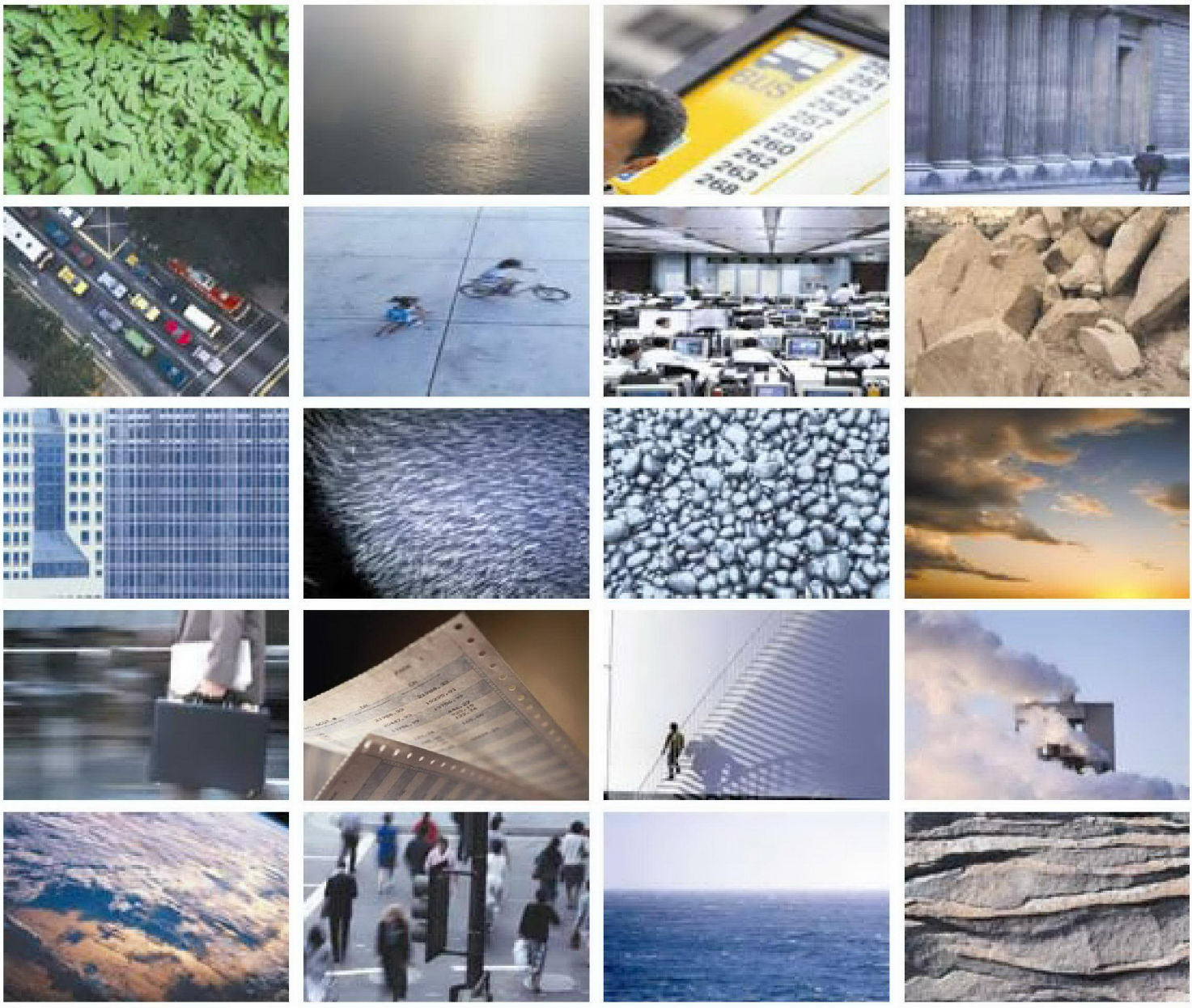

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Sampling and Analysis Plan:
Arkema Crosby, Texas Facility

Arkema Inc.
Crosby, Texas

September 14, 2017

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Sampling and Analysis Plan:
Arkema Crosby, Texas Facility

September 14, 2017

Project No. 0399237

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1.0 INTRODUCTION AND SAMPLING OBJECTIVES

This Sampling and Analysis Plan (SAP) was developed, and will be implemented, to provide technical guidance for sampling activities in support of initial assessment activities at the Arkema Crosby Facility located at 18000 Crosby Eastgate Road, Crosby, Texas (the "Site"– see Figure 1). This SAP describes the methods and procedures that will be followed during collection of environmental samples.

The objective of the assessment activities is to obtain data that can be used to assess the lateral and vertical extent of potentially affected soils and/or ditch sediments resulting from spills and/or releases occurring during the week of August 28, 2017 in specific Areas of Interest (AOIs) at the Site.

