back-up documentation that includes equivalent information fields included on the various CLP Statement of Work forms. Tabulated data will be organized by method and sample with reference to the sample by both field and laboratory identifications.

For the inorganic analyses, a full “CLP-like” data package and case narrative will be provided for each SDG. In addition, each “CLP-like” data package will include all applicable sample preparation records, including extraction sheets, digestion sheets, percent solids, logbook pages, and run log pages. Level II data packages will be prepared for all non-Target Analyte List analytes.

8.3 Data Validation

Data validation entails a review of the QC data and the raw data to verify that the laboratory was operating within required limits, the analytical results are correctly transcribed from the instrument readouts, and which, if any, environmental samples are related to any out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements and to determine if the quality is sufficient to meet the data quality objectives.

The validator will use the most recent versions of the following USEPA document available at the time of project initiation as guidance, where appropriate:

- USEPA Contract Laboratory Program National Functional Guidelines (NFG) for Inorganic Data Review, EPA-540-R-04-004 (October 2004).

The data validator will conduct a comprehensive, technical evaluation of the data reported by each laboratory. This evaluation will include examination of the finished data sheets, calculation sheets, document control forms, blank data, duplicate data, and recovery data for matrix and surrogate spikes. The material will be checked for legibility, completeness, correctness, and the presence of necessary dates, initials, and signatures. Assessment of analytical data will also include checks for data consistency by assessing comparability of duplicate analyses, comparability to previous data from the same sampling location (if available), adherence to accuracy and precision criteria, transmittal errors, and anomalously high or low parameter values. The results of these checks will be assessed and reported to the ARCADIS Project Manager noting any discrepancies and their effect on the acceptability of the data.

Validation of analytical data not specifically covered in any of the existing validation guidelines will be performed based on adherence to the specific method and best professional judgment.

It should be noted that the existence of qualified results does not automatically invalidate data. This point is repeatedly emphasized in the USEPA NFGs and is inherently acknowledged by the very existence of the data validation/flagging guidelines. The goal to produce the best possible data does not necessarily mean producing data without QC qualifiers. Qualified data can provide useful information.

Resolution of any issues regarding laboratory performance or deliverables will be handled between the ARCADIS data validator and the ARCADIS Quality Assurance Manager. Suggestions for reanalysis may be made to the ARCADIS Quality Assurance Manager at this point.

Upon completion of the validation of each SDG/parameter, a report addressing the following topics, as applicable to each method, will be prepared by the validator:

Inorganic Analyses

- Sample holding time;
- Sample preparation log;
- Instrument calibration;
- Blanks;
- Interference check sample analysis;
- MS analysis;
- Laboratory control sample analysis;
- Quarterly verification of instrument parameter report; and
- Overall assessment of data.

9. Data Management

The purpose of the data management is to ensure that all of the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The field investigations will encompass the collection of data for a large number of samples and analytes from a large geographic area. Due to the large amount of resulting data, the need arises for a structured, comprehensive, and efficient program for management of data.

The data management program established for the project includes field documentation and sample QA/QC procedures, methods for tracking and managing the data, and a system for filing all Site-related information. More specifically, data management procedures will be employed to efficiently process the information collected such that the data are readily accessible and accurate. These procedures are described in detail in the following section.

The data management plan has four elements: 1) sample designation system; 2) field activities; 3) sample tracking and management; and 4) data management system.

9.1 Sample Designation System

A concise and easily understandable sample designation system is an important part of the project sampling activities. It provides a unique sample number that will facilitate both sample tracking and easy re-sampling of select locations to evaluate data gaps, if necessary. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sample collected, as outlined in the FSP.

9.2 Field Activities

Field activities designed to gather the information necessary to make decisions require consistent documentation and accurate recordkeeping. During Site activities, standardized procedures will be used for documentation of field activities, data security, and QA. These procedures are described in further detail in the following subsections.

9.2.1 Field Documentation

Complete and accurate recordkeeping is a critical component of the field investigation activities. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To ensure that the field investigation is thoroughly documented, several different information records, each with its own specific reporting requirements, will be maintained, including:

- Field logs; and
- COC forms.

A description of each of these types of field documentation is provided below.

Field Logs

The personnel performing the field activities will keep a field log that details all observations and measurements made during the remedial investigation. Data will be recorded directly into Site-dedicated, bound notebooks, with each entry dated and signed. To ensure at any future date that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry, initialing it, and then documenting the proper information. In addition, certain media sampling locations will be surveyed to accurately record their locations. The survey crew will use their own field logs and will supply the sampling location coordinates to the Project Manager or his/her designee.

Chain-of-Custody Forms

COC forms are used as a means of documenting and tracking sample possession from time of collection to the time of disposal. A COC form will accompany each field sample collected, and one copy of the form will be filed in the field office. All field personnel will be briefed on the proper use of the COC procedure.

9.2.2 Data Security

Measures will be taken during the field investigation to ensure that samples and records are not lost, damaged, or altered. When not in use, all field notebooks will be stored at the field office or locked in the field vehicle. Access to these files will be limited to the field personnel who utilize them.

9.3 Sample Management and Tracking

A record of all field documentation will be maintained to ensure the validity of data used in the Site analysis. To effectively execute such documentation, specific sample tracking and data management procedures will be used throughout the sampling program.

Sample tracking will begin with the completion of COC forms. The completed COC forms associated with samples collected will be faxed to the Quality Assurance Coordinator (QAC). Copies of all completed COC forms will be maintained in the field office. The laboratory shall verify receipt of the samples electronically (via email) on the following day.

When analytical data are received from the laboratory, the QAC will review the incoming analytical data packages against the information on the COCs to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis were received. Any discrepancies noted will be promptly followed up by the QAC.

9.4 Data Management System

In addition to the sample tracking system, a data management system will be implemented. The central focus of the data management system will be the use of the LOCUS Environmental Information Management data management system and may include a personal computer-based project database. Laboratory analytical data will go directly to LOCUS, with the ARCADIS Database Administrator responsible for the import of data into the database and export the data in various formats. The project database, to be maintained by the Database Administrator, will combine pertinent geographical, field, and analytical data. Information that will be used to populate the database will be derived from three primary sources: surveying of sampling locations, field observations, and analytical results. Each of these sources is discussed in the following sections.

9.4.1 Computer Hardware

If a personal computer-based project database is created for the project, this database will be constructed on personal computer work stations connected through a network server. The network will provide access to various hardware peripherals, such as laser printers, backup storage devices, image scanners, modems, etc. Computer hardware will be upgraded to industrial and corporate standards, as necessary, in the future.

9.4.2 Computer Software

LOCUS is a web-based system with a structured query language server back-end. ARCADIS personnel will have access to the web-based interface only. If a personal computer-based project database is created for the project, this database will be written in Microsoft Access, running in a Windows operating system. Custom applets, such as diskette importing programs, will be written in either Microsoft VBA or Microsoft Visual Basic. Geographic Information System (GIS) applications will be developed in ESRI ArcGIS, with additional customization performed with Visual Basic. Tables and other database reports will be generated through Access in conjunction with Microsoft Excel, Microsoft Word, and/or Seagate Crystal Reports. These software products will be upgraded to current industrial standards, as necessary.

9.4.3 Survey Information

Each location sampled will be surveyed to ensure accurate documentation of sample locations for mapping and GIS purposes, to facilitate the re-sampling of select sample locations during future monitoring programs, if needed, and for any additional activities. The surveying activities that will occur in the field will consist of the collection of information that will be used to compute a northing and easting in state plane coordinates for each sample location and the collection of information to compute elevations relative to the National Geodetic Vertical Datum of 1988 for select sample locations, as appropriate. All field books associated with the surveying activities will be stored as a record of the project activities.

9.4.4 Field Observations

An important part of the information that will ultimately reside in the data management system for use during the project will originate in the observations that are recorded in the field.

During each sampling event, appropriate field documentation will be prepared by the field personnel who performed the sampling activities. The purpose of the documentation is to create a summary and a record of the sampling event. Items to be included are the locations sampled, the sampling methodologies used, blind duplicate and MS/MSD sample identification numbers, equipment decontamination procedures, personnel involved in the activity, and any other noteworthy events that occurred.

9.4.5 Analytical Results

Analytical results will be provided by the laboratory in both a digital and a hard copy format. The data packages will be examined to ensure that the correct analyses were performed for each sample submitted and that all of the analyses requested on the COC form were performed. If discrepancies are noted, the QAC will be notified and will promptly follow up with the laboratory to resolve any issues.

Each data package will be validated. Any data that do not meet the specified standards will be flagged pending resolution of the issue. The flag will not be removed from the data until the issue associated with the sample results is resolved. Although flags may remain for certain data, the use of that data may not necessarily be restricted.

Following completion of the data validation, the digital files will be used to populate the appropriate database tables. This format specifies one data record for each constituent for each sample analyzed. Specific fields include:

- Sample identification number;
- Date sampled;
- Date analyzed;
- Parameter name;
- Analytical result;
- Units;
- Detection limit; and
- Qualifier(s).

The individual electronic data deliverables (EDDs), supplied by the laboratory in either an ASCII comma separated value format or in a Microsoft Excel worksheet, will be loaded from the LOCUS data management system into the appropriate database table. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually. After entry into the database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

9.4.6 Data Analysis and Reporting

The database management system will have several functions to facilitate the review and analysis of the data. Routines have been developed to permit the user to scan analytical data from a given site for a given media. Several output functions are also available which can be modified, as necessary, for use in the data management system.

A valuable function of the data management system will be the generation of tables of analytical results from the project databases. The capability of the data management system to directly produce tables reduces the redundant manual entry of analytical results during report preparation and precludes transcription errors that may occur otherwise. This data management system function creates a digital file of analytical results and qualifiers for a given media. The file can then be processed into a table of rows and columns which can be transferred to word processing software (e.g., Microsoft Word) for final formatting and addition of titles and notes. Tables of analytical data will be produced as part of data interpretation tasks and the reporting of data.

Another function of the data management system will be to create digital files of analytical results and qualifiers suitable for transfer to mapping/presentation software. A function has been created by ARCADIS that creates a digital file consisting of sample location number, state plane coordinates, sampling date, and detected constituents and associated concentrations and analytical qualifiers. The file is then transferred to an AutoCAD workstation, where another program has been developed to plot a location's analytical data in a "box" format at the sample location (represented by the state plane coordinates). This routine greatly reduces the redundant keypunching of analytical results and facilitates the efficient production of interpretative and presentation graphics.

The data management system also has the capability of producing a digital file of select parameters that exists in one or more of the databases. This type of custom function is accomplished on an interactive basis and is best used for transferring select information into a number of analysis tools, such as statistical or graphing programs.

9.4.7 Document Control and Inventory

ARCADIS maintains project files at its Raleigh, North Carolina, office. Each client project is assigned a file/job number. Each file is then broken down into the following subfiles:

1. Agreements/Proposals (filed chronologically)
2. Change Orders/Purchase Orders (filed chronologically)
3. Invoices (filed chronologically)
4. Project Management (filed by topic)
5. Correspondence (filed chronologically)
6. Notes and Data (filed by topic)
7. Public Relations Information (filed by topic)
8. Regulatory Documents (filed chronologically)
9. Marketing Documents (filed chronologically)
10. Final Reports/Presentations (filed chronologically)
11. Draft Reports/Presentations (filed chronologically)
12. Documents Prepared by Others (filed chronologically)

Originals, when possible, are placed in the files. These are the central files and will serve as the Site-specific files for the investigations.

10. Field and Laboratory Control Checks

10.1 Field Quality Control Checks

Field and laboratory QC checks are both proposed for the Site characterization. In the event that there are any deviations from these checks, the ARCADIS Quality Assurance Manager will be notified. The proposed field and laboratory control checks are discussed below.

10.1.1 Field Measurements

To verify the quality of data using field instrumentation, multiple measurements will be obtained and reported for all field measurements. The frequency of field measurements is specified in the FSP, also an appendix to the Work Plan. Project QC limits for field measurements are identified in Table 10-1.

10.1.2 Sample Containers

Sample containers that are cleaned and quality controlled in accordance with Office of Solid Waste and Emergency Response Directive No. 9240.0-05, *Specifications and Guidance for Obtaining Contaminant-Free Sample Containers* (1991) will be supplied by the laboratory. Sample containers used are in compliance with the method and USEPA criteria.

10.1.3 Field Duplicates

Field duplicates will be collected for soil and groundwater samples to check reproducibility of the sampling methods. Field duplicates will be prepared as discussed in the FSP. In general, soil and groundwater sample field duplicates will be analyzed at a 5 percent frequency (1 for every 20 samples).

10.1.4 Equipment Rinse Blanks

Equipment rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Rinse blanks will be prepared and submitted for analysis at a frequency of one rinse blank per type of equipment per decontamination event, not to exceed one per day. Rinse blanks will be collected at the beginning of the day prior to the sampling event and the blank must accompany those samples that were taken that day to ensure that the blank will be associated with the proper samples during data validation.

Reusable sampling equipment will be initially decontaminated. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory) that has been routed through a cleaned sampling device. All sampling equipment that may come into contact with the sampled medium must be included in the rinse blank process. For example, demonstrated analyte-free water will be poured over the stainless steel bowls and spoons used to homogenize soils as well as the split-spoon sampler and sample trowel. When sample containers are used to collect the samples, rinse blanks will not be necessary. Rinse blanks will not be collected for dedicated, pre-cleaned sampling equipment.

10.2 Laboratory Quality Control Checks

Internal laboratory QC checks will be used to monitor data integrity. These checks will include method blanks, MS/MSDs, laboratory control standards, internal standards, surrogate standards, calibration standards, and reference standards. Project QC limits for spike recovery and duplicate precision are identified in Tables 10-2 and 10-3.

10.2.1 Method Blanks

Sources of contamination in the analytical process, whether specific analytes or interferences, need to be identified, isolated, and corrected. The method blank is useful in identifying possible sources of contamination within the analytical process. For this reason, it is necessary that the method blank be initiated at the beginning of the analytical process and encompasses all aspects of the analytical work. As such, the method blank would assist in accounting for any potential contamination attributable to glassware, reagents, instrumentation, or other sources that could affect sample analysis. One method blank will be analyzed with each analytical series associated with no more than 20 samples. SW-846 guidelines for acceptance will be used. Guidelines for non-standard methods are provided in the appropriate protocols.

10.2.2 Matrix Spikes/Matrix Spike Duplicates

MS/MSDs will be used to measure the accuracy of analyte recovery from the sample matrices. All MS/MSD analyses will be performed on Site-specific samples. An MS/MSD will be analyzed at a 5 percent frequency (1 for every 20 samples). MS/MSD will be identified on the chain of custody.

MS results will be examined in conjunction with laboratory control standard (Section 10.2.3 of this QAPP) and surrogate spike (Section 10.2.4) results to assess the accuracy of the analytical method. When MS recoveries are outside QA acceptance limits, associated laboratory control standard and surrogate recoveries will be evaluated to attempt to verify the reason, often matrix interference, for the variance(s), and to determine the effect on the reported sample results.

10.2.3 Laboratory Control Standards

Laboratory control standards will be included to provide an additional assessment of analytical accuracy. The laboratory control standards provide an assessment of method performance without interferences that may be present in environmental samples and will be analyzed at a frequency of one blank per batch. For laboratory control standard analyses, clean matrix is spiked and recoveries are calculated similar to MS recoveries. The clean matrix will consist of laboratory-supplied analyte-free water. Laboratory control standard data will be assessed in conjunction with MS data, as discussed in Section 10.2.2 of this QAPP.

10.2.4 Laboratory Duplicates

For inorganic compounds and other supplemental parameters, laboratory duplicates will be analyzed to assess analytical precision. A laboratory duplicate is defined as a second aliquot of an individual field sample that is analyzed as a separate sample. Laboratory duplicates for the affected analyses will be analyzed at a 5 percent frequency (1 for every 20 samples). MS/MSD analysis may be substituted in place of the laboratory duplicate analysis.

10.2.5 Calibration Standards

Calibration standards will be analyzed according to the specifications of each analytical method to establish linearity and to monitor the instruments' stability on a regular basis. Laboratory instrument calibration standards will be analyzed following the guidance provided in the analytical methods summarized in Table 3-2.

10.2.6 Reference Standards

Reference standards are standards of known concentration and independent in origin from the calibration standards. Reference standards are generally available through the USEPA, the National Bureau of Standards, or are specified in analytical methods.

Reference standards are included in the analytical process, although in some aspects of sample handling and preparation these standards may not reflect the analytical process. The intent of reference standard analysis is to provide insight into the analytical proficiency within an analytical series. This includes the preparation of calibration standards, the validity of calibration, sample preparation, instrument set-up, and the premises inherent in quantitation.

11. Performance and System Audits

Performance and systems audits will be completed in the field and the laboratory during the Site characterization, as described below.

11.1 Performances Audits

The appropriate Task Manager will monitor field performance. Field performance audit summaries will contain an evaluation of field measurements and field meter calibrations to verify that measurements are taken according to established protocols. ARCADIS Quality Assurance Manager will review all field reports and communicate concerns to the ARCADIS Project Manager and/or Task Managers, as appropriate. In addition, the ARCADIS Quality Assurance Manager will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures.

11.1.1 Internal System Audits

A field internal systems audit is a qualitative evaluation of all components of field QA/QC. The systems audit compares scheduled QA/QC activities from this document with actual QA/QC activities completed. The appropriate Task Manager and Quality Assurance Manager will periodically confirm that work is being performed consistent with this QAPP, the Work Plan, the FSP, and the HASP.

11.1.2 External Audits

USEPA representatives may conduct audits of field operations, if determined necessary.

11.2 Laboratory Audits

Internal system audits are conducted by the laboratory Quality Assurance Manager. The audit is a qualitative evaluation of all components of the laboratory QC measurement system. The audit serves to determine if all measurement systems are being used appropriately. The system audits are conducted to evaluate the following:

- Sample handling procedures;
- Calibration procedures;
- Analytical procedures;

- QC results;
- Safety procedures;
- Recordkeeping procedures; and
- Timeliness of analysis and reporting.

In addition, as participants in various state and federal programs, laboratories are subject to external audits by the associated regulatory agencies. The focus of these audits is to assess general laboratory practices and conformance to specific program protocol.

ARCADIS reserves the right to conduct an on-site audit of the laboratory prior to the start of analyses for this project. Additional audits may be performed during the course of the project, as deemed necessary.

Laboratory performance is also reviewed by the laboratory Quality Assurance Manager. The laboratory Quality Assurance Manager evaluates laboratory precision and accuracy through comparison of results of duplicate samples and analyses, and through review of QC samples, spikes, and blanks. Analytical results are checked by the laboratory manager or other client services individual prior to distribution.

A review of laboratory performance and results of check samples analyzed as part of the USEPA and/or state certification requirements will be performed annually. In addition, ARCADIS may conduct performance audits by sending “double blind” performance evaluation (PE) samples (e.g., samples that are not discernable from routine field samples) to the analytical laboratory. The PE samples will consist of water containing a known amount of an analyte of interest.

11.2.1 Performance Evaluations

The laboratory participates in PE audits in accordance with state and other certifying agency requirements. At a minimum, the laboratory complies with the requirements of the National Environmental Laboratory Accreditation Council guidelines. Additionally, the laboratory participates in several regulatory agency, certifying group, or client-requested performance audits. These performance audits include both single- and double-blind PE samples. Internal performance audits are logged into the laboratory information management system and analyzed and reported in the same manner as samples. Results from these performance audits are reported to management, agencies, and clients as required. Nonconformance reports and corrective action reports are issued when appropriate.

11.2.2 External Audits

There are three mechanisms by which external laboratory audits may be conducted.

1. The data validator will provide an evaluation of laboratory performance for all data packages submitted for review.

2. The USEPA may conduct audits of laboratory operations, if deemed necessary.

3. As a participant in state and federal certification programs, sections at the laboratory are audited by representatives of the regulatory agency issuing certification. Audits focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification.

12. Preventive Maintenance

Preventive maintenance schedules have been developed for both field and laboratory instruments. A summary of the maintenance activities to be performed is presented below.

12.1 Field Instruments and Equipment

Prior to any field sampling, each piece of field equipment will be inspected to ensure it is operational. If the equipment is not operational, it must be serviced prior to use. All meters that require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, it is the responsibility of the appropriate Task Manager or designee to follow the maintenance schedule and arrange for prompt service.

Field instrumentation to be used in this study includes an XRF Spectrum Analyzer. Field equipment also includes sampling devices for soil and groundwater. A logbook will be kept for each field instrument. Each logbook contains records of operation, maintenance, calibration, and any problems and repairs. Calibration information will be traced to serial numbers. The ARCADIS Task Manager will review calibration and maintenance logs.

Field equipment returned from a site will be inspected to confirm it is in working order. This inspection will be recorded in the logbook or field notebooks as appropriate. It will also be the obligation of the last user to record any equipment problems in the logbook.

Non-operational field equipment will be either repaired or replaced. Appropriate spare parts will be made available for field meters. A summary of preventive maintenance requirements for field equipment is provided in Table 12-1. Details regarding field equipment maintenance, operation, and calibration are provided in the FSP.

12.2 Laboratory Instruments and Equipment

Instruments and equipment will be serviced only by qualified personnel. All repairs, adjustments, and calibrations will be documented in dedicated logbooks. Documentation includes details of any observed problems, corrective measure(s), routine maintenance, and instrument repair (which will include information regarding the repair and the individual who performed the repair).

Preventive maintenance of laboratory equipment generally will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired immediately by in-house staff or through a service call from the manufacturer.

The laboratory will maintain a sufficient supply of spare parts to minimize downtime. Whenever possible, back-up instrumentation will be maintained.

A summary of required equipment maintenance is provided in Table 12-2.

13. Data Assessment Procedures

The analytical data generated during the Site characterization will be evaluated with respect to precision, accuracy, and completeness and compared to the DQOs set forth in Sections 1 and 3 of this QAPP. The following tables summarize QC limits required to evaluate analytical performance:

Table	Title
10-2	Water Analyses Spike Recovery and Duplicate Precision QC
10-3	Soil Analyses Spike Recovery and Duplicate Precision QC

The procedures utilized when assessing data precision, accuracy, and completeness are presented below.

13.1 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision for inorganic analyses will be monitored through the use of MS/MSD sample analyses. For other parameters, laboratory data precision will be monitored through the use of field duplicates as identified in Table 3-1.

Precision objectives for duplicate analyses are identified in Tables 10-2 and 10-3.

13.2 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs.

Laboratory accuracy will be assessed via the use of MS, surrogate spikes, and reference standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated in terms of percent recovery as follows:

$$\% \text{ Recovery} = \frac{A - X}{B} \times 100\%$$

where:

A = Value measured in spiked sample or standard

X = Value measured in original sample

B = True value of amount added to sample or true value of standard

This formula assumes constant accuracy between the original and spiked sample measurements. Accuracy objectives for MS recoveries are identified in Tables 10-2 and 10-3.

13.3 Data Completeness

Completeness of a field or laboratory data set will be calculated by comparing the number of valid (or usable) sample results generated to the total number of results generated:

$$\text{Completeness} = \frac{\text{No. Valid Results}}{\text{Total No. Results Generated}} \times 100\%$$

As a general guideline, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

14. Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QAPP, the Work Plan, or the FSP. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the Site characterization are described below.

14.1 Field Procedures

When conducting the Site characterization fieldwork, if a condition is noted that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action implemented will be documented on a Corrective Action Report Form (Figure 14-1) and reported to the appropriate ARCADIS Task Manager, Quality Assurance Manager, and Project Manager. The Quality Assurance Manager will be responsible for follow-up and acceptance of corrective actions.

Examples of situations that would require corrective actions are provided below:

- Protocols as defined by the QAPP and FSP have not been followed;
- Equipment is not in proper working order or properly calibrated;
- QC requirements have not been met; and
- Issues resulting from performance or systems audits.

Project personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

14.2 Laboratory Procedures

14.2.1 General

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action to be taken will be documented and reported to the appropriate project manager and Quality Assurance Manager.

Corrective action may be initiated, at a minimum, under the following conditions:

- Protocols as defined by this QAPP have not been followed;
- Predetermined data acceptance standards are not attained;
- Equipment is not in proper working order or calibrated;
- Sample and test results are not completely traceable;
- QC requirements have not been met; and
- Issues resulting from performance or systems audits.

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities. Additional details of corrective action procedures used by each laboratory are provided below.

14.2.2 Laboratory Procedures

If, because of audits or QC sample analyses, the methods system proves to be unsatisfactory, corrective action shall be implemented. The Laboratory Project Manager, Department Manager, Quality Assurance Officer, Supervisor, and Analyst may be involved in the corrective action. If previously reported data are affected by a situation requiring correction or if the corrective action impacts a project budget or schedule, the action will directly involve the Project Manager (and Quality Assurance Manager).

For immediate or long-term corrective actions, steps comprising a closed-loop corrective action system are as follows:

1. Define the problem.
2. Assign responsibilities for problem investigation.
3. Investigate and determine the cause of the problem:
   a. Check all calculations;
   b. Reanalyze the sample;
   c. Verify the integrity of the spiking solution, laboratory control sample, or calibration standard; and
   d. Check instrument and operating conditions to preclude the possibility of malfunctions or operator error.

4. Determine the corrective action(s) necessary to eliminate the problem.
5. Assign and accept responsibilities for implementing the corrective action.
6. Establish the effectiveness of the corrective action and implement the correction.
7. Verify and document that the corrective action has eliminated the problem (using a Discrepancy Report Form).

Depending upon the nature of the problem, the corrective action implemented may be formal or informal. In either case, occurrence of the problem, the corrective action employed, and verification that the problem has been eliminated must be documented.

In addition, if the corrective action mandates the preparation of a new standard or calibration solution(s), a comparison study between the new solution versus the old solution will be performed. The results are supplied with the weekly QC submittal as verification of problem elimination.