The field procedures and sampling protocol described in this SAP are based on the following standard operating procedures (SOPs) included in Attachment 1:

SOP-1	Geologic Logging and Material Classification
SOP-2	Soil and Sediment Sampling
SOP-3	Equipment Decontamination

2.0 *PRELIMINARY SITE SCREENING*

To assess the Site, seven discrete Areas of Interest (AOI-01 through AOI-07) were identified during a site walk conducted with Arkema on Thursday, September 7, 2017. These areas are as follows:

- Area of Interest 1 (AOI-01) is located in the southeastern portion of the Site adjacent to Buildings 21 and 27 (Figure 2). AOI-01 includes the immediate and surrounding area where a fire occurred.
- Area of Interest 2 (AOI-02) is located near the central portion of the Site adjacent to Building 29 (Figure 3). AOI-02 includes the immediate vicinity around the location where a portable generator leaked diesel fuel and hydraulic oil.
- Area of Interest 3 (AOI-03) is located near the central portion of the Site (Figure 4). AOI-03 includes the immediate downgradient area of a hazardous storage aboveground storage tank containment berm that overflowed during recent storms.
- Area of Interest 4 (AOI-04) is located in the north central portion of the Site (Figure 5). AOI-04 includes the immediate and surrounding area where a fire occurred.
- Area of Interest 5 (AOI-05) is located in the southwestern portion of the Site where drums and other items migrated to during recent storms and subsequent flooding (Figure 6). There is a potential for contents from the drums or other items to have leaked. AOI-05 includes the immediate and surrounding area where the drums and other items were found.
- Area of Interest 6 (AOI-06) Storm water outfalls – Based on the combination of releases occurring concurrently with significant rainfall at the Site, there is a potential for constituents of potential concern (COPCs) to have been transported through the facility storm water management ditches to its permitted outfalls (Figure 7).
- Area of Interest 7 (AOI-07) Storm water ditch – Based on the combination of releases occurring concurrently with significant rainfall at the Site, there is a potential for COPCs to have migrated off-site via the roadside storm water ditch along the eastern edge of Crosby Eastgate Road (Figure 8).

Soil / ditch sediment samples collected from the AOIs listed above will be analyzed for applicable COPCs identified in Table 1.

3.0 *SAMPLE MEDIA, ANALYSES, AND QUANTITY*

The medium of interest is shallow surface soil and ditch sediment from the AOIs described in Section 2.0 of this SAP. Surface soil and/or sediment samples may be collected and analyzed for the Site Specific COPC concentrations included in Table 1. The COPCs results will be evaluated against TCEQ's Texas Risk Reduction Program (TRRP) Critical Protective Concentration Levels (cPCLs) published on March 30, 2017. For the purpose of this assessment the Tier 1 30-acre source area Residential surface soil (zero to 15 foot below ground surface) PCLs will serve as the initial target laboratory reporting limit. Table 1 includes a list of the COPCs, CAS numbers, and cPCLs (*i.e.*, the desired laboratory reporting limits).

For the purpose of this SAP, AOIs 1 – 5 have been divided into a number of subareas as shown on Figures 2 - 6. A sample will be collected at the approximate centroid of each sub area. Because AOI 6 and 7 are linear features, samples will be collected on a linear foot basis. The subareas and proposed sample locations are presented on Figures 2 – 8. In addition to these proposed sample locations, if observed field conditions within any AOI identify locations of stained soil that would not be represented by the planned sample locations for that AOI, an additional bias soil samples of the stained soil area(s) will be collected.

Quality Assurance/Quality Control (QA/QC) samples including equipment blanks and field duplicates are summarized in Section 4.4 of this SAP.

4.0 SAMPLING METHODOLOGY

This section summarizes the field procedures to be used for collection of soil samples and ditch sediments for the purpose of laboratory analytical testing. Collected soil and ground water samples (including QA/QC samples) will be submitted to a NELAC-accredited laboratory for analysis. The selected laboratory will be able to achieve the target reporting limits listed in Table 1-1. The following analytical methods will be used for the various COPCs.

Analyte(s)	*Analytical Method*
Site Specific Volatile Organic Compounds (VOCs)	SW-846 8260C
Site Specific Semivolatile Organic Compounds (SVOCs)	SW-846 8270D
Dissolved Gasses	RSK-175
Total Petroleum Hydrocarbons (TPH)	TX 1005
RCRA Metals	SW-847 6020A (including mercury by 7471A)

4.1 FIELD LOG BOOK AND RECORD KEEPING

Field records will be maintained through the use of a field log book. Daily records of significant events, observations, and measurements will be maintained. All entries will be dated and kept as a permanent record.

4.2 SAMPLE NOMENCLATURE

The sample identification numbers for each sample collected during this assessment will appear on sample labels, chain-of-custody forms and the other applicable documentation used during the sampling activity. The sample identification will change when the location changes, but will not change because different analyses are requested for the same media at the same sample location. For example, a sample collected at the same location, date and time for total metals and for VOCs would have the same sample identification.