15. Quality Assurance Reports

The data validator will submit validation report(s) to the ARCADIS Quality Assurance Manager, consistent with the requirements presented in Section 8.3. The ARCADIS Quality Assurance Manager will review analytical concerns identified by the data validator with the laboratory. For data qualified by the data validator, data usability will be assessed by data users relative to project decision-making requirements. Supporting data (e.g., related field or laboratory data) will be reviewed to assist with determining data quality, as appropriate. The ARCADIS Quality Assurance Manager will incorporate results of data validation reports and assessments of data usability into a summary report that will be submitted to the ARCADIS Project Manager and appropriate Task Managers. This report will be filed in the project file at ARCADIS' office in Raleigh, North Carolina, and will include the following:

- Assessment of data accuracy, precision, and completeness for both field and laboratory data;
- Results of the performance and systems audits;
- Significant QA/QC problems, solutions, corrections, and potential consequences; and
- Analytical data validation report.

16. References

USEPA. 1991. Office of Solid Waste and Emergency Response (OSWER) Directive No. 9240.0-05, *Specifications and Guidance for Obtaining Contaminant-Free Sample Containers.* July.

USEPA. 2002. Guidance for Quality Assurance Project Plans. EPA-QA/G-5. Office of Environmental Information. December.

USEPA. 2004. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540-R-04-004. October.

USEPA. 2007. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Washington, D.C., SW-846 Third Edition, Update IV: Office of Solid Waste and Emergency Response. February.

USEPA. 2012. *Field Branches Quality System and Technical Procedures*, USEPA Region 4, Athens, Georgia. January.

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Tables

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Table 3-1
Environmental and Quality Control Sample Analyses
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Environmental Sample Matrix Laboratory Parameters	Estimated Environmental Sample Quantity	Field QC Samples						Estimated Environmental and Field QC Sample Total	Laboratory QC Samples[\2]				Total Estimated Environ. and QC Samples
		Trip Blank		Field Duplicate		Rinse Blank[\1]			Matrix Spike		Matrix Spike Duplicate		
		Freq.	No.	Freq.	No.	Freq.	No.		Freq.	No.	Freq.	No.	
Soil													
Total Arsenic and Lead	151	--	--	1/20	8	1/day	15	174	1/20	9	1/20	9	191
pH	146	--	--	1/20	7	--	--	153	--	--	--	--	153
TCLP Arsenic and Lead	5	--	--	1/20	1	--	--	6	1/20	1	--	--	7
TCLP Metals	1	--	--	--	--	--	--	1	--	--	--	--	1
Groundwater (Hydropunch™/Temporary Monitoring Wells)													
Dissolved Arsenic and Lead	5	--	--	1/20	1	1/day	2	8	1/20	1	1/20	1	12
Groundwater (Permanent Monitoring Wells)													
Total Arsenic and Lead[\5]	10	--	--	1/20	1	1/day	3	14	1/20	1	1/20	1	16
Dissolved Arsenic and Lead[\5]	6			1/20	1	1/day	2	9	1/20	1	1/20	1	11
TAL Metals	2	--	--	--	--	--	--	2	--	--	--	--	2
pH	12	--	--	--	--	--	--	12	--	--	--	--	12

Notes:

\1 One rinse blank per day per type of sample collection equipment used.

\2 The number of laboratory QC analyses is based on the frequencies given for the number of environmental samples estimated not including field QC analyses, but assumes that the samples will be processed in groups of 20 samples.

3. The number of soil samples analyzed for metals and pH is estimated.
4. TAL and metals analyses will be run using SW-846 methods.
5. In case the existing groundwater monitoring wells are found in a good condition, groundwater samples will be collected for total and dissolved lead and arsenic.

QC - Quality Control

TCLP - Toxicity Characteristic Leaching Procedure

TAL - Target Analyte List

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Table 3-2
Parameters, Methods, and Reporting Limits
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Water and Soil Samples Chemical Constituents Target Analyte List (TAL) SW-846 Analytical Procedures		
	Reporting Limit	
Analyte	Water (ppb)	Soil\1 (ppm)
Aluminum	100	20
Antimony	10	10
Arsenic	10	1
Barium	10	2
Beryllium	4	1
Cadmium	1	1
Calcium	1000	100
Chromium	5	1
Cobalt	20	3
Copper	10	2
Iron	50	10
Lead	5	1
Magnesium	1000	10
Manganese	15	3
Mercury	0.2	0.1
Nickel	10	2
Potassium	1000	100
Selenium	10	2
Silver	5	1
Sodium	1000	200
Thallium	10	2
Vanadium	20	10
Zinc	50	10

Analyses	Reporting Limit
Soil Supplemental Parameters	
pH (SW-846 9040B/9045C)	0-14 s.u.
TCLP - SW-846 1311/6000/7000 (mg/L)	
Arsenic	0.1
Barium	0.1
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.01
Selenium	0.1
Silver	0.05

Notes:

\1 Estimated soil reporting limits based on method specifications and water detection limits.

mg/L - milligrams per liter

ppb - parts per billion

ppm - parts per million

QC - Quality Control

s.u. - standard units

TAL - Target Analyte List

TCLP - Toxicity Characteristic Leaching Procedure

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Table 4-1
Sample Containers, Preservation, and Holding Times
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Parameter	Method	Bottle Type	Preservation	Holding Time
Soil				
Arsenic and Lead	SW-846 6010	500mL glass or plastic jar *(2 or 4oz glass or plastic jar)*	No temperature requirement	6 months from collection
pH	SW-846 9045D		Cool to <6°C	Analyze as soon as possible
TCLP Metals	SW-846 6010C/1311	4oz glass jar	Cool to <6°C	RCRA metals minus Hg=180 days; Hg=28 days
Water				
Total Arsenic and Lead	SW-846 6010	250mL Poly	HNO3 to pH<2	6 months from collection
Dissolved Arsenic and Lead	SW-846 6010	If field filtering: 250mL Poly w/HNO_3 If lab filtering: 250mL Poly NP	HNO3 to pH<2 (depending on filtering location)	6 months from collection
TAL Metals (minus Hg)	EPA 200.7	250mL Poly	HNO3 to pH<2	180 days from collection
Mercury	EPA 245.1	250mL Poly	HNO3 to pH<2	28 days from collection
pH	SW-846 9040C or SM 4500 H B	125mL Poly	Cool to <6°C	Analyze as soon as possible

Notes:
TAL - Target Analyte List
SM - Standard Method
TCLP - Toxicity Characteristic Leaching Procedure
RCRA - Resource Conservation and Recovery Act

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Table 6-1
Field Calibration Frequency
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Equipment	Calibration Check	Calibration Standard	Calibration Standard Holding Time
pH Meter	Prior to use - daily	pH 4.0 pH 7.0 pH 10.0	1 month
Conductivity Meter	Prior to use - daily	1,000 mg/L Sodium Chloride	1 month
Dissolved Oxygen Meter	Prior to use - daily	Atmospheric Oxygen	1 week
Water Level Meter	Prior to implementing field work	100-foot engineer's tape	Not Applicable
Turbidity Meter	Prior to use - daily	Formazin 0.5 NTU, 5.0 NTU, 40.0 NTU	Not Applicable
Photoionization Detector (PID)	Prior to use - daily	100 ppm isobutylene	2 years
Multi-Rae Plus Gas Monitor with PID	Prior to use - daily	100 ppm isobutylene and gas blend (50 ppm CO, 2.5% by volume of methane, 25 ppm hydrogen sulfide, and the balance is air)	2 years
X-ray Fluorescence (XRF) Analyzer	Prior to use - at least daily	National Institute of Standards and Technology (NIST)	Not Applicable

mg/L - milligrams per liter
NTU - Nephelometric turbidity units
ppm - parts per million

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Table 10-1
Field Measurements Quality Control
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Field Parameter	Matrix	Precision\1	Accuracy
Water Temperature	Water	± 1°C	± 1°C instrument capability
pH	Water	± 1 pH s.u.	± 1 pH s.u. (instrument capability)
Conductivity	Water	± 10 mS/cm	± 5% standard
Dissolved Oxygen	Water	± 0.5 ppm O_2	± 1 ppm O_2
Water Level	Water	± 0.01 foot	± 0.1 foot
Turbidity	Water	± 1 NTU	± 2% standard
Photoionization Detector	Soil	± 0.1 ppm	± 1%

Notes:

\1 Precision units presented in applicable significant figures.

mS/cm - millisiemens per centimeter

NTU - Nephelometric turbidity unit

ppm - parts per million

s.u. - standard units

Table 10-2
Water Analyses Spike Recovery and Duplicate Precision QC[1]
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Constituent	Method	Accuracy\2 (% Recovery)	Precision\3 (RPD)
Inorganics			
All TAL Inorganics	SW-846	75-125	50

Notes:

\1 The listed QC limits are based on SW-846 guidance and are advisory. The actual limits are determined based on laboratory performance. Frequent failure to meet the QC limits; however, warrant investigation of the laboratory.

\2 For matrix spike.

\3 For laboratory duplicates.

QC - Quality Control

TAL - Target Analyte List

RPD - Relative Percent Difference

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Table 10-3
Soil Analyses Spike Recovery and Duplicate Precision QC[1]
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Constituent	Method	Accuracy[\2] (% Recovery)	Precision[\3] (RPD)
Inorganics			
All TAL Inorganics	SW-846	75-125	100
TCLP metals	SW-846	80-120	100

Notes:
\1 The listed QC limits are based on SW-846 guidance and are advisory. The actual limits performance is determined based on laboratory limits performance. Frequent failure to meet the QC limits, however, warrant investigation of the laboratory.
\2 For matrix spike.
\3 For laboratory duplicates.
QC - Quality Control
TAL - Target Analyte List
TCLP - Toxicity Characteristic Leaching Procedure
RPD - Relative Percent Difference

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Table 12-1
Field Equipment Preventive Maintenance
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Maintenance	Frequency
Conductivity and pH Meters	
-Store in protective casing	D
-Inspect equipment after use	D
-Clean probe	D
-Keep log book on instrument	D
-Have replacement meter available	D
-Replace probes	X
-Return to manufacturer for service	X
-Calibration	D
Thermometer	
-Store in protective casing	D
-Inspect equipment after use	D
-Have a replacement thermometer	D
Water Level Meter	
-Store in protective covering	D
-Inspect equipment after use	D
-Check indicators/batteries	D
-Keep log book on instrument	D
-Have a replacement meter available	X
Photoionization Detector	
-Store in protective casing	D
-Inspect equipment after use	D
-Check and re-charge batteries	D
-Clean UV lamp and ion chamber	Monthly, or as needed
-Update instrument log book	D
-Calibrate	D
-Return to manufacturer for service	X
Turbidity Meter	
-Store in protective casing	D
-Inspect equipment after use	D
-Clean sample cells	X
-Clean lens	D
-Check and re-charge batteries	D
-Keep log book on instrument	D
-Have replacement meter available	D
-Return to manufacturer for service	X
-Calibrate	D
X-ray fluorescence (XRF) Analyzer	
-Store in protective casing	D
-Inspect equipment after use	D
-Check and re-charge batteries	D
- Check the measurement window	D
-Update instrument log book	D
-Calibrate	D
-Return to manufacturer for service	X

Notes:
D = Daily
X = Operator's discretion

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Table 12-2
Laboratory Equipment Preventive Maintenance
Quality Assurance Project Plan
VCC Memphis Site - Memphis, Tennessee

Instrument	Maintenance Procedure	Spare Parts
pH Meter	1. Keep electrode properly filled with appropriate electrolyte solution. 2. After use with samples containing free oil, wash the electrode in soap and rinse thoroughly with water. Immerse the lower third of the electrode in diluted HCl solution for 10 minutes to remove any film formed. Rinse thoroughly with water.	1. Standard buffer solutions 2. Filling electrolyte 3. Spare electrode
Balance	1. Check balance against certified weights daily. 2. If weights are outside control limits, return unit to manufacturer for service. 3. Have balance inspected by a certified technician annually.	1. Backup balance

Figure

FIGURE 14-1

Quality Assurance Project Plan
Corrective Action Form

CAR No.: ___________________________________ Date:_____________________

To: _______________________________________ cc: Task Manager

You are hereby requested to take corrective actions indicated below and as otherwise determined by you (A) to resolve the noted condition and (B) to prevent it from reoccurring. Your written response is to be returned to the Quality Assurance Officer (QAO).

____

Condition

____

Reference Documents

____

Recommended Corrective Actions

____

Originator Date QAO Approval Date P.M. Approval Date

____

Response

____

Corrective Action

A. Resolution
B. Prevention
C. Affected Documents

Signature______________________________ Date_____________________________

____

Follow-up

Corrective Action Verified:

By: ___________________________________ Date: ____________________________

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Attachment A

TestAmerica Laboratories QAM – Revision 21 (included on CD-ROM)

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Appendix C

Health and Safety Plan

Infrastructure · Water · Environment · Buildings

Imagine the result

ExxonMobil Environmental Services Company

Health and Safety Plan

Former Virginia-Carolina Chemical Corporation Site

Memphis, Tennessee

May 2012

ARCADIS

I have read and approved this Health and Safety Plan (HASP) with respect to project hazards, regulatory requirements, and ARCADIS procedures.

Project Name: Former Virginia-Carolina Chemical Corporation Site, Memphis, Tennessee

Project Number: B0085789

Matthew Pelton, Project Manager

Greg Ertel, CIH, CSP, Health and Safety Officer

I acknowledge receipt of this HASP 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/or the Health and Safety Officer.

Site Supervisor

Health and Safety Plan

Former Virginia-Carolina Chemical Corporation Site, Memphis, Tennessee

Prepared for:
ExxonMobil Environmental Services Company

Prepared by:
ARCADIS U.S., Inc.
801 Corporate Center Drive
Suite 300
Raleigh
North Carolina 27607
Tel 919.854.1282
Fax 919.854.5448

Our Ref.:
B0085789.1201.00002

Date:
May 2012

Attachments

Control Page – Document Control

This Health and Safety Plan (HASP) should be amended whenever there is a new work scope activity, significant change in site conditions, change in personnel, etc.

Because this document may be revised frequently, document control is necessary to ensure that changes, if any, get incorporated in an effective manner. Each time the HASP is amended or updated, the date of the latest revision should be included on the cover page and the document control list that follows.

Copy	Rev. #	Person	Location
001	01	Lauren Gordon, EMES	Fairfax, VA
002	01	Matthew Pelton, ARCADIS	Raleigh, NC
003	01	Site copy (because EMES does not own the land or buildings on the property, this copy is to be checked out by Field Technicians before going to the site).	Raleigh, NC (see M. Pelton)

Revision History

Initial Date:	2/18/10	Rev-00	By:	Anna Hagemeister
Revision Date:	5/1/12	Rev-01	By:	Ashima Bagga
Revision Date:				
Revision Date:			By:	
Revision Date:			By:	
Revision Date:			By:	

Health and Safety Plan and Job Safety Analysis Acknowledgment

I have developed/reviewed the Health and Safety Plan and Job Safety Analyses for the VCC Memphis, Tennessee site. I understand the contents and I agree to abide by the procedures.

Name (Print)	Signature	Representing/Title	Date

Emergency Contact Information

Local Emergency Contacts – Notify Immediately as Needed

Local Emergency Contacts	Telephone No.
Fire: Memphis Fire Department	901.458.8281 or 911 Alternate No.: 901.458.3311
Police: Memphis Police	901.545.2677 or 911
Hospital/Ambulance: Methodist LeBonheur Germantown Hospital	901.516.6970 or 911
WorkCare Clinic: Concentra – Memphis	901.348.0200
USEPA National Response Center	1.800.424.8802
Poison Control Center	1.800.222.1222
ARCADIS Near Loss Reporting Hotline	1.866.242.4304
Work Care	1.800.455.6155

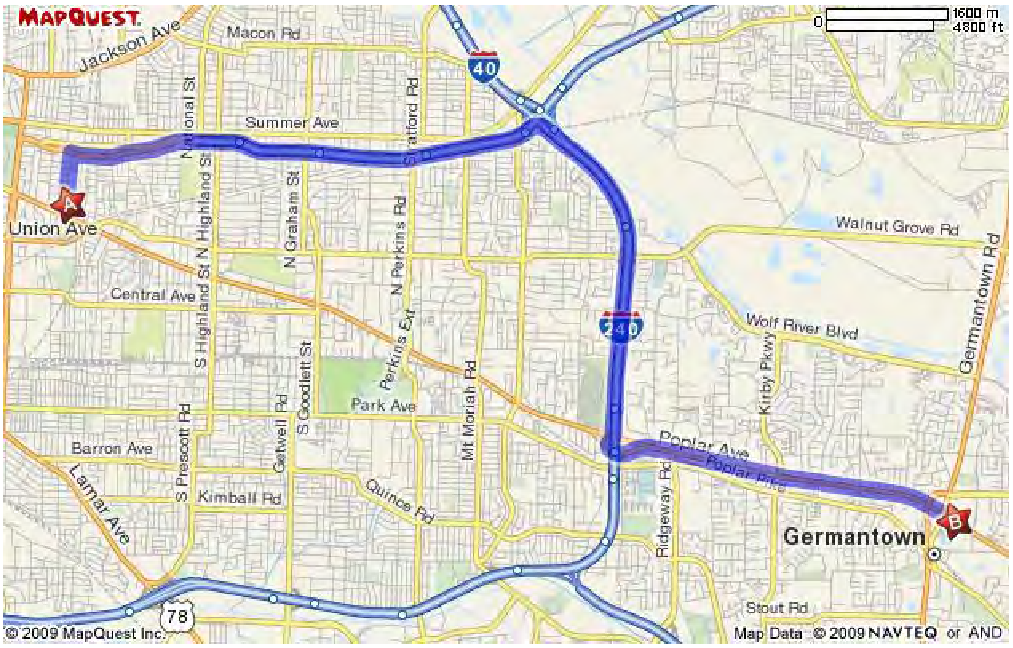
Emergency Project Manager Contacts – Notify Immediately

Project Emergency Contacts		Telephone No.
ARCADIS: Matthew Pelton 801 Corporate Center Drive, Suite 300 Raleigh, NC 27607	Work	919.415.2308
	Cell	919.270.9512
EMES: Lauren Gordon 3225 Gallows Road, Room 8B1020 Fairfax, VA 22037	Work	703.846.3804
	Cell	703.673.8854

Key Personnel – Notify Within 24 Hours

ARCADIS Personnel		
Role	**Name**	**Address/Telephone No.**
Health and Safety Officer	Greg Ertel, CIH, CSP	295 Woodcliff Drive Third Floor Suite 301 Fairport, NY 14450 Work: 585.385.0090 Cell: 585.303.0633
Site Supervisor/ Health and Safety Supervisor	TBD	TBD
Subcontractor Personnel		
Role	**Name**	**Address/Telephone No.**
Subsurface Utility Locating	U.P. Spec Services Tom Stevens	315 Wild Turkey Trail Cleveland, GA 30528 Cell: 706.892.8095
Drillers	TBD	TBD
Surveyor	TBD	TBD

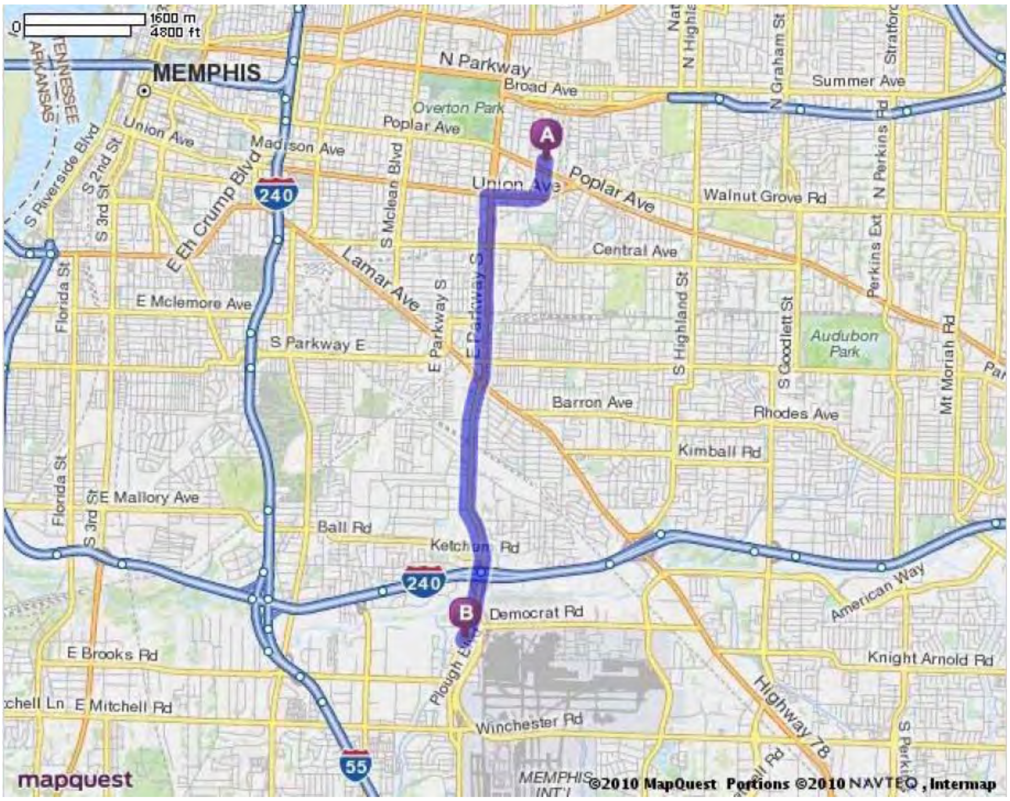
Directions to Methodist LeBonheur Germantown Hospital



Directions to Methodist LeBonheur Germantown Hospital:	**Distance**
Start out going NORTH on COLLINS ST. toward SCHOOL AVE	0.5 mi
Turn RIGHT onto SAM COOPER BLVD	4.9 mi
Merge onto I-240 W via EXIT 10A toward JACKSON MISS.	3.5 mi
Take the US-72 E/POPLAR AVE exit, EXIT 15, toward GERMANTOWN	0.5 mi
Turn SLIGHT LEFT onto POPLAR AVE / US-72 E / TN-57 E.	3.7 mi

End at Methodist LeBonheur Germantown Hospital, on the RIGHT
7691 Poplar Avenue, Memphis, TN 38138 Total distance: 13.09 mi

Directions to Concentra – Memphis



Directions to Concentra - Memphis:	**Distance**
Start out going SOUTH on COLLINS ST. toward WESSLEY AVE	0.1 mi
COLLINS ST becomes UNION AVE EXT.	0.2 mi
Take the TN-23 ramp.	0.1 mi
Turn SLIGHT RIGHT onto UNION AVE/TN-23.	0.4 mi
Merge onto TN-277 S via the ramp on the left.	2.0 mi
TN-277 S becomes AIRWAYS BLVD.	2.7 mi

End at Concentra - Memphis, on the RIGHT
2831 Airways Blvd., Bldg A, Suite 102, Memphis, TN 38132 Total distance: 5.63 mi

1. Emergency Procedures

1.1 Objective

This Health and Safety Plan (HASP) is to be used to provide procedures for soil and groundwater sampling activities to be conducted at the former Virginia-Carolina Chemical Corporation (VCC) Memphis Site located at 152 Collins Street in Memphis, Tennessee (the Site). Procedures include potential encounters with Site contaminants, general safety hazards, and emergency and contingency planning at the Site.

The objective of this HASP is to provide a mechanism for establishing safe working conditions at the Site. The safety organization, procedures, and levels of personal protective equipment (PPE) were established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies were evaluated and selected to minimize the potential of injury, illness, or other hazardous incident.

1.2 Emergency Response

If an incident occurs, the following steps will be taken:

- The Site Supervisor will evaluate the incident and assess the need for assistance;
- The Site Supervisor will call for outside assistance as needed;
- The Site Supervisor will immediately notify the ExxonMobil Environmental Services Company (EMES) Project Manager and the ARCADIS Project Manager of the incident; and
- The Site Supervisor will take appropriate measures to stabilize the incident scene.

In the event of a contaminant release, notify the Site Supervisor immediately, don required level of PPE, and prepare to implement control procedures. The Site Supervisor has the authority to commit resources as needed to contain and control released material and to prevent its spread to off-site areas.

1.3 Medical Emergency

ARCADIS and Subcontractor Site Illness and Injury Management Procedures (IIMPs) for EMES Projects are provided in Attachment 1.

All employee injuries must be promptly reported to the Site Supervisor, who will:

- Provide the injured employee with prompt first-aid and medical attention;
- In emergency situations, the worker will be transported by appropriate (self-transport to the hospital is not allowed) means to the nearest urgent care facility (normally a hospital emergency room); and
- If the injured person is an ARCADIS employee, contact Workcare at 1.800.455.6155 and notify the Project Team Health and Safety Lead Greg Ertel at 585.303.0633 and the ARCADIS Workers Compensation coordinator Pat Bullock at 720.344.3844 as soon as possible after the employee has been safely evacuated from the scene.

1.3.1 Emergency Care Steps

Upon entering an accident area, Site personnel should follow these emergency care steps:

- Survey the scene. Determine if it is safe to proceed. Try to determine if the conditions that caused the incident are still a threat. Protect yourself from exposure before attempting to rescue the victim.
- Do a primary survey of the victim. Check for airway obstruction, breathing, and pulse. Assess likely routes of chemical exposure by examining the eyes, mouth, nose, and skin of the victim for symptoms.
- Phone Emergency Medical Services (EMS). Give the location, telephone number used, caller’s name, what happened, number of victims, victim’s condition, and help being given.
- Maintain airway and perform rescue breathing as necessary.
- Perform cardiopulmonary resuscitation (CPR) as necessary.

- Do a secondary survey of the victim. Check vital signs and do a head-to-toe exam.
- Treat other conditions as necessary. If the victim can be moved, take him/her to a location away from the work area where EMS can gain access.

1.4 WorkCare (ARCADIS Employees Only)

WorkCare is a 24-hour service that provides professional medical assistance over the telephone for non-emergency injuries or illness. The WorkCare nurse or doctor may assess the injury or symptoms, advise the employee as to appropriate care, and assist in identifying a medical facility if necessary.

Note: First-aid should be administered and, when needed, emergency medical treatment should be sought prior to contacting WorkCare. The WorkCare number is 1.800.455.6155.

1.5 Hazard Communication (HazCom)

All project-required chemicals will be handled in accordance with the Occupational Safety and Health Act (OSHA) 29 Code of Federal Regulations (CFR) 1910.1200 and ARCADIS-required procedures. The Health and Safety Supervisor will act as the HazCom Program Coordinator for the Site and will maintain the Master Inventory List of hazardous chemicals kept on the job Site. The Health and Safety Supervisor will maintain Material Safety Data Sheets (MSDSs) on site for all chemicals. MSDSs will be located in each ARCADIS field vehicle. The Health and Safety Supervisor will communicate the location of the MSDSs and the hazards associated with these chemicals to all project Site ARCADIS employees and subcontractors during the safety orientation. This information will be reviewed during tailgate briefings, especially if new chemicals or materials are introduced on site. An example of a Daily Site Safety Meeting Checklist is provided in Attachment 2.

The Health and Safety Supervisor will ensure that all containers of chemicals (including drums, bags, pails, tanks, vessels, etc.) are labeled appropriately: the contents of the container, the proper name of the chemical, associated hazards and appropriate hazard warnings, and the name and address of the manufacturer/importer. Chemicals will not be accepted or allowed on site that are not properly labeled. If transferred to a secondary container, the new container will be labeled as described.

The Health and Safety Supervisor will ensure that the PPE necessary for work around the particular chemical is available and that project Site employees have been trained in its use.

The Project Manager will ensure that all project personnel have received HazCom training as required in OSHA 29 CFR 1910.1200 (h).

1.6 First-Aid - General

All persons must report any injury or illness to their immediate supervisor and the Site Supervisor. Trained personnel will provide first-aid. Injuries and illnesses requiring medical treatment must be documented. The Site Supervisor must conduct an Incident Investigation as soon as emergency conditions no longer exist and first-aid and/or medical treatment have been obtained. Incident Investigations must be completed and submitted to the ARCADIS Project Manager within 24 hours after the incident.

If first-aid treatment is required, first-aid kits are kept in the work vehicles. If treatment beyond first-aid is required, the injured person(s) should be transported to the medical facility. If the injured person is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedics should be summoned. If there is any doubt as to the injured worker’s condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

1.6.1 First-Aid – Inhalation

Any employee complaining of symptoms of chemical overexposure will be removed from the work area and transported to the designated medical facility for examination and treatment.

1.6.2 First-Aid – Ingestion

Call EMS and consult a poison control center for advice. If available, refer to the MSDSs for treatment information. If the victim is unconscious, keep them on their side and clear the airway if vomiting occurs.

1.6.3 First-Aid – Skin Contact

Project personnel who have had skin contact with contaminants will, unless the contact is severe, proceed to the wash area. Personnel will remove any contaminated clothing and then flush the affected area with water. The worker should be transported to the medical facility if he/she shows any sign of skin reddening, irritation, or if he/she requests a medical examination.

1.6.4 First-Aid – Eye Contact

Project personnel who have had contaminants splashed in their eyes or who have experienced eye irritation must immediately proceed to the eyewash station. Do not decontaminate prior to using the eyewash. Remove whatever protective clothing is necessary to use the eyewash. Flush the eye for 15 minutes with clean running water. Arrange prompt transport to the designated medical facility.

1.7 Non-Emergency, Non-Life Threatening Work-Related Injury or Illness

For minor illnesses or injuries that may be work-related and are not life threatening or emergencies (e.g., you're in your hotel room and your lower back tightens up, earlier in the day you hand-augured 50 borings; you cut your hand in the office, put a band-aid on the cut, and go back to work, but when you get home you realize the cut is deep and is still bleeding; you hit your head on a cabinet while loading paper, and later on that day you suddenly feel dizzy), employees will take the following steps before seeking medical treatment at a medical treatment facility:

As soon as possible, contact WorkCare at 1.800.455.6155 (once you have spoken with WorkCare, you can let your supervisor know).

- WorkCare will discuss the medical issues with you and provide appropriate medical guidance.

If WorkCare feels that you should see a physician:

- They will help you locate a physician/clinic and will contact the clinic to discuss the treatment plan. If they have a concern about the treatment plan, one of the WorkCare physicians will attempt to contact the treating physician to discuss the plan and will keep you advised.

If WorkCare feels that first-aid/self-treatment is medically appropriate:

- They will provide the treatment information to you and will follow up with you to determine effectiveness.
- If the medical issue persists, WorkCare will advise alternative treatment or will refer you to a physician.
- Keep your supervisor informed on what action you will be taking. If you are seen by a physician, keep them advised as to your work status and upcoming medical appointments.

If an injury or illness is life-threatening or an emergency, please seek medical attention immediately. As soon as possible, notify your supervisor.

1.8 Reporting Injuries, Illnesses, and Near-Loss Incidents

Injuries and illnesses, however minor, will be reported to the Site Supervisor immediately. The Site Supervisor will complete an injury report and submit it to the Client, ARCADIS Project Manager, Health and Safety Manager, and Principal-in-Charge within 24 hours.

Near-loss incidents are situations in which no injury or property damage occurred, but under slightly different circumstances an injury or property damage could have occurred. Near losses are caused by the same factors as injuries; therefore, they must be reported and investigated in the same manner. A safe performance self-assessment (SPSA) must be done immediately after an injury, illness, near loss, or other incident to determine if it is safe to proceed with the work.

If the Site Supervisor or employee(s) conducting fieldwork does not have real-time access to the web, ARCADIS has established a toll-free Near-Loss Reporting Hotline.

THE ARCADIS NEAR-LOSS REPORTING NUMBER IS 1-866-242-4304.

Callers will be prompted to provide the following information:

- Name and phone number;
- Date of near loss;

- Location;
- Project number (if applicable);
- A brief description of what happened;
- Name of division or office Vice President;
- What you think could have happened if this situation had resulted in an injury or damage; and
- Any other information you think may be important.

The intent of this service is to enable employees to phone in near misses immediately and have the events entered onto the EMES Near-Loss Form which will be emailed back to the Site Supervisor. Entry into the database does not relieve the caller from the responsibility of following through with the near-loss investigation or of notifying other employees in the office or project team of the occurrence.

2. Training

2.1 Authorization to Enter

Only personnel with the appropriate training and medical certifications will be allowed to work at the Site. The Site Supervisor will maintain a list of authorized persons; only personnel on the authorized persons list will be allowed to enter the Site work areas.

2.2 Loss Prevention System (LPS)

All ARCADIS employees and subcontractors at the Site must participate in the LPS system. LPS is a behavior-based program which aims to eliminate accidents, environmental incidents, and deviations from prescribed work procedures. LPS consists of the following tools which will be implemented at the Site and include SPSA, Loss Investigation (LI) and Near-Loss Investigation (NLI), Loss Prevention Observation (LPO), Job Safety Analysis (JSA), and Stewardship. Optimization of the LPS depends upon timely reporting (both internal and external) of all types of LPS tools (e.g., near-loss, observations, incidents).

2.2.1 Safe Performance Self-Assessment

All on-site personnel are required to perform an SPSA prior to beginning any activity. This three-step process requires each individual to:

- **Assess** the risk of the task to be performed. Ask the following questions:
  - What could go wrong?
  - What is the worst thing that could happen if something does go wrong?
- **Analyze** the ways the risk can be reduced. Ask the following questions:
  - Do I have all the necessary training and knowledge to do this task safely?
  - Do I have all the proper tools and PPE?
- **Act** to control the risk and perform the task safely.
  - Take the necessary action to perform the job safely.

- Follow written procedures, and ask for assistance, if necessary.

This process must be performed prior to beginning any activity, and must be performed after any near loss or other incident in order to determine if it is safe to proceed.

2.2.2 Job Safety Analysis

A JSA is a tool used to identify potential hazards and develop corrective or protective systems to eliminate the hazard. The person doing the work shall contribute to the development of the JSA. A JSA lists all the potential hazards associated with an activity. Hazards may be physical, such as lifting hazards or eye hazards, or environmental, such as weather or biological (stinging insects, snakes, etc.). Following the identification of the hazards associated with an activity, control measures are evaluated and protective measures or procedures are then instituted. JSAs are reviewed periodically to ensure that the procedures and protective equipment specified for each activity are current and technically correct. Any changes in Site conditions and/or the scope of work may require a review and modification to the JSA in question. During this review process, comments on the JSA and its procedures should be obtained from personnel associated with the activity being analyzed.

Prior to starting work on this site JSAs will be prepared, reviewed, and updated by the employees who will perform the work and the Site Supervisor. Current site conditions will be captured within the updates. JSAs will be maintained in the OIMS binder or a readily accessible location for easy access and reference by the Project Team.

2.2.3 Loss Prevention Observation

Anyone trained in LPS may perform an LPO. The purpose of an LPO is to identify and correct potential hazards and to positively reinforce behaviors and practices that are correct. The LPO can identify potential deviations from safe work practices that could possibly result in an incident and take prompt corrective action. The LPO process steps are:

- Identify tasks that have the greatest potential for hazardous incidents;
- Review the standard procedure for completing the task;
- Discuss with the observed employee the task and the role in observing the task;

- Observe the employee completing the task;
- Reference the LPO form for criteria. Document positive comments as well as areas in need of improvement;
- Discuss the results of the LPO with the employee. Discuss corrective action necessary;
- Implement corrective action; and
- Communicate the results of the LPO and corrective action to the ARCADIS Project Manager and the ARCADIS Health and Safety Supervisor.

A schedule for completing LPOs will be prepared by the ARCADIS Project Manager and the Site Supervisor during the initial phases of the project.

2.2.4 Loss Investigation and Near Loss Investigation

A loss is a specific event / sequence of events or extended conditions that resulted in an unwanted or unintended impact(s) on: safety, health of people, property, environment, or on legal or regulatory compliance. A loss is any of the following events: first-aid cases, injuries, illnesses, spills/leaks, equipment and property damage, motor vehicle accidents, regulatory violations, fires, and business interruptions. A near loss is a specific event, sequence of events, or extended conditions that COULD HAVE under slightly different circumstances resulted in unwanted or unintended impacts on: safety, health of people, property, environment, or on legal or regulatory compliance. All losses and near losses shall be investigated within 24 hours and reported to the EMES Project Manager, the ARCADIS Project Manager, and the ARCADIS Health and Safety Supervisor. In the event that one of those individuals cannot be contacted, a voice message should be left and the next individual in the chain should be contacted. Follow-up with the absent individual should occur as soon as possible.

The purpose of an LI and NLI is to prevent the reoccurrence of a similar hazardous event. The investigation evaluates all incidents in the same manner using the LPS root cause analysis flow chart. Using the information gathered during an Incident Investigation, appropriate measures will be taken to protect personnel from the hazard in question.

2.2.5 Stewardship

Stewardship of the LPS program will include systematic evaluations of the program to verify effective implementation. Stewardship activities will include the following:

1. Quality review of tools by first line supervisors;

2. Field verification and validation by first line supervisors;

3. Monthly LPS safety meeting;

4. Field verification and validation by other managers;

5. Quality review of tools by other managers;

6. Formal stewardship sessions; and

7. LPS field assessments.

2.3 Occupational Safety & Health Administration

All on-site project personnel who work in areas where they may be exposed to Site contaminants must be trained as required by OSHA Regulation 29 CFR 1910.120 (HAZWOPER). Personnel who completed their initial training more than 12 months prior to starting the project must have completed an 8-hour refresher course within the past 12 months. The Site Supervisor has completed the additional 8 hours of supervisory training. All employees assigned to this project that will be working on site must attend an LPS training session and schedule a site health and safety orientation briefing with the ARCADIS Health and Safety Supervisor.

2.4 Site-Specific Training

Site-specific training will be accomplished by on-site personnel reading this HASP and associated JSAs. The review must include a discussion of the chemical, physical, and biological hazards; PPE; safe work procedures; and emergency procedures for the project.

No person will be allowed in the work area during Site operations without first being given a Site orientation, safety briefing, and LPS training and/or refresher training.

Following this initial meeting, safety meetings will be held as required. All people entering the Site work areas, including visitors, must document their attendance at this briefing, as well as any required safety meetings, on the Visitor Acknowledgement and Acceptance of HASP form included in Attachment 2 with the forms included with this plan. No person will be allowed in the work area unless they are wearing the minimum PPE. A safety meeting must also be held prior to new tasks, and repeated if new hazards are encountered.

2.5 Field Health & Safety Handbook

The Field Health & Safety Handbook is an ARCADIS document containing information about topic-specific health and safety requirements for the field. This handbook contains relevant general topics and is used as part of the overall HASP process. To aid in the consistency of the HASP process, the handbook will be used as an informational source in conjunction with this HASP. The following four handbook sections are minimally required reading for this project:

- Section III-F. General Housekeeping, Personal Hygiene and Field Sanitation
- Section III-G. Site Security, Work Zone and Decontamination for HAZWOPER Sites
- Section III-GG. HAZWOPER and HAZMAT Response
- Section III-II. Drums and other Material Handling

The following handbook sections are additional required reading for this project:

- Section III-H. Personal Safety and Other Unique Site Conditions
- Section III-L. Noise
- Section III-P. Medical Surveillance
- Section III-LL. Traffic Control
- Section III-MM. Utility Protection

- Section IV-E. Heavy Equipment
- Section III-NN. Backing Safety

2.6 First-Aid and Cardiopulmonary Resuscitation

At least one employee current in first-aid/CPR will be assigned to the work crew and will be on site during operations. Refresher training in first-aid and CPR is required to keep the certificate current. These individuals must also receive training regarding the precautions and PPE necessary to protect against exposure to blood-borne pathogens.

2.7 Certification Documents

A training and medical file has been established for this project and will be kept on site during Site operations. Specialty training, such as first-aid/CPR certificates, as well as current medical clearances for all project field personnel, will be maintained within that file. All ARCADIS and subcontractor personnel must provide their training and medical documentation to the Site Supervisor prior to starting work.

3. Levels of Protection

PPE is required to safeguard Site personnel from various hazards. Varying levels of protection may be required depending on contaminant of concern (COC) levels and the degree of physical hazard. This section presents the various levels of protection and defines the conditions of use for each level.

3.1 Contaminants of Concern

The major COCs at the Site are arsenic, lead, and decontamination solution which may include isopropyl alcohol and 10% nitric acid. MSDSs and chemical hazard information for the COCs are included in Attachments 3 and 4, respectively.

3.2 Air Monitoring

Air monitoring should be performed continuously using a Multi-RAE Plus Gas Monitor (O_2/H_2S/CO/lower explosive limit) with Photoionization Detector (10.6 eV bulb) or equivalent during drilling and boring activities. If the results of air monitoring indicate the presence of organic vapors in a concentration causing concern, personnel will stop work and evacuate the area. Action levels are listed in Table 3-1.

Air monitoring results will dictate work procedures and the selection of PPE. The ARCADIS Health and Safety Supervisor will be responsible for utilizing the air monitoring results to determine appropriate health and safety precautions for ARCADIS personnel and subcontractors. Air monitoring results should be recorded in field notebooks or on an air monitoring log (Attachment 2).

3.2.1 Airborne Particulates

Air monitoring must be conducted using a portable dust monitor (e.g., PDR1000 or equivalent) during all activities that have the potential to generate airborne particulates. Readings should be taken in the breathing zone of Site workers as well as downwind of Site activities in order to identify potential off-site impacts. If ground intrusive activities are conducted in such a manner as to minimize dust (i.e., water suppression) then particulate monitoring may not be required.

Table 3-1
AIRBORNE CONTAMINANT ACTION LEVELS

Parameter	Reading	Action
Airborne Particulates	NA	TBD if excavation activities are conducted.
Total Organic Vapors	0 ppm to < 0.5 ppm	Normal operations; record breathing zone monitoring measurements every hour
	> 0.5 ppm to 5 ppm	Increase recording frequency to at least every 15 minutes
	> 5 ppm to < 25 ppm	Stop work and evacuate area. Investigate source of vapors.
	> 25 ppm	Stop work; evacuate work area, investigate cause of reading, reduce through engineering controls, contact Health and Safety Officer.
Flammable Vapors (Lower Explosive Limit)	<10%	Normal Operations
	≥ 10%	Stop work and evacuate area. Investigate source of vapors.
Oxygen	> 19.5 %, <23.5%	Normal Operations
	< 19.5%, >23.5%	Stop work and evacuate area.
Hydrogen Sulfide	< 5 ppm	Normal Operations
	≥ 5 ppm	Stop work and evacuate area. Investigate source of vapors.
Carbon Monoxide	< 25 ppm	Normal Operations
	≥ 25 ppm	Stop work and evacuate area. Investigate source of vapors.

3.3 Level D Protection

The minimum level of protection that is required of personnel and subcontractors at the Site is Level D, which is worn when activities do not involve potential dermal contact with contaminants and there is no indication that no inhalation hazard exists. Level D protection includes the following equipment unless otherwise specified in the JSAs:

- Work clothing as prescribed by weather including a high-visibility shirt or vest (long sleeves are required) and pants;
- General purpose work gloves (ASTM Level 2 cut-resistant gloves required if working with sharps or using any type of cutting device);

- Steel-toe work boots, meeting ASTM F2412 and F2413 ;
- Safety glasses with side shields or goggles, meeting ASTM F2412 and F2413;
- Hard hat, meeting American National Standards Institute (ANSI) Z89, when falling object hazards are present; and
- Hearing protection (if noise levels exceed 85 A-rated decibels [dBA], then hearing protection with a U.S. Environmental Protection Agency [USEPA] noise reduction rating [NRR] of at least 20 dBA must be used).

3.4 Modified Level D Protection

Modified Level D will be used when airborne contaminants are not present at levels of concern for inhalation, but Site activities present the potential for skin contact with contaminated materials. Modified Level D consists of the following equipment unless otherwise specified in the JSAs:

- Work clothing as prescribed by weather including a high-visibility shirt or vest (long sleeves are required) and pants;
- Nitrile surgical gloves when contact with COC-impacted media is anticipated;
- Protective gloves worn over/under nitrile surgical gloves, when necessary based on task (ASTM Level 2 cut-resistant gloves required if working with sharps or using any type of cutting device) ;
- Steel-toe work boots, meeting ASTM F2412 and F2413 ;
- Safety glasses with side shields or goggles, meeting ASTM F2412 and F2413;
- Face shield in addition to safety glasses or goggles when projectiles or splash hazards exist;
- Tyvek® sleeves to prevent exposed skin when using decontamination fluids;
- Hard hat, meeting ANSI Z89, when falling object hazards are present; and

- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used).

3.5 Using Personal Protective Equipment

The level of personal protection selected will be based on the work environment and an assessment by the Site Supervisor and Health and Safety Supervisor of the potential for skin contact with COC. This matrix is based on information available at the time this plan was written.

PPE Selection Matrix

Task	Anticipated Level of Protection
Mobilization/Site Survey	Level D
Installation of Soil Borings and Monitoring Wells	Modified Level D
Soil/Groundwater Sampling Activities	Modified Level D
Decontamination	Modified Level D
Demobilization	Level D

Depending on the level of protection selected, specific donning and doffing procedures may be required. The procedures presented in this section are mandatory if Modified Level D PPE is used. All personnel entering the exclusion zone (EZ) must put on the required PPE in accordance with the requirements of this HASP. When leaving the EZ, PPE will be removed in accordance with the procedures listed to minimize the spread of COCs.

3.5.1 Donning Procedures

These procedures are mandatory only if Modified Level D PPE is used on the Site:

- Remove street clothes and store in clean location;
- Put on work clothes or coveralls;
- Put on the required chemical protective gloves; and
- Don remaining PPE, such as safety glasses or goggles and hard hat.

When these procedures are instituted, one person must remain outside the work area to ensure that each person entering has the proper protective equipment.

3.5.2 Doffing Procedures

The following procedures are only mandatory if Modified Level D PPE is required for the Site. Whenever a person leaves the work area, the following decontamination sequence will be followed:

- Remove protective garments and equipment; all disposable clothing should be placed in plastic bags, which are labeled with contaminated waste labels;
- Clean reusable protective equipment;
- Wash hands, face, and neck (or shower if necessary); and
- Proceed to clean area and dress in clean clothing.

All disposable equipment, garments, and PPE must be bagged in plastic bags and labeled for off-site disposal/treatment.

4. Roles and Responsibilities

4.1 Policy Statement

ARCADIS and ExxonMobil's policy is to provide a safe and healthful work environment. No aspect of operations is of greater importance than injury and illness prevention. A fundamental principle of safety management is that all injuries, illnesses, and incidents are preventable. ARCADIS will take every reasonable step to eliminate or control hazards to minimize the possibility of injury, illness, or incident.

This HASP prescribes the procedures that must be followed during Site activities. Operational changes that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the EMES Project Manager or the ARCADIS Project Manager and the ARCADIS Health and Safety Supervisor. Significant changes in Site conditions and/or the scope of work will require a review and modification to this HASP. Such changes will be completed in the form of an addendum or a revision to this HASP.

The provisions of this HASP are mandatory for all ARCADIS personnel and ARCADIS subcontractors assigned to the project. All visitors to ARCADIS work areas on site must abide by the requirements of this HASP.

4.2 All Personnel

All ARCADIS and subcontractor personnel must adhere to the procedures outlined in this HASP while performing their work and participate in the LPS program. Each person is responsible for completing tasks safely and reporting any unsafe acts or conditions to their supervisor. No person may work in a manner that conflicts with these procedures. After due warnings, the ARCADIS Project Manager, the ARCADIS Health and Safety Supervisor, or the Site Supervisor will dismiss from the Site any person or subcontractor who violates safety procedures. Prior to initiating Site activities, all ARCADIS and subcontractor personnel will receive training in accordance with applicable regulations and be familiar with the requirements and procedures contained in this HASP. In addition, all personnel will attend daily safety meetings (tailgate meetings) to discuss Site-specific hazards prior to beginning each day's work. Every ARCADIS employee, subcontractor, and EMES employee at the Site has the responsibility to stop the work of a coworker or subcontractor if the working conditions or behaviors are considered unsafe.

4.2.1 Project Manager

The ARCADIS Project Manager is responsible for verifying that project activities are completed in accordance with the requirements of this HASP. The ARCADIS Project Manager is responsible for confirming that the Site Supervisor has the equipment, materials, and qualified personnel to fully implement the safety requirements of this HASP and/or those subcontractors assigned to this project meet the requirements established by ARCADIS. It is also the responsibility of the ARCADIS Project Manager to:

- Consult with the ARCADIS Health and Safety Officer on Site health and safety issues;
- Verify that subcontractors meet health and safety requirements prior to commencing work;
- Validate, via questioning, the performance of SPSAs;
- Participate in LPO feedback sessions;
- Review LPO forms;
- Verify that all incidents are thoroughly investigated;
- Report all Near Losses to the EMES Project Manager and the ARCADIS Health and Safety Supervisor within 24-hours;
- Verify that NLI corrective actions are implemented within the appropriate time period;
- Contact the ARCADIS Health and Safety Supervisor and the EMES Project Manager immediately of any injury or accident;
- Approve, in writing, addenda or modifications of this HASP; and
- Suspend work or modify work practices, as necessary, for personal safety, protection of property, and regulatory compliance.

4.2.2 Health and Safety Officer

The ARCADIS Health and Safety Officer, or his designee, the Health and Safety Manager, has overall responsibility for the technical health and safety aspects of the project, including review and approval of this HASP. Inquiries regarding ARCADIS health and safety procedures, project procedures, and other technical or regulatory issues should be addressed to this individual.

4.2.3 Site Supervisor

The Site Supervisor is responsible for implementing this HASP including communicating requirements to on-site personnel and subcontractors. The Site Supervisor will be responsible for informing the ARCADIS Health and Safety Supervisor and the ARCADIS Project Manager of changes in procedures or Site conditions so that those changes may be addressed in this HASP. Other responsibilities are to:

- Consult with the ARCADIS Health and Safety Supervisor regarding Site health and safety issues;
- Conduct LPO feedback sessions and complete the LPO forms;
- Obtain a Site map and determine and post routes to hospital and emergency telephone numbers;
- Observe on-site project personnel for signs of ill health effects;
- Investigate and report any incidents to the ARCADIS Health and Safety Supervisor;
- Verify that all on-site personnel have had applicable training;
- Verify that on-site personnel have read the HASP or its contents have been presented to them, they understand the contents, and agree to abide by them;
- Verify that on-site personnel are informed of the physical, chemical, and biological hazards associated with Site activities and the procedures and protective equipment necessary to control the hazards;

- Suspend work, modify work practices, or stop work as necessary for personnel safety, protection of property, or regulatory compliance; and

- Complete all necessary forms that are included in this HASP.

4.2.4 Health and Safety Supervisor

The ARCADIS Health and Safety Supervisor is responsible for field health and safety issues, including the execution of this HASP. Questions in the field regarding health and safety procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. Although the ARCADIS Health and Safety Officer may not be on site, the ARCADIS Health and Safety Supervisor is the primary Site contact for health and safety matters and coordinates with the Site Supervisor. It is the responsibility of the ARCADIS Health and Safety Supervisor to:

- Provide technical assistance and LPS training to all on-site staff, including subcontractors;

- Participate in all Incident Investigations and ensure that they are reported to the EMES Project Manager, Health and Safety Manager/Health and Safety Officer, Project Manager, and Principal-in-Charge within 24 hours;

- Designate the Site Supervisor to conduct Site safety orientation training and safety meetings;

- Verify that ARCADIS personnel and subcontractors have received the required physical examinations and medical certifications;

- Review Site activities with respect to compliance with this HASP;

- Maintain required health and safety documents and records;

- Assist the Site Supervisor in instructing field personnel on project hazards and protective procedures;

- Review LPO forms; and

- Suspend or modify work practices, as necessary, for personnel safety, protection of property, or regulatory compliance.