Soil sample identification numbers will consist of a sample location number and the depth at which the sample was collected. The sample location number will start with 01 and increase consecutively. The following are examples of completely numbered samples, with each component identified:

Area of Concern 01 = AOC-01
Soil samples: AOC-01_0.0-1.0

Duplicate samples will be identified as primary samples with fictional sample location codes. Duplicates will be assigned sequential location numbers separately from primary samples. They will be numbered consecutively starting with 01 and will not indicate depth in order to keep the duplicate samples blind. Duplicate samples will use the prefix "DS" to identify them as duplicates.

Equipment blanks will be identified with the prefix "EB," by the type of sampling equipment used and the date that it was collected. The samples associated with each equipment blank will be noted in the field log book.

Trip Blanks will be identified as "TB" and the date shipped. The samples associated with each trip blank will be noted in the field log book and on the chain of custody.

4.3 *SOIL SAMPLING PROGRAM*

Sampling procedures that will be used are based primarily on approved protocols developed by EPA, including those presented in *A Compendium of Superfund Field Operations Methods* (EPA, 1987). The following subsections summarize the sampling methods to be utilized in each media.

Soil samples will be collected using hand auger, trowel, or shovel. Each sample will be transferred to an appropriate laboratory supplied container, properly labeled, and placed in a cooler and maintained at a temperature of approximately 4°C, if preservation by temperature control is required. Sampler will ensure that head space is minimized to prevent loss of COCs due to volatilization. Soil sampling methods are summarized below and detailed in SOP-2 (Attachment 1). Chain-of-custody forms will be completed for each sample with laboratory analysis specified in Table 1.

4.3.1 *Air Monitoring*

Total organic vapors will be periodically measured during installation of shallow soil borings using an organic vapor meter OVM equipped with a 10.3eV photoionization detector (PID). Monitoring of total organic vapors will be performed as follows:

- Readings in ambient air at the breathing zone and ground surface of soil borings; and
- Background readings in ambient air during augering/digging

PID monitoring for total organic vapors in the breathing zone and ground surface during soil sampling activities will be conducted to protect field staff from potential exposure of harmful levels of organic vapor.

4.3.2 *Soil Sampling*

Soil samples will be collected from predetermined intervals for chemical analysis, index properties, and moisture-density properties. Composite samples from the interval will be mixed using stainless steel tools and bowls that will be decontaminated between use (SOP-3; Attachment 1). Borings will be cored continuously and the soil core from these borings will be visually inspected, and logged utilizing the Unified Soil Classification System (USCS) (See SOP-1;

Attachment 1). Soil samples will be placed into resealable plastic bags and allowed to equilibrate for approximately ten minutes. Subsequently, the headspace gases that accumulate in the bags will be screened with an OVM. The maximum detected reading by the OVM will be recorded for each soil sample location.

4.4 QA/QC SAMPLES

The QA/QC samples to be collected will consist of field blanks, equipment blanks, and blind duplicates and will apply only to COC analysis. Blind duplicates will be collected on a frequency of one blind duplicate for every 10 samples collected per media. True duplicates of soil samples are not typically possible because chemical constituents are rarely distributed uniformly in the media, even within small distances in the soil matrix. Therefore, some differences can be expected from "duplicate" soil samples. Field or equipment blanks will be collected on a frequency of one per day for each type of sampling method used. QA/QC sample nomenclature is provided in Section 4.2 of this SAP.

4.5 DECONTAMINATION PROCEDURES

Sample tools that are non-disposable will be thoroughly decontaminated prior to reuse. Decontamination of the sampling equipment will be performed prior to collection of each sample (SOP-3; Attachment 1). The decontamination procedure for sampling equipment will consist of the following:

- Scrub with a stiff bristle brush using non-phosphate soap and potable water;
- Rinse with potable water; and
- Rinse with distilled water.

Thorough decontamination of sampling tools and adherence to appropriate QA/QC protocols will prevent cross-contamination of samples and will preserve the integrity and representativeness of the field conditions. To verify that decontamination procedures are effective, equipment blanks will be collected (see Sections 4.2 and 4.4 of this SAP).

Decontamination liquids will be containerized and managed as investigation derived waste (IDW) as described below.

4.6 BOREHOLE ABANDONMENT

At the completion of borehole advancement, logging and soil sampling, each borehole will be backfilled with remnant soil cuttings from the respective location.

4.7 DISPOSAL/MANAGEMENT OF INVESTIGATION DERIVED WASTES

IDW will be containerized in 55-gallon, Department of Transportation (DOT)-approved, steel drums and labeled as to type of waste (soil or water), the source location, and date. The drums will be labelled and secured, and will remain on site pending management, characterization, profiling, and disposal of IDW generated by Arkema.

4.8 COORDINATE AND ELEVATION SURVEY

A lateral coordinate survey of investigation locations will be conducted at the site. Soil borings will be surveyed by the Arkema contractor representative using a commercial grade hand-held Global Positioning System (GPS) survey equipment. The accuracy of the GPS tool is approximately is 3 feet or less.

5.0 REFERENCES

EPA. 1987. A Compendium of Superfund Field Operations Methods (EPA/540/P-87-001).

Tables

September 14, 2017
Project No. 0399237
Arkema Crosby

Environmental Resources Management
CityCentre Four
840 West Sam Houston Parkway North, Suite 600
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281-600-1000

TABLE 1

Consitutents of Potential Concern
Arkema Crosby
Crosby, TX

Constituent of Potential Concern	CAS	Recommended Method	Target Reporting Limit (mg/kg)	AOI-1	AOI-2	AOI-3	AOI-4	AOI-5	AOI-6	AOI-7
Acetone	67-64-1	8260C	21	X		X	X	X	X	X
Benzene	71-43-2	8260C	0.013	X	X	X	X	X	X	X
Ethylbenzene	100-41-4	8260C	3.8	X	X	X	X	X	X	X
Naphthalene	91-20-3	8270D	16	X		X	X	X	X	X
1,2,4-Trimethylbenzene	95-63-6	8260C	16	X		X	X	X	X	X
Xylenes	1330-20-7	8260C	61	X	X	X	X	X	X	X
Cumene	98-82-8	8260C	170	X		X	X	X	X	X
Heptane	142-82-5	8260C	360	X		X	X	X	X	X
Methyl Ethyl Ketone (2-Butanone)	78-93-3	8260C	15	X		X	X	X	X	X
t-butyl alcohol	75-65-0	8260C	2.3	X		X	X	X	X	X
Acetophenone	98-86-2	8270D	4.1	X		X	X	X	X	X
Benzoic Acid	65-85-0	8270D	95	X		X	X	X	X	X
Isobutane	75-28-5	RSK-175	Not Applicable	X		X	X	X	X	X
Isobutene	115-11-7	RSK-175	Not Applicable	X		X	X	X	X	X
Toluene	108-88-3	8260C	4.1		X					
Acenaphthene	83-32-9	8270D	120		X					
Anthracene	120-12-7	8270D	3400		X					
Benz-a-anthracene	56-55-3	8270D	41		X					
Benzo-a-pyrene	50-32-8	8270D	3.8		X					
Benzo-b-fluoranthene	205-99-2	8270D	41		X					
Benzo-k-fluoranthene	207-08-9	8270D	420		X					
Chrysene	218-01-9	8270D	4100		X					
Dibenz-a,h-anthracene	53-70-3	8270D	4		X					
Fluorene	86-73-7	8270D	150		X					
Indeno-1,2,3-cd-pyrene	193-39-5	8270D	42		X					
Pyrene	129-00-0	8270D	560		X					
Total Petroleum Hydrocarbons	NA	TX1005	33		X					

Figures

September 14, 2017
Project No. 0399237
Arkema Crosby

Environmental Resources Management
CityCentre Four
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Houston, Texas 77024-3920
281-600-1000

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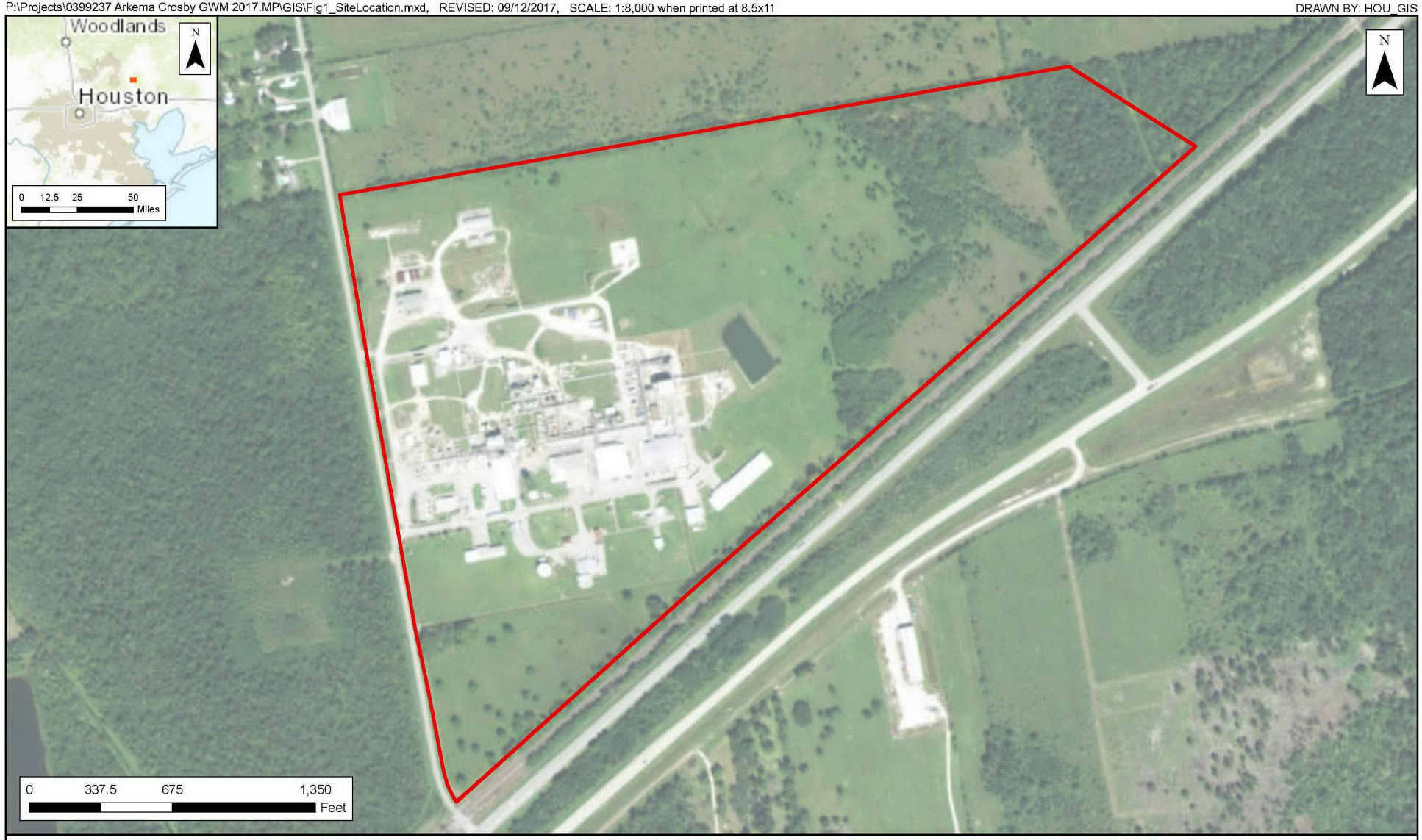