4.3 Short Service Employee (SSE) Program

Recognizing that employees who are new to the Firm are at a greater risk for incidents, the following guidelines are established to identify those employees and ease their transition. SSEs will have an assigned field mentor to assist them in adjusting to the project requirements and procedures. SSEs will be identified in the field by wearing an orange hardhat or baseball-type cap.

- ARCADIS employees new to the industry and new to ARCADIS will be designated SSEs for 6 months.
- ARCADIS employees experienced in the industry but new to ARCADIS will be designated SSEs for 3 months.

Additionally, the following apply:

- A crew of two to three may have one SSE on site;
- A crew of four to nine may have two SSEs on site; and
- A crew of ten or more may have no more than three SSEs on site.

4.4 Subcontractors

Subcontractors and their personnel must understand and comply with applicable regulations and Site requirements established in this HASP. All subcontractor personnel will receive training in accordance with applicable regulations and be familiar with the requirements and procedures contained in this HASP prior to initiating Site activities. All subcontractor personnel will attend an initial LPS safety training session prior to beginning work at the Site. Additionally, on-site subcontractor personnel must attend and participate in required daily safety meetings.

4.5 All On-site Personnel

All on-site personnel (including subcontractors) must read and acknowledge their understanding of this HASP before commencing work and abide by the requirements of the plan. All on-site personnel will sign the HASP Acknowledgement Form (provided at the front of this HASP) following their review of this HASP.

All ARCADIS and subcontractor personnel will receive training in accordance with applicable regulations and be familiar with the requirements and procedures contained in this HASP prior to initiating Site activities. In addition, all on-site personnel must attend a mandatory LPS training session prior to beginning work at the Site. Attendance is also required for daily safety meeting and any other required safety meetings as necessary.

All on-site personnel must perform an SPSA prior to beginning each work activity. The SPSA process involves determining worst-case scenarios for the tasks at hand and then taking adequate steps to eliminate or mitigate the risk. This process must be performed prior to beginning each activity and after any near-loss or other incident to determine if it is safe to proceed. The ARCADIS Site Supervisor or the EMES Project Manager may verify the performance of SPSAs through random interviews with any or all on-site personnel. On-site personnel will immediately report the following to the Site Supervisor:

- Personnel injuries and illnesses no matter how minor;
- Unexpected or uncontrolled release of chemical substances;
- Symptoms of chemical exposure;
- Unsafe or hazardous situations;
- Unsafe or malfunctioning equipment;
- Changes in Site conditions that may affect the health and safety of project personnel;
- Damage to equipment or property;
- Situations or activities for which they are not properly trained; and
- Near losses.

4.6 Visitors

All visitors to ARCADIS work areas must check in with the Site Supervisor. Visitors will be cautioned to avoid skin contact with surfaces, soils, or other materials that may be suspected to be impacted by COCs.

All visitors will receive a general safety orientation prior to having any access to the work area. Visitors will be restricted to non-working areas at the Site and will not be allowed access to any portion of the work area without escort by Site personnel or another authorized ARCADIS or EMES representative. Visitors do not include personnel associated with the USEPA or other regulatory agencies.

4.7 Stop Work Authority

Every ARCADIS employee and subcontractor is empowered, expected, and has the responsibility to stop the work of another co-worker if the working conditions or behaviors are considered unsafe.

4.8 Cell Phones

Cell phone use while driving on this project is prohibited.

5. Project Hazards and Control Measures

5.1 Site Description

The former VCC Memphis fertilizer plant was located in Memphis, Shelby County, Tennessee. The Site is in an old industrial area located within downtown Memphis, northeast of the intersection of Collins Street and Poplar Avenue. The property that contains most of the Memphis Site has a street address of 152 Collins Street. The approximate geographical location of the center of the Site is at 33.5452° North latitude and 86.7872° West longitude (North American Datum of 1983 [NAD83]).

Currently, the former Memphis Site is occupied by 4 tax parcels. The northern portion of the Site currently contains the ACEE Business Center, while a Self Storage Center is located on the southernmost parcel. The majority of the former Site is currently paved as a parking lot or covered by buildings which comprise the ACEE Business Center. The former Site is bordered to the north by the City of Memphis Department of Public Works; to the east by railroad tracks associated with the Illinois Central Gulf Railroad, followed by the Bell Industrial Plaza; to the south by Poplar Avenue (U.S. Route 72), followed by commercial and industrial development (i.e., Bank of America and Clear Channel Television Center); and to the west by Collins Street, followed by residential areas, with minor commercial development to the southwest.

Structures associated with the former plant included a fertilizer mill building, two different acid chamber structures, a burner house, a mill, an engine house, a bag house, a carpenter shop, a nitre house, a deep well pump, a 170,000 gallon reservoir, a shed, an office, a stage, a storage house, and rail sidings. The majority of these historical features associated with the former plant were located on the parcel currently identified as 152 Collins Street.

5.2 Job Safety Analysis

A JSA identifies potential safety, health, and environmental hazards associated with each type of field activity. Because of the complex and changing nature of field projects, supervisors must continually inspect the work site to identify hazards that may harm Site personnel, the community, or the environment. The Site Supervisor must be aware of these changing conditions and discuss them with the ARCADIS Health and Safety Supervisor and the ARCADIS Project Manager whenever these changes impact employee health, safety, the environment, or performance of the project. The Site Supervisor will keep ARCADIS and ARCADIS subcontractor personnel informed of the changing conditions. It is anticipated that the JSAs to be prepared and followed during site activities include, but are not limited to, the following:

- Mobilization/Demobilization;
- Utility Locating;
- Surveying;
- Hand Augering;
- Drilling and Monitoring Well Installation;
- Groundwater Sampling; and
- Soil Sample Collection/Processing.

5.3 Field Activities, Hazards, Control Procedures

The following sections discuss general safety hazards associated with specific field activities outlined in the scope of work for this project. ARCADIS has also specified minimum safety precautions for various field activities. Each ARCADIS subcontracted company must review these activities and safety procedures with respect to their own standard safe operating procedures. Each subcontracted company may utilize their own standard safe operating procedures provided the minimum requirements set forth in this HASP, 29 CFR 1910, and 29 CFR 1926 are met. Each subcontracted company is responsible for operating in a safe and healthful manner in order to protect their personnel and all Site personnel.

5.3.1 Mobilization

Site mobilization includes driving equipment and personnel both to the Site and to the proposed sample locations. In addition, mobilization may also include the setup of equipment areas and decontamination areas. Due to the size of the Site and the distance between adjacent sampling points, a singular support zone and decontamination area or multiple support zones/decontamination areas may be set up to facilitate work progress. This will be determined at the onset of work activities. During this initial phase, project personnel will walk the Site to confirm the existence of anticipated hazards and identify safety and health issues that may have arisen since the writing of this HASP.

The hazards of this phase of activity are associated with manual Site preparation and exposure to vehicular traffic. Manual Site preparation may cause blisters, sore muscles, and joint and skeletal injuries and may present eye, contusion, and laceration hazards. The work area presents slip, trip, and fall hazards from scattered irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces, and unstable soil. Exposure to vehicular traffic at the Site is likely. In order to minimize exposure, Site personnel must isolate the work area with barricades, signs, cones, caution tape, or other appropriate means to alert passing motorists to the presence of an active work area. Also, personnel who are exposed to vehicular traffic must wear an outer layer of orange warning garments, such as vests, jackets, or shirts.

Environmental hazards may include plants, such as poison ivy and poison oak; aggressive fauna, such as ticks, fleas, mosquitoes, wasps, spiders, chiggers, and snakes; weather, such as lightning and rain; and pathogens, such as rabies, Lyme disease, and blood borne pathogens.

5.3.2 Soil Boring and Groundwater Monitoring Well Installation

This task includes installing groundwater monitoring wells and/or advancing soil borings in various locations. Direct-push sampling equipment (e.g., Geoprobe®) may be used to collect soil samples based on field conditions. Direct-push sampling equipment is typically mounted on trucks, tractors, or other mobile equipment.

Direct-push samplers use static force and dynamic percussion force to advance small-diameter sampling tools. The equipment poses a hazard if not properly operated. The presence of overhead utilities and underground obstacles poses a hazard if boring equipment contacts them because the hazards are similar to those encountered when using a conventional drill rig.

5.3.2.1 Drilling/Geoprobe® Hazards

The primary physical hazards for this activity are associated with the use of drilling equipment, because tools and equipment (such as cat lines and wire rope) have the potential for striking, pinning, or cutting personnel.

- Cat Lines – Cat lines are used on drilling rigs to hoist material. Accidents that occur during cat-line operations may injure the employee doing the rigging, as well as the operator. Minimal hoisting control causes sudden and erratic load movements, which may result in hand and foot injuries.

- Materials Handling – The most common type of accident that occurs in material handling operations is the “caught between” situation when a load is being handled and a finger or toe gets caught between two objects. This type of hazard is of particular concern when handling augers during drilling or using the jackhammer to advance soil borings. In addition, rolling stock can shift and/or fall from a pipe rack or truck bed.

- Rig Accidents – Rig accidents can occur as a result of improperly placing the rig on uneven or unstable terrain or failing to adequately secure the rig prior to starting operations.

- Falls – Personnel advancing soil borings using the jackhammer can slip or fall if the stepladder is slippery or placed on unstable or uneven terrain.

- Utility Lines – Underground and overhead utility lines can create hazardous conditions if contacted by drilling equipment.

- Wire Rope – Worn or frayed wire rope presents a laceration hazard if loose wires protrude from the main bundle.

- Working Surfaces – Slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, and slips and falls.

5.3.2.2 Controls

The following control procedures are required for this activity:

- Drill Crews – All drillers must possess required state or local licenses to perform drilling work. All members of the drill crew must receive Site-specific training prior to beginning work. The driller is responsible for the safe operation of the drill rig, as well as the crew's adherence to the requirements of this HASP. The driller must confirm that all safety equipment is in proper condition and is properly used. The members of the crew must follow all instructions of the driller, wear appropriate PPE, and be aware of all hazards and control procedures. The drill crews must participate in the daily safety meetings and be aware of all emergency procedures.

- Rig Inspection – Each day, prior to starting work, the drill rig and associated equipment must be inspected by the driller and/or drill crew. Inspections must be documented on the Tier 1 Best Practice *Drill Rig Inspection Check List* provided in the OIMS binder for the project. The following items must be inspected:

- Vehicle condition;
- Proper equipment storage;
- Condition of all wire rope and hydraulic lines;
- Conditions of threads and heads on drilling rods;
- Fire extinguisher; and
- First-aid kit.

- Underground Utility Clearance – Before drilling activities commence, the existence and location of underground pipes, electrical equipment, and gas lines must be determined. Tennessee One Call Center must be contacted prior to initiating subsurface activities. The ExxonMobil Subsurface Clearance Procedure Checklist (Attachment 5) will be used to document that nearby utilities have been marked on the ground and that the excavation and drilling areas have been cleared.

  Consistent with ExxonMobil's Subsurface Clearance Protocol Guidance (Tier 2 Best Practice) and the ARCADIS Utility Clearance Procedure, ARCADIS will attempt to conduct soil probing to 5 feet below ground surface at or adjacent to the intended boring locations in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas. As such, ARCADIS will attempt to identify the presence of all subsurface utilities at the Site by contracting with a private subsurface utility locating contractor and by probing to a depth of 5 ft bgs in non-critical utility areas and 8 ft bgs or the bottom of the deepest invert in critical utility areas. The utility contractor will verify utility markouts within the property easements as marked out by the Tennessee One Call Center and clear all proposed soil boring/monitoring well locations in the field in advance of intrusive activities. Drilling/soil borings will not be performed within or immediately adjacent to visible utility corridors at the Site.

- Overhead Electrical Clearances – If drilling activities are conducted in the vicinity of overhead power lines, the lines must be de-energized, or the equipment must be positioned such that no part (including the excavation boom) can come within the minimum clearances as follows:

Minimum Overhead Electrical Clearances (All Equipment)

Nominal System Voltage	Minimum Required Clearance
0-50 kilovolt (kV)	10 feet
51-100kV	12 feet
101-200kV	15 feet

Nominal System Voltage	Minimum Required Clearance
201-300kV	20 feet
301-500kV	25 feet
501-750kV	35 feet
751-1,000kV	45 feet

When the drill rig is in transit, with the boom lowered and no load, the equipment clearance must be at least 4 feet for voltages less than 50kV, 10 feet for voltages of 50kV to 345kV, and 16 feet for voltages above 345kV.

- Drill Rig Setup - The following control procedures apply to rig setup:
  - The driller shall inspect all proposed well sites prior to establishing the location of the rig to verify that a stable surface exists. This is especially important in areas where soft, unstable terrain is common.
  - The drill rig shall be properly blocked and leveled prior to raising the derrick. Blocking provides a more stable drilling structure by evenly distributing the weight of the rig. Proper blocking ensures that differential settling of the rig does not occur. When the ground surface is soft or otherwise unstable, wooden blocks, at least 24 inches by 24 inches and 4 inches to 8 inches thick, shall be placed between the jack swivels and the ground. The emergency brake shall be engaged, and the wheels that are on the ground shall be chocked. The leveling jacks shall not be raised until the derrick is lowered. The rig will be moved only after the derrick has been lowered.
- Hoisting Operations – The following control procedures apply to hoisting operations:
  - Drillers shall not engage the rotary clutch without watching the rotary table to ensure it is clear of personnel and equipment.
  - Unless the draw works is equipped with an automatic feed control, the brake will not be left unattended without first being tied down.
  - Auger strings or casing will be picked up slowly.
  - During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller will be on the rig floor; no one else should be on the rig or derrick.
  - The driller shall test the brakes on the draw works of the drill rig each day. The brakes shall be thoroughly inspected by a competent individual each week and documented on the Tier 1 Best Practice *Drill Rig Inspection Check List*.

- A hoisting line with a load imposed will not be permitted to be in direct contact with any derrick member or stationary equipment unless it has been specifically designed for line contact.
- Workers should never stand near the borehole whenever any wire-line device is being run.
- Hoisting control stations will be kept clean and controls labeled as to their functions.
- Personnel shall not be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

• Cat-Line Operations – The following control procedures apply to cat-line operations:

- Only experienced workers will be allowed to operate the cathead controls. The kill switch must be clearly labeled and operational prior to operating the cat line. The cathead area must be kept free of obstructions and entanglements.
- Personnel will not stand near, step over, or go under a cable or cat line that is under tension.
- Employees rigging loads on cat lines must:

  ✓ keep out from under the load;
  ✓ keep fingers and feet where they will not be crushed;
  ✓ be sure to signal clearly when the load is being picked up;
  ✓ use standard visual signals only and not depend on shouting to coworkers for communication; and
  ✓ ensure the load is properly rigged, because a sudden jerk in the cat line will shift or drop the load.

• Wire Rope – The following control procedures apply to the use of wire rope:

- When two wires are broken, or rust or corrosion is found adjacent to a socket or end fitting, the wire rope must be removed from service or resocketed. Special attention must be given to the inspection of end fittings on boom support, pendants, and guy ropes.
- Wire rope removed from service due to defects must be cut up or plainly marked as being unfit for further use as rigging.
- Wire rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope; the clip nuts shall be retightened immediately after initial load carrying use and at frequent intervals thereafter.

- When a wedge socket fastening is used, the dead or short end of the wire rope shall have a clip attached to it or it shall be looped back and secured to itself by a clip; the clip shall not be attached directly to the live end.
- Protruding ends of strands in splices on slings and bridles must be covered or blunted.
- Except for eye splices in the ends of wires and for endless wire rope slings, wire rope used in hoisting, lowering, or pulling loads shall consist of one continuous piece without knot or splice.
- Wire rope shall not be secured by knots. Wire rope clips shall not be used to splice rope.
- Eyes in wire rope bridles, slings, or bull wires must not be formed by wire clips or knots.

• Auger Handling — The following control procedures apply to auger handling:

- Auger sections that cannot be safely carried by one person must be transported by cart or carried by two persons.
- Workers will not be permitted on top of the load while loading, unloading, or transferring rolling stock.
- When equipment is being hoisted, personnel will not stand where the bottom end of the equipment could whip and strike them.
- Augers stored in racks, catwalks, or on flatbed trucks will be secured to prevent rolling.

5.3.3 Monitoring Well Development

Field operations will consist of developing the well after installation to remove material or contaminants from the well prior to its being placed in service.

The physical hazards of monitoring well development are primarily associated with manipulating and operating the pump and its associated equipment. Other physical hazards of this phase of activity are associated with Site conditions and manual materials handling. Equipment operation may present noise and vibration hazards and the potential for employee contact with hot surfaces. Manual materials handling may cause blisters, sore muscles, and joint and/or skeletal injuries. The work area may present slip, trip, and fall hazards from scattered debris and wet or irregular walking surfaces. Wet weather may cause wet, muddy, and/or slick walking surfaces. Exposure to soil and water containing COCs is also possible.

To control dermal exposure during monitoring well development activities, a minimum of Modified Level D protection will be worn. If necessary, based on field observations and Site conditions, the level of PPE may be upgraded. The decision to upgrade the level of PPE will be made by the ARCADIS Health and Safety Supervisor, the ARCADIS Project Manager, or the Site Supervisor.

5.3.4 Field Sampling

The following field sampling activities will be undertaken during this project:

- Soil sampling; and
- Groundwater sampling.

Hazards and control measures and procedures for each sampling activity are discussed in the following subsections.

5.3.4.1 Soil Sampling

This task involves collecting soil samples for subsequent analysis and evaluation of potential impact by COCs. The physical hazards of these operations are primarily associated with the sample collection methods and procedures used. In addition, personnel may be exposed to hazards associated with working on or near heavy equipment.

Before sampling activities commence, the existence and location of underground pipes, electrical equipment, and gas lines must be determined. Tennessee One Call Center must be contacted prior to initiating subsurface activities. The Subsurface Utility Checklist will be used to document that nearby utilities have been marked on the ground and that the soil boring location has been cleared.

Consistent with ExxonMobil’s Subsurface Clearance Protocol Guidance (Tier 2 Best Practice) and the ARCADIS Subsurface Utility Clearance Procedure, ARCADIS will attempt to conduct soil probing to 5 feet below ground surface at or adjacent to the intended boring locations in non-critical utility areas and 8 ft bgs or the bottom of the deepest utility invert in critical utility areas. ARCADIS will attempt to identify the presence of all subsurface utilities at the Site by contracting with a private subsurface utility locating contractor and by hand augering to a depth of 5 ft bgs. The utility contractor will verify utility markouts within the property easements as marked out by

Tennessee One Call and clear all proposed soil boring locations in the field in advance of intrusive activities. Soil borings will not be installed within or immediately adjacent to visible utility corridors at the Site.

Inhalation and absorption of COCs are the primary routes of entry associated with soil sampling due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During this project, several different soil sampling methodologies may be used based on equipment accessibility and the types of materials to be sampled. These sampling methods may include the use of hand-auger/sampling probes, sampling spoons, or trowels. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area, or the conditions under which samples must be collected, may present chemical and physical hazards. The hazards directly associated with soil sampling procedures are generally limited to strains or sprains and potential eye hazards. Exposure to decontamination solutions and soil containing COCs is also possible. In addition to the safety hazards specific to sampling operations, hazards associated with the operation of vehicles (especially large vehicles with limited operator visibility), is a concern. Of particular concern will be the backing up of trucks and other support vehicles.

To control dermal exposure during soil sampling activities, a minimum of Modified Level D protection will be worn including nitrile gloves. Nitrile gloves will be changed between samples. Avoid laying tools and equipment on the ground to avoid contact with native poisonous or irritating flora and fauna. In addition, an outer layer of high-visibility clothing will be worn.

5.3.4.2 Groundwater Sampling

Groundwater sampling and monitoring will involve uncapping, purging (pumping water out of the well), sampling, and gauging new monitoring wells. A mechanical pump may be used to purge the wells and can be hand- or electric-operated. Water samples taken from the wells are then placed in containers and shipped to an analytical laboratory for analysis. The physical hazards of these operations are primarily associated with the sample collection methods and procedures used.

Absorption of COCs is the primary route of entry associated with groundwater sampling, due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During this project, several different groundwater sampling methodologies may be used based on equipment accessibility and the types of materials to be sampled. These sampling methods may include hand bailing or mechanical pumping. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area, or the conditions under which samples must be collected, may present chemical and physical hazards. The hazards directly associated with groundwater sampling procedures are generally limited to strains or sprains from hand bailing and potential eye hazards. Exposure to water containing COCs is also possible. Avoid laying tools and equipment on the ground to avoid contact with native poisonous or irritating flora and fauna.

5.4 Environmental Hazards

The flora and fauna of the Site may present hazards of poison ivy, poison oak, ticks, fire ants, fleas, mosquitoes, wasps, spiders, and snakes. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, and/or slick walking surfaces and unstable soil.

5.5 Personal Protective Equipment

PPE is required to safeguard personnel from various hazards. Based on job conditions and an assessment of the Site-specific COCs, Site personnel will conduct work activities in accordance with the Level D protection unless otherwise specified in the JSAs. If necessary, the level of protection may be modified or upgraded based on new or unforeseen hazards. All disposable equipment, garments, and PPE must be bagged in plastic bags for disposal.

5.6 Decontamination

All personnel must undergo personal decontamination prior to exiting the work area. Personnel decontamination will include the removal of gross contamination from their outer clothing and boots and the removal and disposal or cleaning of PPE. In addition, all equipment used on site will be decontaminated prior to leaving the Site. The rinsate will be collected for disposal.

6. General Safety Practices

6.1 General Safety Rules

General safety rules for Site activities include, but are not limited to, the following:

- At least one copy of this HASP must be in a location at the Site that is readily available to personnel, and all project personnel shall review the plan prior to starting work.

- Wear all PPE as required, and stop work and replace damaged PPE immediately.

- Upon skin contact with materials that may be impacted by COCs, remove contaminated clothing and wash the affected area immediately. Contaminated clothing must be changed. Any skin contact with materials potentially impacted by COCs must be reported to the Site Supervisor or the ARCADIS Health and Safety Supervisor immediately. If needed, medical attention should be sought.

- Practice contamination avoidance. Avoid contact with surfaces either suspected or known to be impacted by COCs, such as mud or discolored soil.

- Remove PPE as required before leaving the work area to limit the spread of COC-containing materials.

- Dispose of all soiled gloves in designated receptacles.

- Report all injuries, including first-aid events, illnesses, near losses, and unsafe conditions or work practices to the Site Supervisor.

6.2 Protection of Residents/Visitors

Permission to access the property has been granted by the property owner. Care will be taken to protect the residents and visitors during sampling activities. Protection will include, but is not limited to:

- Notify the owner in advance of all activities to be performed;

- Stop work if a resident or visitor gets within 15 feet of the work zone;

- Take extra caution while working around utilities; and

- Implement traffic safety procedures.

6.3 Biological Hazards

Biological hazards may include poison ivy, snakes, thorny bushes and trees, ticks, mosquitoes, chiggers, fire ants, and other pests.

6.3.1 Tick-Borne Diseases

Lyme disease commonly occurs in summer and is transmitted by the bite of infected ticks. Erlichiosis also commonly occurs in summer and is transmitted by the bite of infected ticks. These diseases are transmitted primarily by the deer tick, which is smaller and redder than the common wood tick. Tick repellant containing diethyltoluamide (DEET) should be used when working in tick-/mosquito-infested areas. In addition, workers should search the entire body daily for attached ticks. Ticks should be removed promptly and carefully without crushing, because crushing can squeeze the disease-causing organism into the skin.

6.3.2 Poisonous Plants

Poisonous plants, including poison sumac and poison ivy, may be present in the work area. Personnel should be alerted to their presence and instructed on methods to prevent exposure. Photographs of poison sumac and poison ivy are presented below to facilitate identification.

Poison sumac grows as a shrub or small tree with large alternate, compound leaves having 7 to 13 leaflets without teeth. All plant parts are poisonous. The lack of: 1) leaflet glands, 2) "wings" between the leaflets, and 3) teeth on the leaves, in addition to this species' red stems supporting the leaflets and leaves, helps to distinguish this plant from similar-looking nonpoisonous species such as other sumacs and tree-of-heaven. Flowers are shades of green, white, and yellow and appear in late spring. Fruits are small white berries that mature in late summer and may last through winter. Poison sumac plants are occasionally present in moist or wet soils.

Poison Sumac

Poison ivy is a woody shrub or vine with hairy looking aerial roots. It grows to 10 feet or more, climbing high on trees, walls, and fences or trails along the ground. All parts of poison ivy, including the roots, are poisonous at all times of the year.

Poison Ivy

Control - The main control for both poison ivy and poison sumac is to avoid contact with the plant, cover arms and hands, and frequently wash potentially exposed skin. Particular attention must be given to avoiding skin contact with objects or protective clothing that have touched the plants. Treat every surface that may have touched the plant as contaminated, and practice contamination avoidance.

Poison ivy and sumac are very easy to treat if you identified your contact with the irritating plant within a few hours of the incident. The urushiol oil present in both plants chemically bonds with the proteins in your skin about 30 minutes after contact. Seventy-five percent of the population is affected by contact with urushiol, although immunity to urushiol today does not ensure immunity tomorrow, and vice versa. Rash symptoms can appear within a few hours, but can take 2 to 5 days to appear. The rash starts as a red, annoyingly itchy area that starts to swell. The area then gets inflamed and will get covered in clusters of tiny pimples. The pimples eventually merge and turn into blisters. The fluid in the blisters turns yellow, dries up, and becomes crusty. L eft completely untreated, this cycle can last as short as 5 days and, in severe cases, as long as 5 to 6 weeks.

If you come in contact with poison ivy or sumac, or a animal is exposed to any of these, or tools, gear, or clothing is exposed to any of these, you should wash off with hot water (not so hot that it burns) and strong soap as soon as possible. If you can get washed up in the first 6 hours, before the first symptoms appear, you have a good chance of avoiding an outbreak, and an even better chance of minimizing the effects if you do have one.

6.3.3 Snakes

The possibility of encountering snakes exists, specifically for personnel working in wooded/vegetated areas. To minimize the threat of snakebites, all personnel walking through vegetated areas must be aware of the potential for encountering snakes and the need to avoid actions which could lead to encounters. If a snakebite occurs, an attempt should be made to visually identify the snake. The victim must be transported immediately to the nearest hospital; first-aid consists of applying a constriction band, and washing the area around the wound to remove any unabsorbed venom.

6.3.4 Spiders

Personnel may encounter spiders during work activities. Two spiders are of concern, the black widow and the brown recluse. Both prefer dark sheltered areas such as basements, equipment sheds and enclosures, and around woodpiles. To minimize the threat of spider bites, all personnel walking through vegetated areas must be aware of the potential for encountering these arachnids. Personnel need to avoid actions that may result in encounters. If a spider bite occurs, the victim must be transported to the nearest hospital as soon as possible; first-aid consists of applying ice packs and washing the area around the wound to remove any unabsorbed venom.

6.3.5 Yellow Jackets/Wasps

Bee stings are very painful and can be very serious when individuals with an allergy are stung. Employees that have an allergy and have a prescribed Epinephrine Auto Injector (EpiPen) should let co-workers know where it is in the event they are stung.

You should only assist in the administering of the EpiPen if you are trained to do so or given permission by the injured person.

To prevent bee stings there are several steps to take:

- Wear dull colored clothing when outdoors. Brightly colored clothing attracts certain bees, wasps, ants, and more. (Remember flowers are brightly colored and many bees and wasps feed on the nectar and pollen of flowers.) Wear orange vests and white hardhats (not yellow).
- Look around the area to see if there are any large groups of bees.
- Avoid wearing perfumes or colognes because it attracts bees and use unscented sunblock and insect repellant for fieldwork.
- If you see a bee, do not run away or make sudden movements; it tends to scare them and they feel in danger.
- If one is flying around you, do not make sudden movements or swat at it. Let it fly around until it decides to leave.
- DO NOT KILL A BEE UNLESS IT IS ABSOLUTELY NECESSARY. Bees emit an odor when they are killed that tells other bees there is danger; when other bees smell it, they attack and sting in large groups.
- If you see a large group of bees, leave them alone and try to complete your task in another area. If it is not feasible, you may have to postpone work until the proper removal of the bees can be accomplished.
- Wear long sleeves and long legged pants outdoors where practical. Bees are attracted to sweaty skin.
- Avoid disturbing likely beehive sites, such as large trees, tree stumps, logs, and large rocks.
- If a colony is disturbed, run and find cover as soon as possible. Running in zigzag pattern may be helpful. Cover as much of the head and face as possible, without obscuring vision, while running. Once clear of the bees, remove stingers and seek medical care if necessary, especially if there is a history of allergy to bee venom.

If you have been stung by a bee, wasp, hornet, or yellow jacket, follow these instructions closely:

- Bees leave behind a stinger attached to a venom sac. Do not try to pull it out because this may release more venom; instead gently scrape it out with a blunt-edged object, such as a credit card or dull knife.

- Wash the area carefully with soap and water. This should be continued several times a day until the skin is healed.

- Apply a cold or ice pack, wrapped in cloth, for a few minutes.

- Apply a paste of baking soda and water and leave it on for 15 to 20 minutes.

- Telephone 911 to summon paramedics if the victim is having an allergic reaction, and use a bee sting emergency survival kit if previously prescribed.

- Treat swelling by elevating the swollen body part above the heart.

- Do not squeeze the sting or rub mud into it. This increases the risk of infection.

- Do not apply meat tenderizer or baking soda. These do not help and can actually cause problems.

- Do not administer drugs not prescribed for the patient.

Seek immediate medical attention if you are stung in the mouth or nose because swelling may block airways. Also seek emergency care if any of the following symptoms are present, because these could indicate an allergic reaction:

- Large areas of swelling;

- Abnormal breathing;

- Tightness in throat or chest;

- Dizziness;

- Hives;

- Fainting;
- Nausea or vomiting; or
- Persistent pain or swelling.

Included in every tailgate safety meeting should be a discussion of which field personnel are allergic to bees, bug bites, etc.

6.4 Spill Control

All personnel must take every precaution to minimize the potential for spills during Site operations. All on-site personnel will immediately report any discharge, no matter how small, to the Site Supervisor. All sorbent materials used for the cleanup of spills will be containerized and labeled appropriately. In the event of a spill, all field personnel will take appropriate measures to contain and control released materials and to prevent their spread.

6.5 Traffic Safety

Work activities will be performed in residential and undeveloped areas. The ARCADIS Roadway Work Zone Safety Program ARC DOT-301 will be followed to minimize the likelihood of project personnel and activities being affected by traffic in the residential areas. When working adjacent to roadways, cones will be placed along the perimeter of the work area to alert drivers to the presence of personnel and equipment. All crewmembers will remain behind the equipment and the traffic barrier. All Site personnel who are potentially exposed to vehicular traffic will wear an outer layer of orange warning garments, such as vests, jackets, or shirts.

6.6 Noise

Exposure to noise over the OSHA action level can cause temporary impairment of hearing; prolonged and repeated exposure can cause permanent damage to hearing. The risk and severity of hearing loss increases with the intensity and duration of exposure to noise. In addition to damaging hearing, noise can impair voice communication, thereby increasing the risk of accidents on site.

All personnel must wear hearing protection when it is difficult to hear a co-worker at normal conversation distance. Activities that require hearing protection include, but are not limited to, direct-push soil sampling and/or monitoring well installation.

6.7 Lifting Safety

Using proper lifting techniques may prevent back strain or injury. The fundamentals of proper lifting include:

- Consider the size, shape, and weight of the object to be lifted.
- The hands and the object should be free of dirt or grease that could prevent a firm grip.
- Fingers must be kept away from points that could crush or pinch them, especially when putting an object down.
- The load should be kept as low as possible, close to the body with the knees bent.
- To lift the load, grip firmly and lift with the legs, keeping the back as straight as possible.
- When putting an object down, the stance and position are identical to that for lifting: the legs are bent at the knees, and the back is straight as the object is lowered.

6.8 Emergency Equipment

Adequate emergency equipment will be available for the activities being conducted on site and as required by applicable sections of 29 CFR 1910. Personnel will be provided with access to emergency equipment, including, but not limited to, the following:

- Fire extinguishers of adequate size, class, number, and location as required by applicable sections of 29 CFR 1910;
- Industrial first-aid kits of adequate size for the number of personnel on site; and

- Emergency eyewash and/or shower if required by operations being conducted on site.

6.9 Heat Stress

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. Because heat stress is one of the most common illnesses associated with heavy outdoor work conducted with direct solar load and, in particular, because wearing PPE can increase the risk of developing heat stress, workers must be capable of recognizing the signs and symptoms of heat-related illnesses. Personnel must be aware of the types and causes of heat-related illnesses and be able to recognize the signs and symptoms of these illnesses in both themselves and their co-workers.

Heat rashes are one of the most common problems in hot work environments. Commonly known as prickly heat, a heat rash is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

Heat cramps are usually caused by performing hard physical labor in a hot environment. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused both by too much or too little salt.

Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution (plus or minus 0.3 percent sodium chloride), excess salt can build up in the body if the water lost through sweating is not replaced.

Under extreme conditions, such as working for 6 to 8 hours in heavy protective gear, a loss of sodium may occur. Drinking commercially available carbohydrate electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

Heat exhaustion occurs from increased stress on various body organs due to inadequate blood circulation, cardiovascular insufficiency, or dehydration. Signs and symptoms include pale, cool, moist skin; heavy sweating; dizziness; nausea; headache, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment.

Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke, which is a medical emergency.

Workers suffering from heat exhaustion should be removed from the hot environment, be given fluid replacement, and be encouraged to get adequate rest.

Heat stroke is the most serious form of heat stress. Heat stroke occurs when the body's system of temperature regulation fails and the body's temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict.

Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g., a rectal temperature of 41 degrees Celsius (°C; 105 degrees Fahrenheit [°F]). If body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of workload and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

If a worker shows signs of possible heat stroke, professional medical treatment should be obtained immediately. The worker should be placed in a shady area and the outer clothing should be removed. The worker's skin should be wetted and air movement around the worker should be increased to improve evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first-aid treatment.

Regardless of the worker's protestations, no employee suspected of being ill from heat stroke should be sent home or left unattended unless a physician has specifically approved such an order.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or exhaustion, that person may be predisposed to additional heat injuries.

6.9.1 Heat Stress Safety Precautions

One or more of the following control measures can be used to help control heat stress:

- Site workers will be encouraged to drink plenty of water and electrolyte replacement fluids throughout the day.
- On-site drinking water will be kept cool (50 to 60°F).
- All personnel will be advised of the dangers and symptoms of heat stroke, heat exhaustion, and heat cramps.
- Employees should be instructed to monitor themselves and co-workers for signs of heat stress and to take additional breaks as necessary.
- A shaded rest area must be provided. All breaks should take place in the shaded rest area.
- Employees must not be assigned to other tasks during breaks.
- Employees must remove impermeable garments during rest periods. This includes white Tyvek®-type garments.

All employees must be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress disorders.

6.10 Cold Stress

Cold stress normally occurs in temperatures at or below freezing, or under certain circumstances, in temperatures of 40°F. Extreme cold for a short time may cause severe injury to exposed body surfaces or result in profound generalized cooling, causing death. Areas of the body that have high surface area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible. Two factors influence the development of a cold weather injury: ambient temperature and the velocity of the wind. For instance, 10°F with a wind of 15 miles per hour is equivalent in chilling effect to still air at -18°F.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of tissue damage associated with frostbite. Frostbite of the extremities can be categorized into:

- Frost Nip or Incipient Frostbite - characterized by sudden blanching or whitening of skin.
- Superficial Frostbite - skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep Frostbite - tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. It can be fatal. Its symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and 5) death. Trauma sustained in freezing or sub-zero conditions requires special attention because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues in addition to providing for first-aid treatment. To avoid cold stress, Site personnel must wear protective clothing appropriate for the level of cold and physical activity. In addition to protective clothing, preventive safe work practices, additional training, and warming regimens may be utilized to prevent cold stress.

6.10.1 Safety Precautions for Cold Stress Prevention

For air temperature of 0°F or less, mittens should be used to protect the hands. For exposed skin, continuous exposure should not be permitted when air speed and temperature results in a wind chill temperature of -25°F.

At air temperatures of 36°F or less, field personnel who become immersed in water or whose clothing becomes wet must be immediately provided with a change of clothing and be treated for hypothermia.

If work is done at normal temperature or in a hot environment before entering the cold, field personnel must ensure that their clothing is not wet as a consequence of sweating. If wet, field personnel must change into dry clothes prior to entering the cold area.

If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work must be modified or suspended until adequate clothing is made available or until weather conditions improve.

Field personnel handling evaporative liquid (e.g., gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F must take special precaution to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling.

6.10.2 Safe Work Practices

Direct contact between bare skin and cold surfaces (< 20°F) should be avoided. Metal tool handles and/or equipment controls should be covered by thermal insulating material.

For work performed in a wind chill temperature at or below 10°F, workers should be under constant protective observation (buddy system). The work rate should be established to prevent heavy sweating that will result in wet clothing. For heavy work, rest periods must be taken in heated shelters and workers should be provided with an opportunity to change into dry clothing if needed.

Field personnel should be provided the opportunity to become accustomed to cold-weather working conditions and required protective clothing.

Work should be arranged in such a way that sitting or standing still for long periods is minimized.

During the warming regimen (rest period), field personnel should be encouraged to remove outer clothing to permit sweat evaporation or to change into dry work clothing. Dehydration, or loss of body fluids, occurs insidiously in the cold environment and may increase susceptibility to cold injury due to a significant change in blood flow to the extremities. Fluid replacement with warm, sweet drinks and soups is recommended. The intake of coffee should be limited because of diuretic and circulatory effects.

6.11 Lightning

Outdoors is the most dangerous place to be during a lightning storm. When lightning is seen or thunder is heard, or when dark clouds are observed, quickly move indoors or into a hard-topped vehicle and remain there until well after the lightning storm ends. Listen to forecasts and warnings through National Oceanic and Atmospheric Administration Weather Radio or your TV and radio stations. If lightning is forecast, plan an alternate work activity or know where you can take cover quickly. Check on client-/Site-specific procedures regarding lightning prior to starting work.

6.11.1 Hazards

Hazards from contact with lightning may include burns, nervous system damage, broken bones, loss of hearing or eyesight, electrocution, and/or death.

6.11.2 Control

1. **Postpone activities promptly. Do not wait for rain.** Many people take shelter from the rain, but most people struck by lightning are not in the rain! Go quickly inside a completely enclosed building, not a carport, open garage, or covered patio. If no enclosed building is convenient, get inside a hard-topped all-metal vehicle. A cave is a good option outside but move as far as possible from the cave entrance.

2. **Be the lowest point. Lightning tends to hit the tallest object.** In the mountains if you are above the tree line, you ARE the highest object around. Quickly get below the tree line and get into a grove of small trees. Do not be the second tallest object during a lightning storm! Crouch down if you are in an exposed area.

3. **Keep an eye on the sky.** Look for darkening skies, flashes of lightning, or increasing wind, which may be signs of an approaching thunderstorm.

4. **Listen for the sound of thunder.** If you can hear thunder, go to a safe shelter immediately.

5. **If you see or hear a thunderstorm coming or your hair stands on end, immediately suspend work and instruct everyone to go inside a sturdy building or car.** Sturdy buildings are the safest place to be. Avoid sheds, picnic shelters, baseball dugouts, and bleachers. If no sturdy building is nearby, a

hard-top vehicle with windows closed will offer some protection. The steel frame of the vehicle provides some protection if you are not touching metal. Work should not be resumed until at least 30 minutes have passed since thunder has been heard or lightning has been seen.

6. **Listen to the Weather Radio**. Listen for alerts.

7. **If you cannot get to a shelter, stay away from trees.** If there is no shelter, crouch in the open, keeping twice as far away from a tree as it is tall.

8. **Avoid leaning against vehicles**. Get off bicycles and motorcycles.

9. **Get out of the water. It is a great conductor of electricity.** Stay off the beach and out of small boats. If caught in a boat, crouch down in the center of the boat away from metal hardware. Wading and scuba diving are NOT safe. Lightning can strike the water and travel some distance beneath and away from its point of contact. Do not stand in puddles of water, even if wearing rubber boots.

10. **Avoid metal!** Drop metal backpacks, stay away from clotheslines, fences, exposed sheds, and electrically conductive elevated objects. Do not hold on to metal items such golf clubs, fishing rods, tennis rackets, or tools. Large metal objects such as drill rigs or excavators can conduct lightning. Small metal objects can cause burns.

11. **Move away from a group of people.** Stay several yards away from other people. Do not share a bleacher bench or huddle in a group.

Make sure you are not the highest object. Lightning tends to strike the highest object. Crouch down. Do not lie down! What you most want to avoid is lightning going through your heart. Lightning follows the path of least resistance. If lightning strikes the ground near you, a ground current will set up in the area nearby. If you are lying flat, your chances of being “hit” by this ground lightning increases. Not only that, the lightning will run through your whole body including your heart. If you are in a crouching position with your heels together, the ground current will enter one foot but it will then return to the ground through your other foot on the ground. The current does not go through your heart.

6.12 Tornadoes

A tornado is a violent windstorm, with winds up to 300 miles per hour, identified by a funnel-shaped cloud. Before a tornado hits, the air may become very still and the wind might die away. If you are caught outdoors, take steps to stay safe. When you see a funnel shaped cloud coming, you have only seconds to make life or death decisions.

Tornados can occur during any month of the year and can develop suddenly. All work will be suspended and site workers will evacuate to the designated shelter during periods of high winds or when a tornado watch or warning is issued for the area. The SSO will determine where the designated shelter is located unless specified by the client. When workers see storms approaching the work site, they should seek the latest weather information via radio or other means. If a tornado watch is issued, workers should continually inspect weather conditions to be aware of approaching storms. When a tornado warning is issued for the area, workers should immediately seek indoor shelter in a building with a permanent foundation (not in construction trailers or storage containers) in interior rooms or hallways outside of the line of sight of windows. The SSO will determine the need to suspend work and evacuate to the designated shelter based on site observations and weather forecasts. The SSO will also determine when work should be resumed after high winds have diminished.

If caught outside during a tornado, find a low lying area or a ditch in which to lie down. Use your arms to cover and protect your head and neck.

If you are outside when a tornado is approaching, always avoid downed electrical power lines, utility poles, trees and bridges.

If you are outside and you can see a tornado in the distance, move out of its path by traveling away from it at right angles. Do not try to outrun it. Either seek shelter or find a low place to lie down. Take necessary precautions to protect your neck and head.

Never try to out-drive a tornado. The average speed of a tornado is 30 miles per hour. However, some travel as fast as 70 miles per hour or become completely stationary. Get out of the car. Move as far away from the automobile as time allows. Find a group of rocks, a ditch or a low lying area and get down, protecting your head and neck from flying debris.

6.13 Animal Bites and Rabies

Animal bites and scratches, even when they are minor, can become infected and spread bacteria to other parts of the body. Whether the bite is from a family pet or an animal in the wild, scratches and bites can carry disease. Cat scratches, for example, even from a kitten can carry "cat scratch disease," a bacterial infection. Other animals can transmit rabies and tetanus. Bites that break the skin are even more likely to become infected.

Rabies – Rabies is a viral infection of certain warm-blooded animals and is caused by a virus in the Rhabdoviridae family. It attacks the nervous system and, once symptoms develop, it is 100 percent fatal in animals if left untreated.

In North America, rabies occurs primarily in skunks, raccoons, foxes, and bats. In some areas, these wild animals infect domestic cats, dogs, and livestock. In the United States, cats are more likely than dogs to be rabid. Generally, rabies is rare in small rodents such as beavers, chipmunks, squirrels, rats, mice, or hamsters. Rabies is also rare in rabbits. In the Mid-Atlantic States, where rabies is increasing in raccoons, woodchucks can also be rabid. The rabies virus enters the body through a cut or scratch, or through mucous membranes (such as the lining of the mouth and eyes), and travels to the central nervous system. Once the infection is established in the brain, the virus travels down the nerves from the brain and multiplies in different organs.

The salivary glands and organs are most important in the spread of rabies from one animal to another. When an infected animal bites another animal, the rabies virus is transmitted through the infected animal's saliva. Scratches by claws of rabid animals are also dangerous because these animals lick their claws.

Symptoms – The incubation in humans from the time of exposure to the onset of illness can range anywhere from 5 days to more than a year, although the average incubation period is about 2 months. The following are the most common symptoms of rabies. However, each individual may experience symptoms differently. Symptoms may include an initial period of vague symptoms, lasting 2 to 10 days and may include the following:

- Fever;
- Headache;

- Decreased appetite;
- Vomiting; and
- Pain, itching, or numbness and tingling at the site of the wound.

Patients often develop difficulty in swallowing (sometimes referred to as "foaming at the mouth") due to the inability to swallow saliva and the sight of water may terrify the patient. Some patients become agitated and disoriented, while others become paralyzed. The symptoms of rabies may resemble other conditions or medical problems.

Control – Being safe around animals, even your own pets, can help reduce the risk of animal bites. Some general guidelines for avoiding animal bites and rabies include the following:

- Refuse to conduct work when property owners do not control their animals;
- Do not try to separate fighting animals;
- Avoid strange and sick animals;
- Leave animals alone when they are eating;
- Do not approach or play with wild animals of any kind, and be aware that domestic animals may also be infected with the rabies virus; and
- Contact the property owner or call the local animal control agency to remove any stray animals.

For bites or puncture wounds from any animal, or for any bite from a strange animal:

- If the bite or scratch is bleeding, apply pressure to it with a clean bandage or towel to stop the bleeding.
- Wash the wound with soap and water under pressure from a faucet for at least 5 minutes, but do not scrub, because this may bruise the tissue.

- Dry the wound and cover it with a sterile dressing, but do not use tape or butterfly bandages to close the wound, because this trap could harmful bacteria in the wound.

- Call a physician or healthcare professional for guidance in reporting the attack and to determine whether additional treatment, such as antibiotics, a tetanus booster, or rabies vaccination is needed. This is especially important for bites on the face, or for bites that cause deeper puncture wounds of the skin.

- If possible and safe to do so, locate the animal that inflicted the wound. Some animals need to be captured, confined, and observed for rabies. Do not try to capture the animal yourself; instead contact the nearest animal warden or animal control office in your area.

- If the animal cannot be found, or if the animal was a high-risk species (skunk or bat), or the animal attack was unprovoked, the victim may need a series of rabies shots.

- Call a physician or healthcare provider for any flu-like symptoms such as a fever, headache, malaise, decreased appetite, or swollen glands following an animal bite.

7. Department of Transportation (DOT) Dangerous Goods Shipping Requirements

ARCADIS has policies in place for transporting small quantities of hazardous materials and for offering for shipping via ground or air. These policies are designed to meet the applicable requirements. As such, only ARCADIS staff that have been trained in the proper methods to prepare and ship hazardous materials are authorized to do so. Tasks associated with the packaging, labeling, marking, and preparation of hazardous materials for shipping or transport must have all appropriate and applicable training.

7.1 Materials of Trade (MOT)

DOT allows for a small amount of hazardous materials that are used in or an inherent part of our work to be transported in company vehicles. This includes things like gasoline, paint, small compressed gas cylinders, calibration gas, etc. To transport these:

- Staff will complete MOT training; and
- Vehicles used in transportation to and from off-site work locations will be in conformance with ARCADIS vehicle safety procedures.

Hazardous materials will be transported as described above as a result of the activities covered in this HASP. Site personnel who transport materials mentioned above will complete the Hazardous Materials Transportation Form included in Attachment 2.

7.2 Department of Transportation

Staff who collect, prepare, package, mark, label, complete shipping declarations, offer shipments to a transporter, directly transport, or are engaged in other activities associated with the transportation of Hazardous Materials (referred to as Dangerous Goods in Canada and by the International Air Transport Association) will have appropriate and applicable training. DOT requires all individuals who participate in hazardous materials shipping including activities such as completing the paperwork (but not signing it), filling a container with a hazardous material (including filling a drum with drill cuttings or purge water), marking, labeling, and packaging the hazardous material, etc., have awareness level training on the DOT requirements.

DOT requires additional job function training for those who conduct specific activities including:

- Staff who have to sign shipping papers or manifests, are listed as the 24-hour emergency contacts on shipping and have the responsibility for identifying, classifying, packaging, marking, and labeling hazardous material packages, and/or are directing or overseeing others who do these tasks will become certified through the completion of additional training; and

- The above training allows the offering employee to ship only by ground. If the shipment is to be offered for air transport, additional training is required.

Shipments as described above will be made as a result of the activities covered in this HASP. Site personnel shipping hazardous materials will complete the Hazardous Materials Shipment Form included in Attachment 2.

8. References

This HASP follows the guidelines established in the references listed below.

American Conference of Governmental Industrial Hygienists. 2009a. *Threshold Limit Values Handbook*.

American Conference of Governmental Industrial Hygienists. 2009b. *Guide to Occupational Exposure Values*.

ARCADIS. 2003. *Health and Safety Manual.* ARCADIS.

ARCADIS. 2008. *Employee Field Health and Safety Handbook*.

ExxonMobil. 2007. *Traffic Control Guidelines*.

Forsberg, K., and S.Z. Mansdorf. 2005. *Quick Selection Guide to Chemical Protective Clothing*, 5th Edition.

National Institute for Occupational Safety and Health. 2005. *Pocket Guide to Chemical Hazards*.

National Institute for Occupational Safety and Health. Occupational Safety and Health Administration, U.S. Coast Guard, and U.S. Environmental Protection Agency. 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. 86116.

U.S. Environmental Protection Agency. 1992. *Standard Operating Safety Guidelines*. Publication 9285.1-03.

ARCADIS

Attachment 1

ARCADIS and Subcontractor Site Illness and Injury Management Procedures (IIMPs) for EMES

ARCADIS Site Illness & Injury Management Procedures (IIMPs) for ExxonMobil Environmental Services Company (EMES) Projects

SCENARIO #1: ARCADIS Employee Suffering an Injury Possibly Requiring ***Minor First-Aid*** (small cuts, blisters, bruises, aches, pains resulting from work)

The ARCADIS SITE SUPERVISOR will:

1. **Stop work** when an incident occurs.
2. Notify a trained first aid responder to report the incident location.
3. Contact ARCADIS on-site Field Technician/Health & Safety (H&S) Manager.
4. Contact WorkCare (WC) at **1.800.455.6155** with employee to review symptoms.
5. Comply with WC instructions regarding first aid or transport to Concentra - Memphis.
6. Dispatch on-site Field Technician/H&S Manager to drive employee to clinic if required (For anything beyond a very minor scratch/sting bite, the ARCADIS SITE SUPERVISOR will drive or accompany the employee to the clinic).
7. If WC recommends visit to clinic, contact Corporate H&S (Workers Compensation) at **720.344.3844** to report incident.
8. Oversee departure of employee to clinic.
9. Notify ARCADIS PM (See below for ARCADIS PM responsibilities).
10. After speaking with on-site Field Technician/H&S Manager at the clinic, contact ARCADIS Corporate H&S to update incident status and receive information as required on Workers Compensation requirements.
11. Check EMPLOYEE status upon return to site to verify treatment and ability to work.
12. Coordinate and implement incident investigation using the Loss Prevention System (LPS) tools.
13. Review conditions that led to the incident with field team, address key issues, and make the determination when to resume work based on feedback.

The ARCADIS on-site Field Technician/H&S Manager will:

1. Report immediately to incident location, and provide first aid as necessary.
2. Review WC instructions with SITE SUPERVISOR and EMPLOYEE.
3. Drive EMPLOYEE to occupational health clinic (Industrial Medical clinic), if needed.
4. Communicate key findings from the health clinic provider.
5. Stay with EMPLOYEE until care is given and EMPLOYEE is allowed to depart clinic.
6. Report back to SITE SUPERVISOR with employee upon discharge to begin incident investigation.