Legend

Approximate Fenceline Boundary

Notes:

1. See Figure 2 through Figure 8 for additional details.

Figure 1
Site Location and Areas of Interest Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

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Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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Legend

- Proposed Sampling Point
- Area of Interest
- Approximate Fenceline Boundary

Notes:

Figure 2
Area of Interest 1 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

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Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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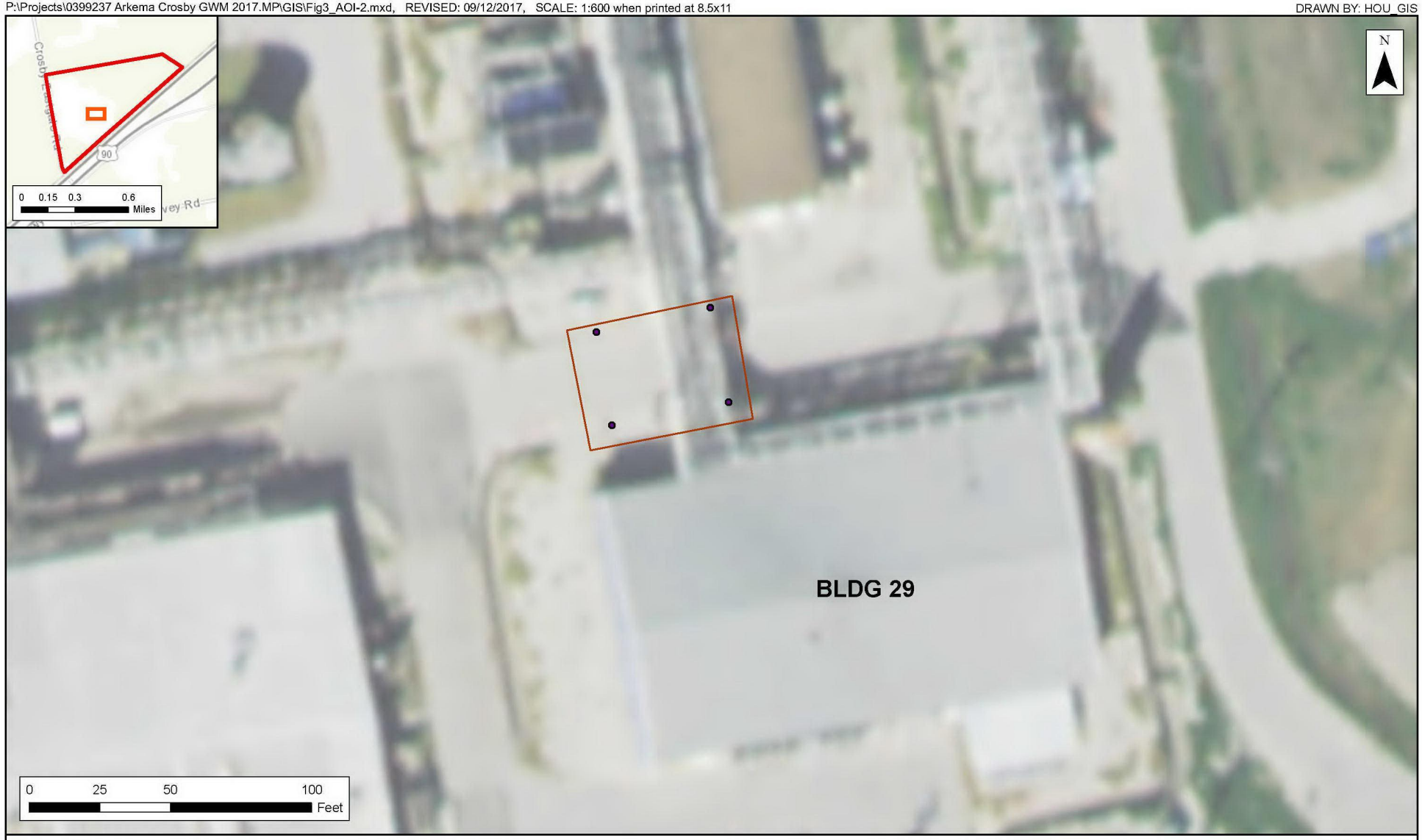