ARCADIS PM will:

1. Communicate with on-site SITE SUPERVISOR as needed to advise on incident.
2. Notify EMES PM Lauren Gordon, the ARCADIS Principal-in-Charge, and the ARCADIS Program Manager.
3. Interface with Corporate H&S to validate whether EMPLOYEE will receive on-site treatment, or require visit to occupational health clinic. Notify Corporate H&S of employee's duties and availability of light duty work, if required.
4. Assist/review in the incident investigation process.

ARCADIS CORPORATE HEALTH AND SAFETY MANAGER will:

1. Handle reporting to Workers Compensation Third Party Administrator (TPA) and then work with the SITE SUPERVISOR, TPA adjuster and employee to ensure appropriate medical care, work release (including light duty release when medically appropriate) and discharge from care.
2. If visit to a physician is not advised, WC will follow up with employee AND Corporate H&S Manager until injury is resolved.
3.

NOTES: When at the clinic, the employee should be treated based upon authorization from WorkCare. If the clinic staff wants to provide services beyond what WC authorized then the clinic must contact WC for authorization.

Scenario # 2: ARCADIS Employee Suffering an Injury Possibly Requiring ***Medical Treatment*** (Deeper cuts, strains/sprains, possible chemical exposure)

The ARCADIS SITE SUPERVISOR will:

1. **Stop work** when an incident occurs.
2. Provide first aid, or request a trained responder to assist the injured employee.
3. Contact ARCADIS on-site H&S Manager.
4. Contact WC at **1.800.455.6155** with EMPLOYEE to review symptoms.
5. Comply with WC instructions regarding first aid or transport to Concentra - Memphis.
6. Accompany or drive the injured EMPLOYEE to the Concentra - Memphis.
7. Contact Corporate H&S (Workers Compensation) at **720.344.3844** to report incident and departure of employee to clinic.
8. Contact ARCADIS PM and ARCADIS EMES Safety Manager Greg Ertel **585.385.0090** (office) or **585.303.0633** (cell).
9. Contact Corporate H&S to update incident status, and receive information as required on Workers Compensation requirements.
10. Stay with the employee until he is released from the clinic, or the situation is stable.
11. Prior to leaving clinic, check EMPLOYEE status to verify treatment and ability to work.
12. Coordinate and implement incident investigation using the Loss Prevention System (LPS) tools.
13. Review conditions that led to the incident with field team, address key issues, and make the determination when to resume work based on feedback.

The ARCADIS on-site Field Technician/H&S Manager will:

1. Report to incident location and provide first aid, as necessary.
2. Review WC instructions with SITE SUPERVISOR and EMPLOYEE.
3. Drive EMPLOYEE to occupational health clinic (Industrial Medical Clinic), if needed.
4. Upon arrival at clinic, contact Corporate H&S (Workers Compensation) at **720.344.3844** to report status of employee.
5. Stay with EMPLOYEE until care is given and EMPLOYEE is allowed to depart clinic.
6. Report back to SITE SUPERVISOR with employee (if EMPLOYEE is able) upon discharge to begin incident investigation.

ARCADIS PM will:

1. Communicate with on-site SITE SUPERVISOR as needed to advise on incident.
2. Notify EMES PM Lauren Gordon, the ARCADIS Principal-in-Charge, and the ARCADIS Program Manager.
3. Interface with Corporate H&S to validate whether EMPLOYEE will receive on-site treatment, or require visit to occupational health clinic (Industrial Medical Clinic). Notify Corporate H&S of employee's duties and availability of light duty work, if required.
4. Assist/review in the incident investigation process using the LPS tools.

ARCADIS CORPORATE HEALTH AND SAFETY MANAGER will:

1. Handle reporting to Workers Compensation Third Party Administrator (TPA) and then work with the SITE SUPERVISOR, TPA adjuster and employee to ensure appropriate medical care, work release (including light duty release when medically appropriate) and discharge from care.
2. If visit to a physician is not advised, WC will follow up with employee AND Corporate H&S Manager until injury is resolved.

NOTES: When at the clinic, the employee should be treated based upon authorization from WorkCare. If the clinic staff wants to provide services beyond what WC authorized then the clinic must contact WC for authorization.

Scenario #3: ARCADIS Emergency Situation (broken limbs, amputation, significant loss of blood, loss of consciousness, heat injuries, chest pain, etc.)

The employee discovering the incident will call for assistance and begin first aid

The ARCADIS SITE SUPERVISOR will:

1. **Stop work** when an incident occurs.
2. Notify a trained first aid responder to report to incident location.
3. Contact ARCADIS on-site Field Technician/H&S Manager.
4. Accompany EMPLOYEE to hospital (Methodist LeBonheur Germantown Hospital).
5. Contact Corporate H&S (Workers Compensation) at **720.344.3844** to report EMPLOYEE status upon arrival at hospital.
6. Notify next of kin as required.
7. Follow guidance from Corporate H&S, as required, during time at hospital.
8. Work with Corporate H&S and Human Resources to determine restricted work, light duty release status, etc., as appropriate.

The ARCADIS on-site Field Technician/H&S Manager will:

1. Report to incident location and make sure that the situation is stabilized.
2. Verify that 911 has been called.
3. Personally go to meet the ambulance and accompany injured employee to incident location.
4. Contact ARCADIS PM and ARCADIS EMES Safety Manager Greg Ertel **585.385.0090** (office) or **585.303.0633** (cell).
5. Contact Corporate H&S (Workers Compensation) at **720.344.3844** to report incident and status of employee upon departure to hospital.
6. Begin incident investigation.

ARCADIS PM will:

1. Communicate with on-site SITE SUPERVISOR as needed to advise on incident.
2. Notify EMES PM Lauren Gordon, the ARCADIS Principal-in-Charge, and the ARCADIS Program Manager.
3. Interface with Corporate H&S to validate whether EMPLOYEE will receive on-site treatment, or require visit to occupational health clinic. Notify Corporate H&S of employee's duties and availability of light duty work, if required.
4. Assist/review in the incident investigation process using the LPS tools.

ARCADIS CORPORATE HEALTH AND SAFETY MANAGER will:

1. Handle reporting to Workers Compensation Third Party Administrator (TPA) and then work with the SITE SUPERVISOR, TPA adjuster and employee to ensure appropriate medical care, work release (including light duty release when medically appropriate) and discharge from care.
2. Assist with Next of Kin notification, if required.

Subcontractor Site Illness & Injury Management Procedures (IIMPs) for ExxonMobil Environmental Services Company Projects

SCENARIO #1: Subcontractor Employee Suffering an Injury Possibly Requiring ***Minor First Aid*** (small cuts, blisters, bruises, aches, pains resulting from work)

Subcontractor Site Supervisor will:

1. **Stop work** when an incident occurs.
2. Provide first aid, or request a trained responder to assist the injured employee.
3. Notify the Subcontractor H&S Manager.
4. Consult with Subcontractor H&S Manager to determine if the employee requires treatment at a health clinic.
5. Notify ARCADIS SITE SUPERVISOR immediately.

The ARCADIS on-site SITE SUPERVISOR will:

1. Contact ARCADIS on-site Field Technician/H&S Manager to render assistance, if needed.
2. Provide resources for incident investigation; validate whether or not the EMPLOYEE needs to be transported to occupational health clinic.
3. Check on EMPLOYEE status to verify treatment and ability to work.

The ARCADIS on-site Field Technician/H&S Manager will:

1. Report to incident location immediately.
2. Assist Subcontractor in first aid response, if required.
3. Assist in conducting the incident investigation using the LPS tools.
4. Contact the ARCADIS PM.

ARCADIS PM will:

1. Communicate with on-site ARCADIS SITE SUPERVISOR, as needed, to advise on incident.
2. Notify EMES PM Lauren Gordon, and the ARCADIS Program Manager.
3. Participate in incident investigation using the LPS tools.

Scenario # 2: Subcontractor Employee Suffering an Injury Possibly Requiring ***<u>Medical Treatment</u>*** (Deeper cuts, strains/sprains, possible chemical exposure)

The Subcontractor Site Supervisor will:

1. **Stop work** when an incident occurs.
2. Secure the area.
3. Administer first aid, or call for a trained responder.
4. Notify the Subcontractor H&S Manager.
5. Notify the on-site ARCADIS SITE SUPERVISOR immediately and coordinate response actions.
6. Drive or accompany EMPLOYEE to designated occupational health clinic and stay for the duration of treatment.
7. Interface with medical personnel in regards to desire to bring employee back to work quickly with no restrictions, or if restrictions are needed, with a positive restriction that indicates activities that the employee CAN DO, rather than what he/she cannot do.
8. Begin incident investigation using the LPS tools.

The Subcontractor H&S Manager will:

1. Assist Subcontractor Site Supervisor, as required, to prepare employee for transport to health clinic.
2. Begin incident investigation with ARCADIS H&S Manager using the LPS tools.

The ARCADIS on-site SITE SUPERVISOR will:

1. **Stop work** when an incident occurs.
2. Notify a trained responder to report to incident location to render assistance.
3. Contact ARCADIS on-site Field Technician/H&S Manager
4. Accompany employee and Subcontractor Supervisor to the health clinic.
5. Notify ARCADIS PM and ARCADIS EMES Safety Manager Greg Ertel **585.385.0090** (office) or **585.303.0633** (cell).
6. Check EMPLOYEE status upon return to site to verify treatment and ability to work.

The ARCADIS on-site Field Technician/H&S Manager will:

1. Report to incident location and provide assistance, if needed.
2. After securing site, assist Subcontractor H&S Manager in conduct of incident investigation using the LPS tools.

ARCADIS PM will:

1. Communicate with on-site ARCADIS SITE SUPERVISOR, as needed, to advise on incident.
2. Notify EMES PM Lauren Gordon, the ARCADIS Principal-in-Charge, and the ARCADIS Program Manager.
3. Participate in incident investigation using the LPS tools.

Scenario #3: Subcontractor Emergency Situation (broken limbs, amputation, significant loss of blood, loss of consciousness, heat injuries, chest pain, etc.)

The employee discovering the incident will call for assistance and begin first aid

The Subcontractor Site Supervisor will:

1. **Call 911.**
2. **Stop work** immediately.
3. Notify a trained responder to report to incident location
4. Secure the site.
5. Contact ARCADIS SITE SUPERVISOR immediately
6. Travel to hospital (Methodist LeBonheur Germantown Hospital) with EMPLOYEE.
7. Notify next of kin, as required.
8. Contact Subcontractor Corporate from hospital to provide incident information.

The ARCADIS SITE SUPERVISOR will:

1. Stop work immediately, if Subcontractor Site Supervisor has not done so.
2. Call 911, if Subcontractor Site Supervisor has not.
3. Notify a trained responder to report to incident location to render assistance
4. Contact ARCADIS on-site H&S Manager to get engaged in the incident.
5. Accompany EMPLOYEE to hospital (Methodist LeBonheur Germantown Hospital).
6. Follow guidance from ARCADIS Corporate H&S as required during time at hospital.
7. Work with Subcontractor management to determine restricted work, light duty release, etc., as appropriate.
8. Assist Subcontractor in incident investigation using the LPS tools.
9. Review conditions that led to the incident with field team, address key issues, and make the determination when to resume work based on feedback.

The ARCADIS H&S Manager will:

1. Report to incident location and make sure that the situation is stabilized.
2. Verify that 911 has been called.
3. Personally go to meet the ambulance and accompany to incident location.
4. Contact ARCADIS PM and ARCADIS Corporate H&S.
5. Begin incident investigation using the LPS tools.

ARCADIS PM will:

1. Communicate with on-site ARCADIS SITE SUPERVISOR, as needed, to advise on incident.
2. Notify EMES PM Lauren Gordon, the ARCADIS Principal-in-Charge, and the ARCADIS Program Manager.

CORPORATE HEALTH AND SAFETY will:

1. Participate in incident investigation using the LPS tools.

ARCADIS

Attachment 2

Forms

Daily Site Safety Meeting Checklist

Revision - 1

Date of Revision - 06/30/10

Date and Time ______________ Site Location ________________________________

Weather Conditions ________________________________

Description of Work ________________________________

Other ________________________________

The purpose of the form is to provide a structure and documentation for Daily Site Safety Meetings. The following topics should be included along with any other discussions as deemed appropriate for the daily work. Details regarding these topics are included in the HASP.
(Same form may be used for multiple days, note additional dates with comments below)

Date					
Name of Person Conducting Meeting					
Topic					
If applicable, ensure all third party permits to construct are in hand and available on-site					
Review HASP, note any outdated or missing information, ensure it is signed and understood by all					
Review Job Safety Analysis (JSA), identify tasks, hazards, and recommendations as needed					
Review PPE and appropriate attire (no shorts, open toe shoes, long sleeves, gloves, etc.)					
All necessary gloves available for each site worker? (nitrile, cut resistant, leather, other?)					
Lock Out / Tag Out, note any activities requiring LO/TO					
Traffic Safety Control, note changes in traffic pattern, volume, visibility, location of daily work, minimum visibility PPE					
Hot Work Permit, note potential ignition sources and fuels and if a Hot Work Permit is needed					
Subsurface work : Drilling, trenching, etc. conducted according to required Protocol, including pre-field preparations, utility mark-out and "hand" clearing					
Proper H&S training and certifications have been obtained for all subcontractors					
Emergency procedures & equipment					
Other Safety Concerns					

The undersigned have attended the daily safety meeting and understand all of the items discussed as listed above.

Print Name	**Signature**	**Date (s)**

ARCADIS

Visitor Acknowledgement and Acceptance of HASP

By signing below, I waive, release, and discharge the Owner of the Site and ARCADIS U.S., Inc., and their employees from any future claims for bodily and personal injuries which may result from my presence at, entering, or leaving the Site and in any way arising from or related to any and all known and unknown conditions on the Site.

Name	Company	Reason for Visit	Date/Time On Site	Date/Time Off Site

Real-Time Air Monitoring Log
Former Virginia-Carolina Chemical Corporation Memphis Site
Memphis, Tennessee
Health and Safety Plan

Instrument: ____________ Model: ____________ Serial #: ____________

Calibration Method:
(material used, settings, etc.) ____________ Date: ____________

Calibrated By: ____________ Ambient Air Temperature (F° or C°): ____________

			Action Levels
Calibration Results:	Carbon Monoxide (CO):	____________	**≥ 25 ppm**
	Hydrogen Sulfide (H_2S):	____________	**≥ 5 ppm**
	Lower Explosive Limit (LEL):	____________	**≥ 10 %**
	Total VOCs:	____________	**≥ 0.5 ppm, > 5 ppm**
	Oxygen (O_2):	____________	**< 19.5%, > 23.5%**

Activity Monitored	Time	Readings					Action Required?
		CO	H_2S	LEL	O_2	VOCs	(Y/N)

Describe Actions Taken as a Result of Air Monitoring and Why:

____

____

ARCADIS

Attachment 3

Material Safety Data Sheets

Material Safety Data Sheet Collection
Genium group inc.
1171 RiverFront Center, Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2006-06

Arsenic
ARS2340

Section 1 - Chemical Product and Company Identification

Material Name: Arsenic **CAS Number:** 7440-38-2
Chemical Formula: As
Structural Chemical Formula: As_4
EINECS Number: 231-148-6
ACX Number: X1002785-7
Synonyms: ARSEN; ARSENIA; ARSENIC; ARSENIC-75; ARSENIC BLACK; ARSENICALS; COLLOIDAL ARSENIC; GRAY ARSENIC; GREY ARSENIC; METALLIC ARSENIC
General Use: In metallurgy for hardening copper, lead alloys. In the manufacture of certain types of glass.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
Arsenic		>98

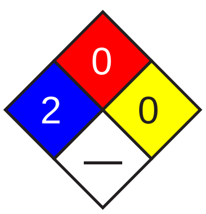
OSHA PEL
TWA: 0.01 mg/m^3.

NIOSH REL
Ceiling: 0.002 mg/m^3 (15-minute).

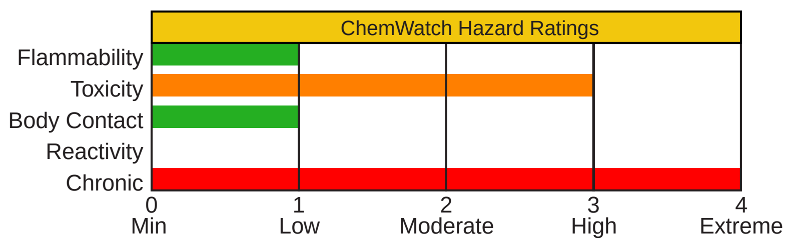
ACGIH TLV
TWA: 0.01 mg/m^3.

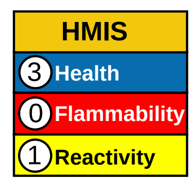
IDLH Level
5 mg/m^3 (as As).

Section 3 - Hazards Identification



Fire Diamond





ANSI Signal Word

Warning!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Brittle, crystalline, silvery-black metal. Irritating to eyes/skin/respiratory tract. Chronic Effects: damage to blood-forming organs, nervous/cardiovascular systems effects. Cancer hazard. Powder is flammable.

Potential Health Effects

Target Organs: liver, kidneys, skin, lungs, lymphatic system
Primary Entry Routes: inhalation, ingestion of dust and fumes, skin absorption
Acute Effects
Inhalation: The dust is toxic and discomforting to the upper respiratory tract and lungs.
Acute inhalation exposure can cause cough, chest pain, shortness of breath, dizziness, headache, pulmonary edema and extreme general weakness.
Prolonged or repeated exposure can cause perforation of the nasal septum.
High exposures can cause poor appetite, nausea, vomiting and muscle cramps. Heart effects with abnormal EKG can also occur with very high exposures.
Eye: The dust may produce eye discomfort causing smarting, pain and redness.
Skin: The material is moderately discomforting to the skin and may be harmful.
Exposure may result in abnormal redness (caused by capillary congestion), burning, itching, swelling, skin eruptions and dermatitis.
Toxic effects may result from skin absorption.
Repeated skin contact can cause thickened skin and/or patchy areas of darkening and loss of pigment. Some persons develop white lines on the nails.

Ingestion: The solid/dust is discomforting to the gastrointestinal tract and is toxic and may be fatal if swallowed. Symptoms of acute poisoning by ingestion, which develop within 4 hours include epigastric pain, vomiting and watery diarrhea. Blood may appear in vomitus and stools. If amount ingested is sufficiently high, shock may develop, followed by death within 24 hours.
Considered an unlikely route of entry in commercial/industrial environments.

Carcinogenicity: NTP - Class 1, Known to be a carcinogen; IARC - Group 1, Carcinogenic to humans; OSHA - Listed as a carcinogen; NIOSH - Listed as carcinogen; ACGIH - Class A1, Confirmed human carcinogen; EPA - Class A, Human carcinogen; MAK - Class A1, Capable of inducing malignant tumors as shown by experience with humans.

Chronic Effects: Symptoms of chronic poisoning by inhalation include weight loss, nausea and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, peripheral neuritis, blood disorders (anemia), striations on fingernails and toenails.
Long-term exposure can cause an ulcer or hole in the `bone' dividing the inner nose. Hoarseness and sore eyes also occur.
High or repeated exposure can cause nerve damage with `pins and needles', burning, numbness, and later weakness of arms and legs. Repeated exposure can also damage the liver, causing narrowing of the blood vessels, or interfere with the bone marrow's ability to make red blood cells.
Many cases of skin cancer have been reported among people exposed to arsenic through medical treatment with inorganic trivalent arsenic compounds. In some instances skin cancers have occurred in combination with other cancers, such as liver angiosarcoma, intestinal and urinary bladder carcinomas and meningioma. Epidemiological studies of cancer after medical treatment have shown an excess of skin cancers but no clear association with other cancers has been shown. An association between environmental exposure to arsenic through drinking water and skin cancer has been observed and confirmed. Epidemiological studies in areas where drinking water contained 0.35-1.14 mg/l arsenic elevated risks for cancers of the bladder, kidney, skin, liver, lung and colon in both men and women.
Occupational exposure to inorganic arsenic, especially in mining and copper smelting, has consistently been associated with an increased risk of cancer. An almost tenfold increase in the incidence of lung cancer was found in workers most heavily exposed to arsenic and relatively clear dose-response relationships have been obtained with regard to cumulative exposure. Other smelter worker populations have been shown to have consistent increases in lung cancer incidence, as well as increases of about 20% in the incidence of gastrointestinal cancer and of 30% for renal cancer and hematolymphatic malignancies.

Section 4 - First Aid Measures

See DOT ERG

Inhalation: Remove to fresh air. Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and wash continuously for at least 15 minutes with fresh running water. Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Quickly but gently, wipe material off skin with a dry, clean cloth.
Immediately remove all contaminated clothing, including footwear.
Wash affected areas with water (and soap if available) for at least 15 minutes. Transport to hospital or doctor.

Ingestion: Contact a Poison Control Center.
If swallowed, and if more than 15 minutes from a hospital, induce vomiting, preferably using Ipecac Syrup APF.
Note: DO NOT INDUCE VOMITING in an unconscious person

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short term repeated exposures to arsenic, soluble compounds:
Treat as per arsenic poisoning.
1. Acute skin lesions such as contact dermatitis usually do not require other treatment than removal from exposure.
2. If more severe symptoms of the respiratory system, the skin or the gastrointestinal tract occur, British Anti-Lewisite (BAL, dimercaprol) may be given. Prompt administration in such cases is vital; to obtain maximum benefit such treatment should be administered within 4 hours of poisoning.
3. In addition, general treatment such as prevention of further absorption from the gastrointestinal tract are mandatory.
4. General supportive therapy such as maintenance of respiration and circulation, maintenance of water and electrolyte balance and control of nervous system effects, as well as elimination of absorbed poison through dialysis and exchange transfusion, may be used if feasible.
5. Dimercaprol is given by deep intramuscular injection as a 5% solution in peanut oil (or a 10% solution with benzyl-benzoate in vegetable oil). It is usually given in a dose of 3 mg/kg, 4-hourly, for the first two days, or twice daily for up to seven days.
6. BAL Therapy is effective for hematological manifestations of chronic arsenic poisoning but not for neurological symptoms. Watch for side effects (e.g. urticaria, burning sensation in the lips, mouth and throat, fever, conjunctivitis etc).
7. Some relief results from administration of diphenhydramine (Benadryl) (1.5 mg/kg intramuscularly or by mouth every 6 hour).

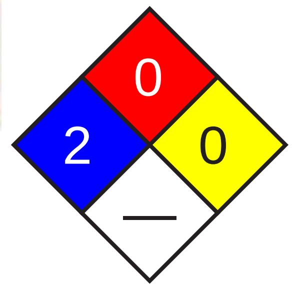
BIOLOGICAL EXPOSURE INDEX - BEI

These represent the determinants observed in specimens collected from a healthy worker exposed at the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Inorganic arsenic metabolites in urine	50 ug/g creatinine	End of workweek	B

B: Background levels occur in specimens collected from subjects NOT exposed
Consult specific documentation.

Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: Noncombustible solid
Extinguishing Media: Use fire fighting procedures suitable for surrounding area.
General Fire Hazards/Hazardous Combustion Products: Solid which exhibits difficult combustion or is difficult to ignite.
Avoid generating dust, particularly clouds of dust in a confined or unventilated space.
Dust may form an explosive mixture with air, and any source of ignition, i.e. flame or spark, will cause fire or explosion.
Dry dust can be charged electrostatically by turbulence, pneumatic transport, pouring, in exhaust ducts and during transport. Build-up of electrostatic charge may be prevented by bonding and grounding.
Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.
Decomposes on heating and produces toxic fumes of arsenic oxides (AsO_x).
Fire Incompatibility: Avoid contact with acids, oxidizing agents, halogens.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves for fire only. Prevent, by any means available, spillage from entering drains or waterways.
Use fire fighting procedures suitable for surrounding area.
Do not approach containers suspected to be hot.
Cool fire exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.
Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: Clean up all spills immediately. Wear protective clothing, impervious gloves and safety glasses. Increase ventilation.
Use a vacuum or a wet method to reduce dust during clean-up. DO NOT dry sweep.
Place in suitable containers for disposal.
Wash area down with large quantity of water and prevent runoff into drains.
Large Spills: POLLUTANT -contain spillage. Clear area of personnel and move upwind.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
If contamination of drains or waterways occurs, advise emergency services.
Shut off all possible sources of ignition and increase ventilation.
Stop leak if safe to do so.
Contain spill with sand, earth or vermiculite.
Use dry clean up procedures and avoid generating dust.
Collect recoverable product into labeled containers for recycling. Collect residues and seal in labeled drums for disposal.
Wash area down with large quantity of water and prevent runoff into drains.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Use good occupational work practice.
Avoid contact with skin and eyes.
Avoid generating and breathing dust.

Use in a well-ventilated area.
Wear protective clothing when risk of exposure occurs.
Avoid sources of heat. Avoid contact with incompatible materials. Avoid physical damage to containers.
Keep containers securely sealed when not in use.
When handling, DO NOT eat, drink or smoke.
Wash hands with soap and water after handling.
Work clothes should be laundered separately: NOT at home.

Recommended Storage Methods: Glass container. Plastic drum. Polyethylene or polypropylene container. Steel drum. Metal drum.
Check that containers are clearly labeled.

Storage Requirements: Observe manufacturer's storing and handling recommendations.
Store in a cool, dry place. Store in a well-ventilated area. Store away from sources of heat or ignition/bare lights.
Avoid storage at temperatures higher than 60 °C. Store away from incompatible materials. Store away from foodstuff containers.
Protect containers against physical damage.
Keep containers securely sealed.
Check regularly for spills and leaks.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: General exhaust is adequate under normal operating conditions.
Local exhaust ventilation may be required.
Use ventilated helmet or air-line hood to provide clean air at the breathing zone.
If risk of overexposure exists, wear NIOSH approved respirator. Correct fit is essential to obtain adequate protection.

Personal Protective Clothing/Equipment:

Eyes: Safety glasses. Chemical goggles.
Full face shield.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Impervious, gauntlet length gloves; Rubber gloves. Neoprene gloves.
Rubber boots.