Legend

- Proposed Sampling Point
- Area of Interest
- Approximate Fenceline Boundary

Notes:

Figure 3
Area of Interest 2 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

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Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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Legend

- Proposed Sampling Point
- Area of Interest
- Approximate Fenceline Boundary

Notes:

Figure 4
Area of Interest 3 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

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Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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Legend

- Proposed Sampling Point
- Area of Interest
- Approximate Fenceline Boundary

Notes:

Figure 5
Area of Interest 4 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

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Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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Legend

- Proposed Sampling Point
- Area of Interest
- Approximate Fenceline Boundary

Notes:

Figure 6
Area of Interest 5 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

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Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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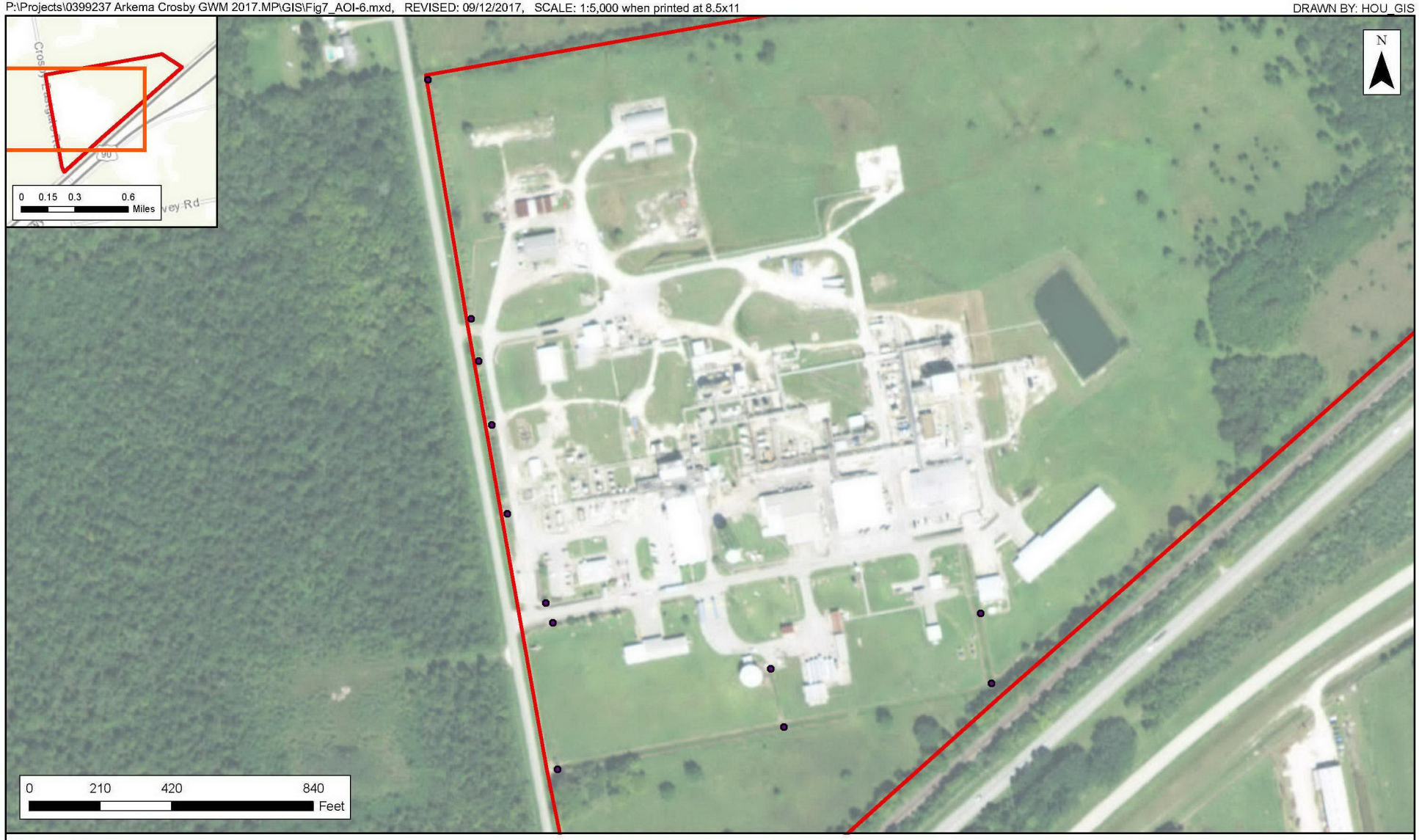

Legend

- Proposed Sampling Point
- Approximate Fenceline Boundary

Notes:

Figure 7
Area of Interest 6 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

Environmental Resources Management
www.erm.com
ERM

Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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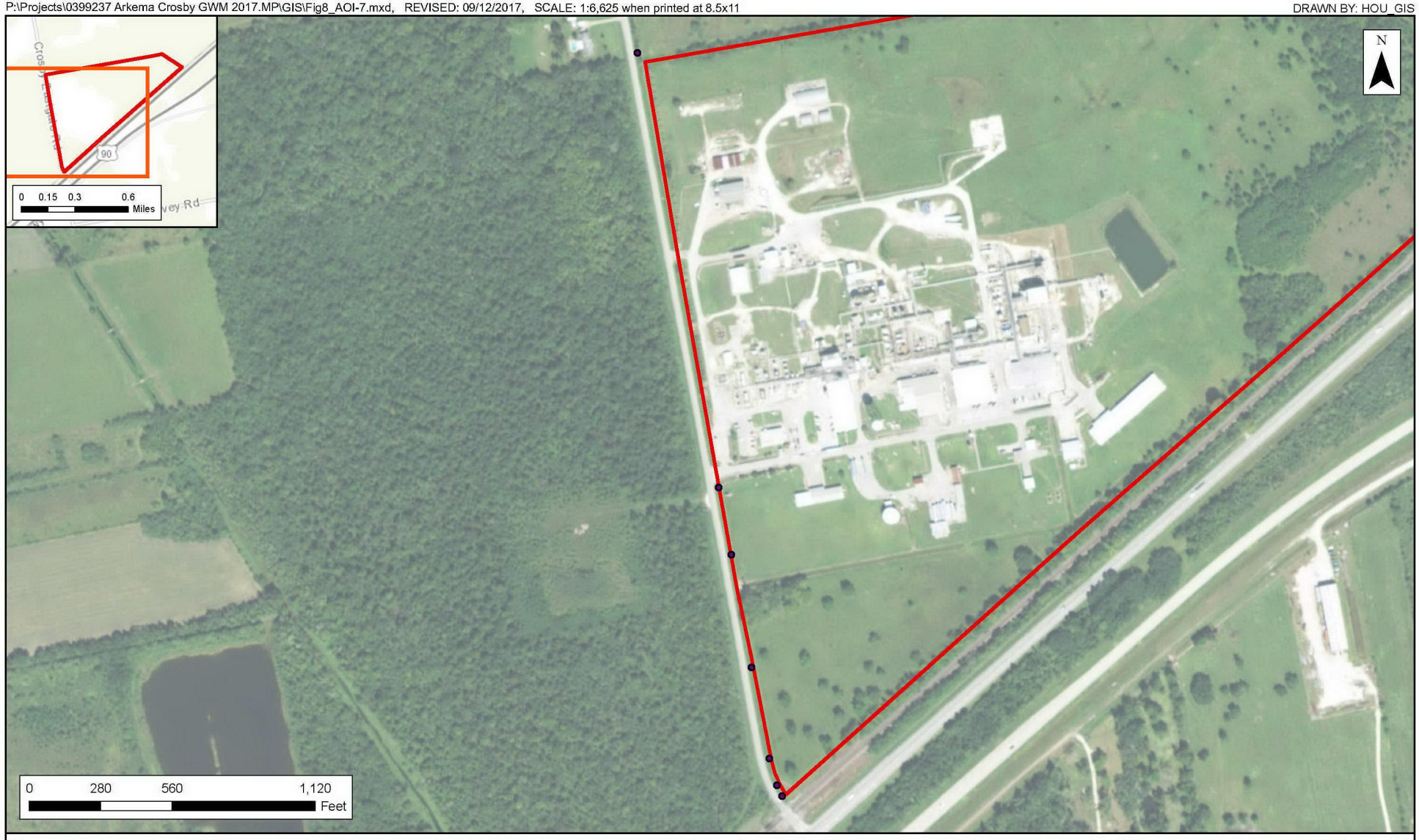

Legend

- Proposed Sampling Location
- Approximate Fenceline Boundary

Notes:

Figure 8
Area of Interest 7 Location Map
Arkema Crosby Sampling and Analysis Plan
Arkema Inc., Crosby
Harris County, Texas