Respiratory Protection:
Exposure Range >0.01 to 0.1 mg/m^3: Air Purifying, Negative Pressure, Half Mask
Exposure Range >0.1 to 1 mg/m^3: Air Purifying, Negative Pressure, Full Face
Exposure Range >1 to <5 mg/m^3: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range 5 to unlimited mg/m^3: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: magenta (P100)

Other: Overalls. PVC apron. PVC protective suit may be required if exposure severe.
Eyewash unit. Ensure there is ready access to a safety shower.
* Preplacement and periodic medical examinations are essential for workers exposed to arsenic. Preplacement physical examinations should give particular attention to allergic and chronic skin lesions, eye disease, psoriasis, chronic eczematous dermatitis, hyperpigmentation of the skin, keratosis and warts, baseline weight, baseline blood and hemoglobin counts, baseline urinary arsenic determinations.
Annual physical examinations should give attention to general health, weight, skin condition, and any evidence of excessive exposure or absorption of arsenic.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Grey, shiny, brittle, metallic-looking rhombohedral crystals. Can be heated to burn in air with a bluish flame, giving off an odor of garlic and dense white fumes of arsenic trioxide. Loses its luster on exposure to air. Converted by nitric acid or hot sulfuric acid into arsenous or arsenic acid.
Brinell hardness: 147
Mohs' scale: 3.5

Physical State: Divided solid
Vapor Pressure (kPa): Not applicable
Vapor Density (Air=1): Not applicable
Formula Weight: 74.92
Specific Gravity (H_2O=1, at 4 °C): 5.73
Evaporation Rate: Not applicable
pH: Not applicable
pH (1% Solution): Not applicable
Boiling Point: Sublimes
Freezing/Melting Point: 817 °C (1502.6 °F) at 28 atm
Volatile Component (% Vol): Not applicable
Water Solubility: Insoluble

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Contact with acids liberates toxic gases. Presence of heat source and ignition source.
Product is considered stable under normal handling conditions. Hazardous polymerization will not occur.

Storage Incompatibilities: Segregate from oxidizing agents, halogens.
Contact with acids produces toxic fumes.

Section 11 - Toxicological Information

Toxicity
Oral (man) TD_{Lo}: 7857 mg/kg/55 years
Oral (rat) LD_{50}: 763 mg/kg
Tumorigenic - Carcinogenic by RTECS criteria.

Irritation
Nil reported

See *RTECS* CG 0525000, for additional data.

Section 12 - Ecological Information

Environmental Fate: No data found.
Ecotoxicity: Food chain concentration potential: Bioaccumulated by fresh water and marine aquatic organisms
BCF: bioaccumulated by aquatic organisms
Biochemical Oxygen Demand (BOD): none

Section 13 - Disposal Considerations

Disposal: Follow all federal, state, and local regulations.

Section 14 - Transport Information

DOT Hazardous Materials Table Data (49 CFR 172.101):

Shipping Name and Description: Arsenic
ID: UN1558
Hazard Class: 6.1 - Poisonous materials
Packing Group: II - Medium Danger
Symbols:
Label Codes: 6.1 - Poison *or* Poison Inhalation Hazard *if inhalation hazard, Zone A or B*
Special Provisions: IB8, IP2, IP4
Packaging: **Exceptions:** None **Non-bulk:** 212 **Bulk:** 242
Quantity Limitations: **Passenger aircraft/rail:** 25 kg **Cargo aircraft only:** 100 kg
Vessel Stowage: **Location:** A **Other:**

Section 15 - Regulatory Information

EPA Regulations:
- **RCRA 40 CFR:** Listed
- **CERCLA 40 CFR 302.4:** Listed per CWA Section 307(a), per CAA Section 112 1 lb (0.454 kg)
- **SARA 40 CFR 372.65:** Listed
- **SARA EHS 40 CFR 355:** Not listed
- **TSCA:** Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Group, Inc. extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet Collection
Genium group inc.
1171 RiverFront Center, Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2006-06

Lead
LEA1000

Section 1 - Chemical Product and Company Identification

Material Name: Lead **CAS Number:** 7439-92-1
Chemical Formula: Pb
Structural Chemical Formula: Pb
EINECS Number: 231-100-4
ACX Number: X1000227-2
Synonyms: C.I. 77575; C.I. PIGMENT METAL 4; GLOVER; KS-4; LEAD; LEAD FLAKE; LEAD INORGANIC; LEAD METAL; LEAD S2; LEAD SZ; OLOW; OMAHA & GRANT; PB-S 100; PLUMBUM
General Use: Used as a construction material in chemical reaction equipment (tank piping,etc.); manufacture of tetraethyl lead; pigments for paints.
Used in pottery glazes, glass, ceramics, bearing metal and alloys, solder and other lead alloys.
Also used in metallurgy of steel and other metals, cable sheathing, storage batteries, radiation shielding and ammunition.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
lead	7439-92-1	>99

OSHA PEL
TWA: 0.05 mg/m^3; as Pb inorganic.

ACGIH TLV
TWA: 0.05 mg/m^3.

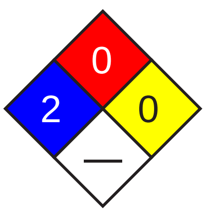
EU OEL
TWA: 0.1 mg/m^3.

NIOSH REL
TWA: 0.050 mg/m^3.

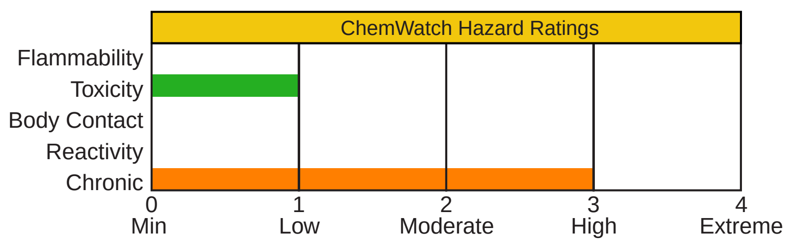
IDLH Level
100 mg/m^3 (as Pb).

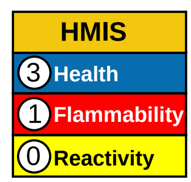
DFG (Germany) MAK
TWA: 0.1 mg/m^3; PEAK: 8 mg/m^3; measured as inhalable fraction of the aerosol; Excluding lead arsenate and lead chromate.

Section 3 - Hazards Identification



Fire Diamond





ANSI Signal Word
Danger!


Poison

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Bluish-white, silvery, or gray metal. Cumulative poison. Chronic Effects: severe neurological effects, blood/kidney damage, sterility, decreased fertility, developmental damage to fetus. Possible cancer hazard.

Potential Health Effects

Target Organs: blood, central nervous system (CNS), peripheral nervous system, kidneys, gastrointestinal (GI) tract
Primary Entry Routes: inhalation, ingestion
Acute Effects
Inhalation: The dust may be discomforting to the upper respiratory tract and may be harmful if inhaled.
Eye: The dust may be discomforting to the eyes.
Skin: The material may be mildly discomforting to the skin.
Prolonged exposure may cause skin reactions.
Skin absorption is not considered a significant route of exposure.
Ingestion: The material is moderately discomforting to the gastrointestinal tract and may be harmful if swallowed.

In rats intestinal lead absorption is bidirectional and does not follow a linear relationship with oral dose.
Acute effects of exposure are generally minor because of its relative insolubility and physical form. Unusual instances of exposure have been reported in inadequately ventilated indoor firing ranges (as fume), in the application of surma, a mascara-like cosmetic agent, to the conjunctival surfaces in Asian countries and in lead-smelting and associated occupations.
In humans lead metabolism fits into a three compartment model. The first compartment in which lead has a half-life of about 35 days includes the blood; it receives blood from the gut and delivers some of it to the urine and communicates with the other two pools. The second compartment in which lead has a similar half-life includes the soft tissues which contain about half the blood level; they share lead with hair, nails, sweat, saliva, bile and other digestive secretions. The skeleton is the third compartment and contains the vast bulk of the total body burden, possesses a very long half-life and demonstrates a difference between the dense and less dense components to bind lead.

Carcinogenicity: NTP - Not listed; IARC - Group 2B, Possibly carcinogenic to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Class B2, Probable human carcinogen based on animal studies; MAK - Not listed.

Chronic Effects: Symptoms of exposure include headache, fatigue, sleep disturbances, abdominal pains and decreased appetite. Overexposure to lead in the form of dust has toxic effects on the lungs and kidneys and on the nervous system resulting in mental disturbances and anemia.
Skin absorption is not considered to be a significant route of exposure.
Worker exposure to lead must be kept to a minimum, especially in cases where lead is worked at temperatures whereby lead vapors are evolved e.g. metal refining.
Lead is an accumulative poison and exposure even to small amounts can raise the body's content to toxic levels.
Potential adverse effects on the offspring of pregnant workers have been cited in the literature.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If available, administer medical oxygen by trained personnel.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water. Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

Ingestion: Rinse mouth out with plenty of water.
Seek medical attention if irritation or discomfort persist.

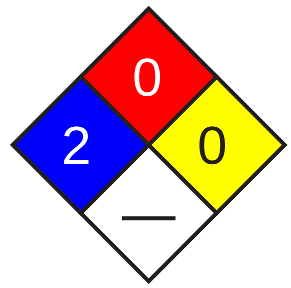
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: 1.Gastric acids solubilize lead and its salts and lead absorption occurs in the small bowel.
2.Particles of less than 1um diameter are substantially absorbed by the alveoli following inhalation.
3.Lead is distributed to the red blood cells and has a half-life of 35 days.
It is subsequently redistributed to soft tissue & bone-stores or eliminated.The kidney accounts for 75% of daily lead loss; integumentary and alimentary losses account for the remainder.
4.Neurasthenic symptoms are the most common symptoms of intoxication.
Lead toxicity produces a classic motor neuropathy.
Acute encephalopathy appears infrequently in adults.
Diazepam is the best drug for seizures.
5.Whole-blood lead is the best measure of recent exposure; free erythrocyte protoporphyrin (FEP) provides the best screening for chronic exposure. Obvious clinical symptoms occur in adults when whole-blood lead exceeds 80 ug/dL.
6.British Anti-Lewisite is an effective antidote and enhances fecal and urinary excretion of lead. The onset of action of BAL is about 30 minutes and most of the chelated metal complex is excreted in 4-6 hours, primarily in the bile.
Adverse reaction appears in up to 50% of patients given BAL in doses exceeding 5 mg/kg. CaNa2EDTA has also been used alone or in concert with BAL as an antidote.
D-penacillamine is the usual oral agent for mobilization of bone lead; its use in the treatment of lead poisoning remains investigational.
2-3-dimercapto-1-propanesulfonic acid (DMPS) and dimercaptosuccinic acid (DMSA) are water soluble analogues of BAL and their effectiveness is undergoing review.
As a rule, stop BAL if lead decreases below 50 ug/dL; stop CaNa2EDTA if blood lead decreases below 40 ug/dL or urinary lead drops below 2 mg/24 hrs.
BIOLOGICAL EXPOSURE INDEX - BEI
These represent the determinants observed in specimens collected from a healthy worker exposed at the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Lead in blood	50 ug/100 mL	Not Critical	B
Lead in urine	150 ug/gm creatinine	Not critical	B
Zinc Protoporphyrin in blood	250 ug/100 mL erythrocytes OR 100 ug/100 mL blood	After 1 month exposure	B

B: Background levels occur in specimens collected from subjects NOT exposed.

Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: Not available; probably noncombustible
Autoignition Temperature: Not applicable
LEL: Not applicable
UEL: Not applicable
Extinguishing Media: There is no restriction on the type of extinguisher which may be used.
General Fire Hazards/Hazardous Combustion Products: Noncombustible.
Not considered to be a significant fire risk; however, containers may burn.
Moderate fire hazard, in the form of dust, when exposed to heat or flames.
Decomposition products may include toxic lead dust and lead oxide fumes.
Fire Incompatibility: Incompatible with strong acids, oxidants, ammonium nitrate, chlorine trifluoride and sodium azide.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Use fire fighting procedures suitable for surrounding area.
Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways.
If safe to do so, remove containers from path of fire.
Cool fire-exposed containers with water spray from a protected location.
Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: Clean up all spills immediately. Avoid contact with skin and eyes.
Wear protective clothing, gloves, safety glasses and dust respirator.
Use dry clean-up procedures and avoid generating dust.
Vacuum up.
Place spilled material in clean, dry, sealable, labeled container.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
Control personal contact by using protective equipment and dust respirator.
Prevent spillage from entering drains, sewers or waterways.
Recover product wherever possible. Avoid generating dust. Sweep / shovel up.
If required, wet with water to prevent dusting.
Put residues in labeled plastic bags or other containers for disposal.
Wash area down with large quantity of water and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Limit all unnecessary personal contact.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.

Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Recommended Storage Methods: Check that containers are clearly labeled.
Packaging as recommended by manufacturer.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: General exhaust is adequate under normal operating conditions.
If risk of overexposure exists, wear NIOSH-approved dust respirator.
Correct fit is essential to obtain adequate protection.
Personal Protective Clothing/Equipment:
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Impervious gloves; rubber gloves.
Rubber boots.
Protective footwear.
Respiratory Protection:
Exposure Range >0.05 to 0.5 mg/m^3: Air Purifying, Negative Pressure, Half Mask
Exposure Range >0.5 to 2.5 mg/m^3: Air Purifying, Negative Pressure, Full Face
Exposure Range >2.5 to 50 mg/m^3: Powered Air Purifying Respirator, Half or Full Facepiece or Hood
Exposure Range >50 to 100 mg/m^3: Supplied Air Respirator with Full Facepiece, Hood, Helmet, or Suit, operated in a Positive Pressure Mode
Exposure Range >100 to unlimited mg/m^3: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: magenta (P100)
Note: (29CFR 1910.1025) for general industry
Other: Overalls. Eyewash unit. Skin cleansing cream.
Provide adequate ventilation in warehouse or closed storage areas.
General and local exhaust ventilation usually required to maintain airborne dust levels to safety levels.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Bluish-white, silvery-gray metal. Malleable, lustrous when freshly cut and tarnishes when exposed to air. Reacts with strong acids like nitric acid, sulphuric or hydrochloric acid. Attacked by water in presence of oxygen. Poor electrical conductor. Lead fumes are formed at temperatures above 500-700 °C.

Physical State: Divided solid
Vapor Pressure (kPa): 0.24 at 1000 °C
Vapor Density (Air=1): Not applicable
Formula Weight: 207.19
Specific Gravity (H_2O=1, at 4 °C): 11.34
Evaporation Rate: Not applicable
pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point: 1740 °C (3164 °F)
Freezing/Melting Point: 327.4 °C (621.32 °F)
Volatile Component (% Vol): Not applicable
Water Solubility: Insoluble in water

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Hazardous polymerization will not occur. Stable under normal storage conditions.
Storage Incompatibilities: Avoid storage with strong acids, oxidants, ammonium nitrate, chlorine trifluoride and sodium azide.

Section 11 - Toxicological Information

Toxicity
Oral (woman) TD_{Lo}: 450 mg/kg/6 years
Inhalation (human) TC_{Lo}: 0.01 mg/m^3
WARNING: Lead is a cumulative poison and has the potential to cause abortion and intellectual impairment to unborn children of pregnant workers.

Irritation
Nil Reported

See *RTECS* OF 7525000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released or deposited on soil, it will be retained in the upper 2-5 cm of soil, especially soils with at least 5% organic matter or a pH 5 or above. Leaching is not important under normal conditions although there is some evidence to suggest that it is taken up by some plants. Generally, the uptake from soil into plants is not significant. It is expected to slowly undergo speciation to the more insoluble sulfate, sulfide, oxide, and phosphate salts. It enters water from atmospheric fallout, runoff or wastewater; little is transferred from natural ores. It is a stable metal and adherent films of protective insoluble salts form that protect the metal from further corrosion. That which dissolves tends to form ligands. It is effectively removed from the water column to the sediment by adsorption to organic matter and clay minerals, precipitation as insoluble salt (the carbonate or sulfate, sulfide), and reaction with hydrous iron and manganese oxide. Under most circumstances, adsorption predominates. It does not appear to bioconcentrate significantly in fish but does in some shellfish such as mussels. When released to the atmosphere, it will generally be in dust or adsorbed to particulate matter and subject to gravitational settling and be transformed to the oxide and carbonate.

Ecotoxicity: LC_{50} Japanese quail (Coturnix japonica), males or females, 14 days old, oral (5-day ad libitum in diet) >5,000 ppm; at 1000, 2236 & 5000 onset of toxic signs began at 7, 7 & 7 days and remissed at 11, 11 & 12 days, respectively, no mortality was observed; control references were dieldrin & dicrotophos; corn oil diluent was added to diet at ratio of 2:98 by wt; (extreme concentrations: 1,000-5,000 ppm)

BCF: freshwater fish 1.38 to 1.65

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible. Consult manufacturer for recycling options. Follow applicable federal, state, and local regulations.

Section 14 - Transport Information

DOT Hazardous Materials Table Data (49 CFR 172.101):

Shipping Name and Description: None

Section 15 - Regulatory Information

EPA Regulations:

- **RCRA 40 CFR:** Listed
- **CERCLA 40 CFR 302.4:** Listed per CWA Section 307(a) 10 lb (4.535 kg)
- **SARA 40 CFR 372.65:** Listed
- **SARA EHS 40 CFR 355:** Not listed
- **TSCA:** Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Group, Inc. extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Section 1 - Chemical Product and Company Identification 61

Material Name: Isopropyl Alcohol **CAS Number:** 67-63-0
Chemical Formula: C_3H_8O
Structural Chemical Formula: $(CH_3)_2CHOH$
EINECS Number: 200-661-7
ACX Number: X1001458-1
Synonyms: ALCOJEL; ALCOOL ISOPROPILICO; ALCOOL ISOPROPYLIQUE; ALCOSOLVE; ALCOSOLVE 2; AVANTIN; AVANTINE; CHROMAR; COMBI-SCHUTZ; (COMPONENT OF) HIBISTAT; DIMETHYL CARBINOL; DIMETHYLCARBINOL; EPA PESTICIDE CHEMICAL CODE 047501; HARTOSOL; 2-HYDROXYPROPANE; IMSOL A; IPA; ISOHOL; ISOPROPANOL; ISOPROPYL ALCOHOL; ISO-PROPYLALKOHOL; LUTOSOL; 1-METHYLETHANOL; 1-METHYLETHYL ALCOHOL; PETROHOL; PRO; 2-PROPANOL; I-PROPANOL; N-PROPAN-2-OL; PROPAN-2-OL; PROPOL; 2-PROPYL ALCOHOL; I-PROPYL ALCOHOL; SEC-PROPYL ALCOHOL; I-PROPYLALKOHOL; SECONDARY PROPYL ALCOHOL; SPECTRAR; STERISOL HAND DISINFECTANT; TAKINEOCOL; VISCO 1152
Derivation: Treating propylene with sulfuric acid and then hydrolyzing or direct hydration of propylene using superheated steam. Most commonly available as rubbing alcohol (70% IPA).
General Use: As a solvent for gums, shellac, and essential oils, chemical intermediate, dehydrating agent, vehicle for germicidal compounds, de-icing agent for liquid fuels; for denaturing ethyl alcohol, preserving pathological specimens; in extraction of alkaloids, quick-drying inks and oils, and an ingredient of skin lotions, cosmetics, window cleaner, liquid soaps, and pharmaceuticals.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
Isopropyl alcohol	67-63-0	100% vol.

Most commonly sold as 70% isopropyl alcohol (rubbing alcohol).

OSHA PEL
TWA: 400 ppm; 980 mg/m^3.

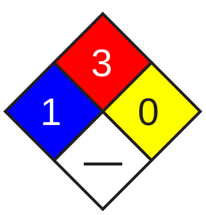
ACGIH TLV
TWA: 200 ppm; STEL: 400 ppm.

NIOSH REL
TWA: 400 ppm (980 mg/m^3);
STEL: 500 ppm (1225 mg/m^3).

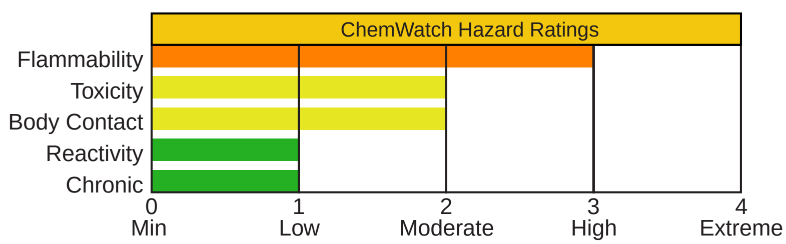
IDLH Level
2000 ppm (10% LEL).

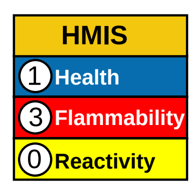
DFG (Germany) MAK
TWA: 200 ppm; PEAK: 400 ppm.

Section 3 - Hazards Identification



Fire Diamond





ANSI Signal Word
Warning!


Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆
Volatile liquid. Irritating to eyes/respiratory tract. Other Acute Effects: CNS depression, possible dermatitis, systemic toxicity. Flammable

Potential Health Effects

Target Organs: Eyes, skin, respiratory system.
Primary Entry Routes: Inhalation, ingestion, skin contact/absorption.

Acute Effects

Inhalation: Vapor inhalation is irritating to the respiratory tract and can cause central nervous system depression at high concentrations. Volunteers exposed to 400 ppm for 3 to 5 min experienced mild eye and respiratory irritation. At 800 ppm, irritation was not severe, but most people found the air uncomfortable to breathe.

Eye: Exposure to the vapor or direct contact with the liquid causes irritation and possible corneal burns.

Skin: Some irritation may occur after prolonged exposure.

Ingestion: Accidental ingestions have provided the most information on isopropyl alcohol toxicity. Symptoms include nausea and vomiting, headache, facial flushing, dizziness, lowered blood pressure, mental depression, hallucinations and distorted perceptions, difficulty breathing, respiratory depression, stupor, unconsciousness, and coma. Kidney insufficiency including oliguria (reduced urine excretion), anuria (absent urine excretion), nitrogen retention, and edema (fluid build-up in tissues) may occur. One post-mortem examination in a case of heavy ingestion showed extensive hemorrhagic tracheobronchitis, broncho pneumonia, and hemorrhagic pulmonary edema. Death can occur in 24 to 36 h post-ingestion due to respiratory paralysis.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Medical Conditions Aggravated by Long-Term Exposure: Dermatitis or respiratory or kidney disorders.

Chronic Effects: Repeated skin contact can cause drying of skin and delayed hypersensitivity reactions in some individuals.

Section 4 - First Aid Measures

See DOT ERG

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

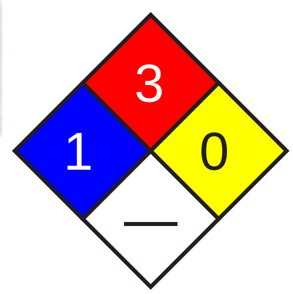
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. Vomiting may be contraindicated because of the rapid onset of central nervous system depression. Gastric lavage is preferred.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Diagnostic test: acetone in urine. Isopropyl alcohol is oxidized in the body to acetone where it is excreted by the lungs or kidneys. Some acetone may be further metabolized to acetate, formate, and finally carbon dioxide. Probable oral lethal dose is 240 mL.

Section 5 - Fire-Fighting Measures

See DOT ERG



Fire Diamond

Flash Point: 53 °F (12 °C), Closed Cup

Burning Rate: 2.3 mm/min.

Autoignition Temperature: 750°F (399°C)

LEL: 2 % v/v

UEL: 12.7 % v/v at 200 °F

Flammability Classification: Class 1B Flammable Liquid

Extinguishing Media: Carbon dioxide, dry chemical, water *spray* (solid streams can spread fire), alcohol- resistant foam, or fog.

General Fire Hazards/Hazardous Combustion Products: Carbon oxides and acrid smoke. Container may explode in heat of fire. Vapors may travel to an ignition source and flash back. Isopropyl alcohol poses an explosion hazard indoors, outdoors, and in sewers.

Fire-Fighting Instructions: If possible without risk, move container from fire area. Apply cooling water to container side until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection.

Section 6 - Accidental Release Measures

See DOT ERG

Spill/Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Water spray may reduce vapor, but may not prevent ignition in closed spaces.

Small Spills: Take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers.

Large Spills: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers.
Never eat, drink, or smoke in work areas. Practice good personal hygiene after using isopropyl alcohol, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Recommended Storage Methods: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec 10). Install electrical equipment of Class 1, Group D.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around IPA. Provide general or local exhaust ventilation systems to maintain airborne levels below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, kidneys, and respiratory system. Be extra cautious when using IPA concurrently with carbon tetrachloride because animal studies have shown it enhances carbon tetrachloride's toxicity.

Personal Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Nitrile rubber (breakthrough time > 8 hr), Neoprene and Teflon (breakthrough time > 4 hr) are suitable materials for PPE. Do not use PVA, PVC or natural rubber (breakthrough time < 1 hr). Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any powered, air purifying respirator with organic vapor cartridges or any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s). For < 10,000 ppm, use any supplied-air respirator (SAR) operated in continuous-flow mode. For < 12,000 ppm, use any air- purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister or any SCBA or SAR with a full facepiece. For emergency or entrance into unknown concentrations, use any SCBA or SAR (with auxiliary SCBA) with a full facepiece and operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Separate contaminated work clothes from street clothes. Launder before reuse. Remove isopropyl alcohol from your shoes and clean personal protective equipment. Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless with a slight odor and bitter taste.

Physical State: Liquid
Odor Threshold: 7.84 to 490 mg/m^3
Vapor Pressure (kPa): 44 mm Hg at 25 °F (77 °C)
Formula Weight: 60.09
Density: 0.78505 at 68°F (20 °C)
Refractive Index: 1.375 at 68 °F (20 °C)
Boiling Point: 180.5 °F (82.5 °C)
Freezing/Melting Point: -129.1 °F (-89.5 °C)
Viscosity: 2.1 cP at 77 °F (25 °C)
Surface Tension: 20.8 dyne/cm at 77 °F (25 °C)
Ionization Potential (eV): 10.10 eV
Critical Temperature: 455 °F (235 °C)
Critical Pressure: 47 atm
Water Solubility: > 10 %
Other Solubilities: Soluble in alcohol, ether, chloroform, and benzene. Insoluble in salt solutions.

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Isopropyl alcohol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization does not occur. Exposure to heat, ignition sources, and incompatibles.

Storage Incompatibilities: Include acetaldehyde, chlorine, ethylene oxide, acids and isocyanates, hydrogen + palladium, nitroform, oleum, phosgene, potassium *t*-butoxide, oxygen (forms unstable peroxides), trinitromethane, barium perchlorate, tetrafluoroborate, chromium trioxide, sodium dichromate + sulfuric acid, aluminum, aluminum triisopropoxide, and oxidizers. Will attack some forms of plastic, rubber, and coatings.

Hazardous Decomposition Products: Thermal oxidative decomposition of isopropyl alcohol can produce carbon oxides and acrid smoke.

Section 11 - Toxicological Information

Acute Oral Effects:

Rat, oral, LD_{50}: 5045 mg/kg caused a change in righting reflex, and somnolence (general depressed activity).

Human, oral, TD_{Lo}: 223 mg/kg caused hallucinations, distorted perceptions, lowered blood pressure, and a change in pulse rate.

Human, oral, LD_{Lo}: 3570 mg/kg caused coma, respiratory depression, nausea, and vomiting.

Irritation Effects:

Rabbit, eye: 100 mg caused severe irritation.

Rabbit, skin: 500 mg caused mild irritation.

Other Effects:

Rat, inhalation: 3500 ppm/7 hr given from 1 to 19 days of pregnancy caused fetotoxicity.

See *RTECS* NT8050000, for additional data.

Section 12 - Ecological Information

Environmental Fate: On soil, IPA will volatilize or leach into groundwater. Biodegradation is possible but rates are not found in available literature. It will volatilize (est. half-life = 5.4 days) or biodegrade in water. It is not expected to bioconcentrate in fish. In the air, it reacts with photochemically produced hydroxyl radicals with a half-life of one to several days. Because it is soluble, removal by rain, snow or other precipitation is possible.

Ecotoxicity: Guppies (*Poecilia reticulata*) LC_{50} = 7,060 ppm/7 days; fathead minnow (*Pimephales promelas*) LC_{50} = 11,830 mg/L/1 hr. BOD = 133 %/5 days.

Octanol/Water Partition Coefficient: log K_{ow} = 0.05

Section 13 - Disposal Considerations

Disposal: Microbial degradation is possible by oxidizing isopropyl alcohol to acetone by members of the genus *Desulfovibrio*. Spray waste into incinerator (permit-approved facilities only) equipped with an afterburner and scrubber. Isopropyl alcohol can be settled out of water spills by salting with sodium chloride. Note: Salt may harm aquatic life, so weigh the benefits against possible harm before application. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. Triple rinse containers.

Section 14 - Transport Information

DOT Hazardous Materials Table Data (49 CFR 172.101):

Shipping Name and Description: Isopropanol *or* Isopropyl alcohol
ID: UN1219
Hazard Class: 3 - Flammable and combustible liquid
Packing Group: II - Medium Danger
Symbols:
Label Codes: 3 - Flammable Liquid
Special Provisions: IB2, T4, TP1
Packaging: **Exceptions:** 150 **Non-bulk:** 202 **Bulk:** 242
Quantity Limitations: **Passenger aircraft/rail:** 5 L **Cargo aircraft only:** 60 L
Vessel Stowage: **Location:** B **Other:**

Section 15 - Regulatory Information

EPA Regulations:

RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Not listed
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Group, Inc. extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Section 1 - Chemical Product and Company Identification

Material Name: Nitric Acid **CAS Number:** 7697-37-2
Chemical Formula: HNO_3
Structural Chemical Formula: HNO_3
EINECS Number: 231-714-2
ACX Number: X1002177-5
Synonyms: ACIDE NITRIQUE; ACIDO NITRICO; AQUA FORTIS; AZOTIC ACID; AZOTOWY KWAS; ENGRAVER'S ACID; ENGRAVERS ACID; HYDROGEN NITRATE; KYSELINA DUSICNE; NITAL; NITRIC ACID; NITRIC ACID OTHER THAN RED FUMING WITH >70% NITRIC ACID; NITRIC ACID OTHER THAN RED FUMING WITH NOT >70% NITRICACID; NITROUS FUMES; NITRYL HYDROXIDE; RED FUMING NITRIC ACID (RFNA); SALPETERSAURE; SALPETERZUUROPLOSSINGEN; WHITE FUMING NITRIC ACID (WFNA)
General Use: Manufacture of organic and inorganic nitrates and nitro compounds for fertilizers, dye intermediates and many organic chemicals.
Used for etching and cleaning metals.
Operators should be trained in procedures for safe use of this material.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
nitric acid	7697-37-2	>95

OSHA PEL
TWA: 2 ppm; 5 mg/m^3.

ACGIH TLV
TWA: 2 ppm; STEL: 4 ppm.

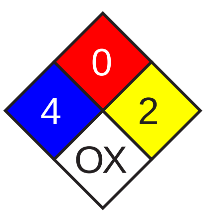
EU OEL
STEL: 2.6 mg/m^3 (1 ppm).

NIOSH REL
TWA: 2 ppm (5 mg/m^3); STEL: 4 ppm (10 mg/m^3).

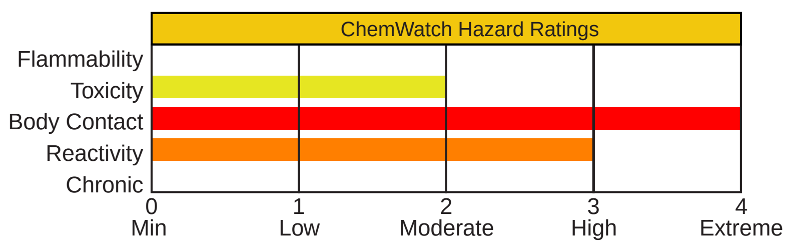
IDLH Level
25 ppm.

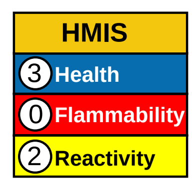
DFG (Germany) MAK
TWA: 2 ppm; PEAK: 2 ppm.

Section 3 - Hazards Identification



Fire Diamond





ANSI Signal Word
Danger!


Corrosive

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Clear to yellow fuming liquid; acrid, suffocating odor. Corrosive. Other Acute Effects: lung damage. Chronic Effects: tooth erosion, bronchitis. Strong oxidizer.

Potential Health Effects

Target Organs: eyes, skin, respiratory system, teeth
Primary Entry Routes: inhalation, ingestion, skin contact, eye contact
Acute Effects
Inhalation: The vapor is extremely discomforting and corrosive to the upper respiratory tract and lungs and the material presents a hazard from a single acute exposure or from repeated exposures over long periods.
Inhalation hazard is increased at higher temperatures.
Reactions may occur following a single acute exposure or may only appear after repeated exposures.

Reactions may not occur on exposure but response may be delayed with symptoms only appearing many hours later.
The material may produce respiratory tract irritation which produces an inflammatory response involving the recruitment and activation of many cell types, mainly derived from the vascular system. Unlike most organs the lung can respond to a chemical insult or agent by first trying to remove or neutralize the irritant and then repairing the damage. The repair process, which initially developed to protect mammalian lungs from foreign matter and antigens, may however, cause further damage the lungs when activated by hazardous chemicals. The result is often the impairment of gas exchange, the primary function of the lungs.
Inhalation of nitric acid mist or fumes at 2 to 25 ppm over an 8 hour period may cause pulmonary irritation and symptoms of lung damage.
Only several minutes of exposure to concentrated atmosphere i.e. 200 ppm may cause severe pulmonary damage and even fatality. Death may be delayed for several days.
Exposure to nitric acid fumes (with concurrent inhalation of nitrogen dioxide and nitric oxide) may elicit prompt irritation of the upper respiratory tract leading to coughing, gagging, chest pain, dyspnea, cyanosis if concentrations are sufficiently high and duration of exposure sufficiently long, pulmonary edema.

Eye: The liquid is extremely corrosive to the eyes and contact may cause rapid tissue destruction and is capable of causing severe damage with loss of sight.
The vapor is extremely discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The material may produce moderate eye irritation leading to inflammation.
Repeated or prolonged exposure to irritants may produce conjunctivitis.
Eye contact with concentrated acid may give no pain, whilst diluted solution causes intense pain and both can cause permanent eye damage or blindness. Burns may result in shrinkage of the eyeball, symblepharon (adhesions between tarsal and bulbar conjunctivae), permanent corneal opacification, and visual impairment leading to blindness.

Skin: The liquid is extremely corrosive to the skin and contact may cause tissue destruction with severe burns.
Bare unprotected skin should not be exposed to this material.
The vapor is highly discomforting to the skin.
The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.
Skin contact causes yellow discoloration of the skin, blisters and scars that may not heal. The skin may be stained bright-yellow or yellowish brown due to the formation of xanthoproteic acid. Dilute solutions may harden the epithelium without producing overt corrosion.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The material is extremely corrosive if swallowed and is capable of causing burns to mouth, throat, esophagus, with extreme discomfort, pain and may be fatal.
Even a small amount causes severe corrosion of the stomach, burning pain, vomiting and shock, possibly causing non-healing scarring of the gastrointestinal tract and stomach. Death may be delayed 12 hours to 14 days or to several months. Such late fatalities are attributed to a chemical lobular pneumonitis secondary to aspiration. Survivors show stricture of the gastric mucosa and subsequent pernicious anemia.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Chronic Effects: Prolonged or repeated overexposure to low concentrations of vapor may cause chronic bronchitis, corrosion of teeth, even chemical pneumonitis.

Section 4 - First Aid Measures

See DOT ERG

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If available, administer medical oxygen by trained personnel.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water. Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Immediately transport to hospital or doctor. DO NOT delay.

Skin Contact: Immediately flush body and clothes with large amounts of water, using safety shower if available.
Quickly remove all contaminated clothing, including footwear.
Wash affected areas with water (and soap if available) for at least 15 minutes. Transport to hospital or doctor. DO NOT delay.

Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Immediately transport to hospital or doctor. DO NOT delay.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to strong acids:

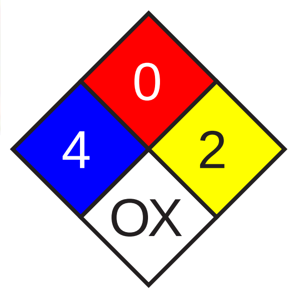
1.Airway problems may arise from laryngeal edema and inhalation exposure.
Treat with 100% oxygen initially.
2.Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling.
3. Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
4.Strong acids produce a coagulation necrosis characterized by formation of a coagulum (eschar) as a result of the desiccating action of the acid on proteins in specific tissues.

INGESTION:
1.Immediate dilution (milk or water) within 30 minutes post-ingestion is recommended.
2.Do not attempt to neutralize the acid since exothermic reaction may extend the corrosive injury.
3.Be careful to avoid further vomiting since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
4.Charcoal has no place in acid management.
5.Some authors suggest the use of lavage within 1 hour of ingestion.

SKIN:
1.Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
2.Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:
1.Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjunctival cul-de-sacs. Irrigation should last at least 20-30 minutes. Do not use neutralizing agents or any other additives. Several liters of saline are required.
2.Cycloplegic drops (1% cyclopentolate for short-term use or 5% homatropine for longer term use), antibiotic drops, vasoconstrictive agents, or artificial tears may be indicated dependent on the severity of the injury.
3.Steroid eye drops should only be administered with the approval of a consulting ophthalmologist.

Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: Nonflammable
Autoignition Temperature: Not applicable
LEL: Not applicable
UEL: Not applicable
Extinguishing Media: Water spray or fog; foam, dry chemical powder, or BCF (where regulations permit).
Carbon dioxide.
General Fire Hazards/Hazardous Combustion Products: Will not burn but increases intensity of fire.
Heating may cause expansion or decomposition leading to violent rupture of containers.
Heat affected containers remain hazardous.
Contact with combustibles such as wood, paper, oil or finely divided metal may cause ignition, combustion or violent decomposition.
May emit irritating, poisonous or corrosive fumes.
Decomposes on heating and produces toxic fumes of nitrogen oxides (NO_x) and nitric acid.
Fire Incompatibility: Oxidizing agents as a class are not necessarily combustible themselves, but can increase the risk and intensity of fire in many other substances.
Reacts vigorously with water and alkali.
Avoid reaction with organic materials/compounds, powdered metals, reducing agents and hydrogen sulfide (H_2S) as ignition may result.
Reacts with metals producing flammable/explosive hydrogen gas.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
Extinguishers should be used only by trained personnel.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.
If fire gets out of control withdraw personnel and warn against entry.
Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

See DOT ERG

Small Spills: Dangerous levels of nitrogen oxides may form during spills of nitric acid.
Wear fully protective PVC clothing and breathing apparatus.
Clean up all spills immediately. No smoking, bare lights, ignition sources.
Avoid all contact with any organic matter including fuel, solvents, sawdust, paper or cloth and other incompatible materials, as ignition may result.
Avoid breathing dust or vapors and all contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb spill with dry sand, earth, inert material or vermiculite. DO NOT use sawdust as fire may result.
Scoop up solid residues and seal in labeled drums for disposal.
Neutralize/decontaminate area.
Use soda ash or slaked lime to neutralize.

Large Spills: DO NOT touch the spill material. Restrict access to area.
Clear area of personnel and move upwind. Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
No smoking, flames or ignition sources. Increase ventilation.
Contain spill with sand, earth or other clean, inert materials.
NEVER use organic absorbents such as sawdust, paper, cloth; as fire may result. Avoid any contamination by organic matter.
Use spark-free and explosion-proof equipment.
Collect any recoverable product into labeled containers for possible recycling. DO NOT mix fresh with recovered material.
Collect residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains. Decontaminate equipment and launder all protective clothing before storage and reuse.
If contamination of drains or waterways occurs advise emergency services.
DO NOT USE WATER OR NEUTRALIZING AGENTS INDISCRIMINATELY ON LARGE SPILLS.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Do not allow clothing wet with material to stay in contact with skin.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area.
WARNING: To avoid violent reaction, ALWAYS add material to water and NEVER water to material.
Avoid smoking, bare lights or ignition sources.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling. Work clothes should be laundered separately.
Launder contaminated clothing before reuse.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.

Recommended Storage Methods: Stainless steel drum. Check that containers are clearly labeled.
Packaging as recommended by manufacturer.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area.
Local exhaust ventilation may be required for safe working, i. e. , to keep exposures below required standards; otherwise, PPE is required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
In confined spaces where there is inadequate ventilation, wear full-face air supplied breathing apparatus.

Personal Protective Clothing/Equipment:

Eyes: Chemical goggles. Full face shield.
DO NOT wear contact lenses. Contact lenses pose a special hazard; soft contact lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Bare unprotected skin should not be exposed to this material. Impervious, gauntlet length gloves i.e., butyl rubber gloves or Neoprene rubber gloves or wear chemical protective gloves, e.g. PVC.

Wear safety footwear or safety gumboots, e.g. Rubber.

Respiratory Protection:

Exposure Range >2 to <25 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 25 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face

Other: Operators should be trained in procedures for safe use of this material.
Acid-resistant overalls or Rubber apron or PVC apron.
Ensure there is ready access to an emergency shower.
Ensure that there is ready access to eye wash unit.
Ensure that there is ready access to breathing apparatus.

Glove Selection Index:

BUTYL .... Best selection
HYPALON .... Best selection
NEOPRENE.............................. Best selection
NEOPRENE/NATURAL.......... Best selection
PE/EVAL/PE .... Best selection
SARANEX-23 .... Best selection
NATURAL RUBBER............... Satisfactory; may degrade after 4 hours continuous immersion
NATURAL+NEOPRENE......... Satisfactory; may degrade after 4 hours continuous immersion
PVC... Poor to dangerous choice for other than short-term immersion
NITRILE+PVC .... Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear, colorless to slightly yellow liquid. Sharp strong odor.
CAUTION: exothermic dilution hazard.
HIGHLY CORROSIVE. Corrosive to most metals. Powerful oxidizing agent.
Darkens to brownish color on aging and exposure to light.

Physical State: Liquid
Odor Threshold: 0.75 to 2.50 mg/m^3
Vapor Pressure (kPa): 8.26
Vapor Density (Air=1): 1.5
Formula Weight: 63.02
Specific Gravity (H_2O=1, at 4 °C): 1.3-1.42
pH: < 1
pH (1% Solution): 1
Boiling Point: 83 °C (181 °F) at 760 mm Hg
Freezing/Melting Point: -42 °C (-43.6 °F)
Volatile Component (% Vol): 100 (nominal)
Decomposition Temperature (°C): Not applicable
Water Solubility: Soluble in all proportions

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Presence of heat source and direct sunlight. Storage in unsealed containers. Hazardous polymerization will not occur.

Storage Incompatibilities: Segregate from reducing agents, finely divided combustible materials, combustible materials, sawdust, metals and powdered metals.
Avoid contamination of water, foodstuffs, feed or seed.
Segregate from alkalies, oxidizing agents and chemicals readily decomposed by acids, i.e. cyanides, sulfides, carbonates.

Section 11 - Toxicological Information

Toxicity

Oral (human) LD_{Lo}: 430 mg/kg
Inhalation (rat) LC_{50}: 2500 ppm/1 hr
Unreported (man) LD_{Lo}: 110 mg/kg

Irritation

Nil reported

See *RTECS* QU 5775000, for additional data.

Section 12 - Ecological Information

Environmental Fate: No data found.
Ecotoxicity: LC_{50} Starfish 100-300 mg/l/48 hr /Aerated water conditions; LC_{50} Shore crab 180 mg/l/48 hr /Static, aerated water conditions; LC_{50} Cockle 330-1000 mg/l/48 hr /Aerated water conditions
BCF: no food chain concentration potential
Biochemical Oxygen Demand (BOD): none

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible. Special hazards may exist - specialist advice may be required.
Consult manufacturer for recycling options.
Follow applicable federal, state, and local regulations.
Treat and neutralize at an approved treatment plant.
Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.
Puncture containers to prevent reuse and bury at an authorized landfill.

Section 14 - Transport Information

DOT Hazardous Materials Table Data (49 CFR 172.101):

Note: This material has multiple possible HMT entries. Choose the appropriate one based on state and condition of specific material when shipped.

Shipping Name and Description: Nitric acid *other than red fuming, with more than 70 percent nitric acid*

ID: UN2031
Hazard Class: 8 - Corrosive material
Packing Group: I - Great Danger
Symbols:
Label Codes: 8 - Corrosive, 5.1 - Oxidizer
Special Provisions: B47, B53, T10, TP2, TP12, TP13
Packaging: **Exceptions:** None **Non-bulk:** 158 **Bulk:** 243
Quantity Limitations: **Passenger aircraft/rail:** Forbidden **Cargo aircraft only:** 2.5 L
Vessel Stowage: **Location:** D **Other:** 44, 66, 89, 90, 110, 111

Shipping Name and Description: Nitric acid *other than red fuming, with not more than 70 percent nitric acid*

ID: UN2031
Hazard Class: 8 - Corrosive material
Packing Group: II - Medium Danger
Symbols:
Label Codes: 8 - Corrosive
Special Provisions: B2, B47, B53, IB2, T8, TP2, TP12
Packaging: **Exceptions:** None **Non-bulk:** 158 **Bulk:** 242
Quantity Limitations: **Passenger aircraft/rail:** Forbidden **Cargo aircraft only:** 30 L
Vessel Stowage: **Location:** D **Other:**

Shipping Name and Description: Nitric acid, red fuming

ID: UN2032
Hazard Class: 8 - Corrosive material
Packing Group: I - Great Danger
Symbols: + - Override definitions
Label Codes: 8 - Corrosive, 5.1 - Oxidizer, 6.1 - Poison *or* Poison Inhalation Hazard *if inhalation hazard, Zone A or B*
Special Provisions: 2, B9, B32, B74, T20, TP2, TP12, TP13, TP38, TP45
Packaging: **Exceptions:** None **Non-bulk:** 227 **Bulk:** 244
Quantity Limitations: **Passenger aircraft/rail:** Forbidden **Cargo aircraft only:** Forbidden
Vessel Stowage: **Location:** D **Other:**

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4) 1000 lb (453.5 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Listed
RQ: 1000 lb
TPQ: 1000 lb
TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Group, Inc. extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

ARCADIS

Attachment 4

Chemical Hazard Information

Arsenic and soluble inorganic compounds (as As) [7740-38-2]	NA	NA	Inh Abs Ing Con	Ulceration of nasal septum; dermatitis; gastrointestinal disturbances; hyperpigmentation of skin (carcinogenic); peripheral neuropathy; respiratory irritation	Eye: Irrigate immediately (15 min) Skin: Soap wash immediately Swallow: Immediate medical attention	0.01 mg/m^3 0.01 mg/m^3 (Ca-29 CFR 1910.1018)	C0.002 mg/m^3	PEL TLV REL	Ca (5 mg/m^3)
Lead, inorganic dusts and fumes (as Pb) [7439-92-1]	NA	NA	Inh Ing Con	Weakness, lassitude, insomnia; facial pallor; eye pallor; anorexia, low weight, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremors; wrist and ankle paralysis; brain damage; kidney damage; irritated eyes; hypotension	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	0.05 mg/m^3 0.05 mg/m^3 <0.1 mg/m^3 See 29 CFR 1910.1025		PEL TLV REL	100 mg/m^3

[1]IP	Ionization potential (electron volts).
[2]Route	Inh, Inhalation; Abs, Skin absorption; Ing, Ingestion; and Con, Skin and/or eye contact.
[3]TWA	Time-weighted average. The TWA concentration for a normal workday (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.
[4]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.
[5]PEL	Occupational Safety and Health Administration (OSHA) permissible exposure limit (29 CFR 1910.1000, Table Z).
[5]TLV	American Conference of Governmental Industrial Hygiene (ACGIH) threshold limit value – TWA.
[5]REL	National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.
[6]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	None established. No evidence could be found for the existence of an IDLH (NIOSH Pocket Guide to Chemical Hazards, Pub. No. 90-117, 1990, 1997).
C	Ceiling limit value which should not be exceeded at any time.
Ca	Carcinogen.
NA	Not applicable.
ND	Not Determined.
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).

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Respirator Selection Guide, 3M Occupational Health and Safety Division, 1993.
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Warning Properties of Industrial Chemicals – Occupational Health Resource Center, Oregon Lung Association.
Workplace Environmental Exposure Levels, American Industrial Hygiene Association, 1992.

ARCADIS

Attachment 5

ExxonMobil Subsurface Clearance Procedure Checklist

ExxonMobil

Subsurface Clearance Procedure Checklist

Revision -1

Date of Revision - 06/30/10

Site Identification: ______________________________

Project Consultant/Contractor: ______________________________

Project Goal: ______________________________

Job Planning and Preparation

ACTIVITY	Yes	No	N/A	COMMENTS INCLUDING JUSTIFICATION IF RESPONSE IS NO OR NOT APPLICABLE
SSHE expectations developed				
Potential hazards identified and addressed through JSA or other risk mitigation plans				
HASP developed for site / project activities				
Applicable local, state and federal permits have been obtained.				
Site access / permission secured				
Most recent as-built drawings, site plans, and other relevant site information obtained and reviewed				
Utility locations identified (public / private / or other means); mark-outs confirmed when available				
Site walk through conducted. Relevant site features noted in work areas				
Critical zones developed				
Work execution plan developed, identifying ground disturbance methods, clearance depths, any special utility protection requirements, or any other execution requirements				
Ground disturbance locations reviewed by PM				
Any deviations identified during planning stage documented via written MOC and endorsed by EMES PM				

Work site set-up and work execution

ACTIVITY	Yes	No	N/A	COMMENTS INCLUDING JUSTIFICATION IF RESPONSE IS NO OR NOT APPLICABLE
Daily site safety meeting conducted, SPSAs performed, JSAs reviewed, appropriate work permits obtained				
HASP is available and reviewed by site workers / visitors				
Subsurface Clearance Procedure has been reviewed with all site workers				
Work area secured; traffic control established as needed. Emergency shut-off switch located. Fire extinguishers / other safety equipment available as needed				
Utility mark outs (public / private) clear and visible				
Critical zone work identified				
Work execution plan reviewed and adhered to (ground disturbance methods, clearance depths, any special utility protection requirements, or any other execution requirements (especially for critical zone work)				
Verbal MOC endorsement received from PM for any required field deviations to work execution plan				

Key reminders for execution:

The Subsurface Clearance Procedure should be referenced to determine all requirements while executing subsurface work. The bullet points below are intended as general reminders only and should not be solely relied upon.

- Critical zone required clearance depth is to 8 ft (2.4 m) or to the burial depth of the deepest utility (the bottom invert) within the critical zone, whichever is deeper
- Non-critical zone required clearance depth is to 5 ft (1.5 m)
- For critical zone work (within 10 ft / 5 m of a utility), additional utility protection measures may be required based upon the utility type. Utility protection measures may take the form of uncovering the utility for visual verification, protecting the utility from the work via shoring or conductor casing, and/or other means. Refer to Appendix G of the Procedure for specific guidance when performing work inside the critical zone.

Utility Verification / Site Walkthrough Record

Name: ______________________________

Date: ______________________________

Instructions: For each utility suspected at the job site, indicate location on the job site, approximate burial depth, and means of detecting the utility. Leave blank if that utility is not believed to be present.

Utility	Description of Location found onsite	Approximate depth below ground surface	Method used to determine location
Electrical lines			
Gas lines			
Pipelines			
Steam lines			
Water lines			
Sanitary & Storm-water Sewer lines			
Pressured air-lines			
Tank vent lines			
Fiber Optic lines			
Underground Storage Tanks			
Phone Lines/Other			

Other Comments / Findings:

Completed by: ______________________________

Name

Signature: ______________________________ ______________

Company Date