Environmental Resources Management
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ERM

Source: Esri - World Topoographic Map; WGS 1984 Web Mercator Auxiliary Sphere

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Standard Operating Procedures (SOPs)

September 14, 2017
Project No. 0399237
Arkema Crosby

SOP-1	Geologic Logging and Material Classification
SOP-2	Soil Sampling
SOP-3	Equipment Decontamination

Environmental Resources Management
CityCentre Four
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Standard Operating Procedure (SOP)
for Geologic Logging and Material Classification
(SOP-1)

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LIST OF ATTACHMENTS

1.0 SCOPE OF PROCEDURE

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-1 (SOP-1) describes the requirements for logging and classifying soil and rock samples during drilling and sampling operations as described in the Sampling and Analysis Plan (SAP) or as otherwise specified for the purpose of characterizing surface and subsurface geologic conditions at the site.

1.2 SCOPE COVERED BY SOP-1

- General Requirements and Considerations
- Identification of Appropriate Sampling Equipment and Supplies
- Logging and Documentation Requirements
- Rock Classification and Handling

1.3 RELATED PROCEDURES AND DOCUMENTS

- Health and Safety Plan (HASP)
- Soil Sampling (SOP-2)
- Equipment Decontamination (SOP-3)
- SAP

1.4 WORK SPECIFICATIONS.

Geologic logging and material classification as described herein will be conducted for all solid media sampled at the site as specified in the SAP or other parent document referencing this SOP.

1.5 DEFINITIONS OF STANDARDS.

Definitions of terms and standards are consistent with those used or implied in the SAP or other parent document referencing this SOP, unless otherwise stated.

1.6 HEALTH AND SAFETY CONSIDERATIONS

This procedure could potentially involve exposure to impacted soils and other solid media via routes of dermal contact and inhalation. Accordingly, personnel must follow the precautions and the use of the appropriate personal protective equipment described in the approved HASP.

2.0 EXECUTION

2.1 GENERAL REQUIREMENTS AND CONSIDERATIONS

Geologic logging and/or material classification will be conducted for all subsurface and surface soil and rock sampling activities based on the following, as appropriate.

- Visual observation of recovered samples
- Examination of soil cuttings

Geologic logging and material classification will be conducted only by a qualified geologist or engineer or by a trained logging technician under the supervision of the geologist or engineer.

Borehole materials may contain hazardous constituents, and the logging personnel therefore must use caution to prevent exposures when extruding and examining samples. Air monitoring, use of personal protective equipment and other safety practices while logging will be in accordance with the approved HASP.

Tools and equipment used while logging boreholes will be decontaminated between samples and boring locations in accordance with SOP-3. Field data and observations associated with borehole logging will be documented during logging and for all drilling and sampling activities in accordance with the SAP. All field logging data will be recorded in the field notebook.

2.2 LOGGING EQUIPMENT AND SUPPLIES

The logging personnel will maintain a collection of logging equipment and supplies ("logging kit") needed to perform all sample handling, preparation, packaging, labeling, and documentation. A checklist of equipment and supplies generally used is presented in Attachment 1-1 to this SOP.

2.3 LOGGING AND DOCUMENTATION

The logging personnel will record all pertinent information in the field notebook. The following technical information will be recorded, as appropriate:

- Project number and name
- Location (boring number) or other sample station identification
- Geologist or engineer overseeing the sampling operation
- Boring date
- Rock and/or soil classification and lithology

- Lithologic changes and boundaries
- Organic vapor analyzer results

2.4 *SOIL SAMPLE CLASSIFICATION AND DESCRIPTIONS*

2.4.1 *Introduction*

All field soil descriptions will be in general accordance with the procedures described in ASTM D2488-90, "Standard Practice for Description and Identification of Soils (Visual Manual Procedure), which includes the Unified Soil Classification System (USCS). The following properties form the basis of USCS soil classification:

- Percentage of gravel, sand, and fines;
- Grain size distribution; and
- Plasticity and compressibility characteristics.

2.4.2 *Description Hierarchy*

The suggested order of terms is as follows:

- Group name - The basic name of the predominant constituent and a single-word modifier indicating the major subordinate constituent. The USCS recognizes 15 soil groups and uses names and letter symbols to distinguish between these groups. The coarse grained soils are subdivided into gravels (G) and sands (S). Both the gravel and sand groups are divided into four secondary groups. Fine grained soils are subdivided into silts (M) and clays (C) (Attachment 1-2).
- Group symbol
- Maximum particle size or dimension
- Percent of cobbles or boulders, or both (by volume)
- Percent of gravel, sand, or fines, or all three (by volume)
- Particle-size range: Gravel - fine, coarse; Sand - fine, medium, coarse
- Particle size gradation: Granular soil (sands or gravels) should be described as well-graded, poorly graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction.
- Particle angularity: angular, subangular, subrounded, rounded
- Particle shape: (if appropriate) flat, elongated, flat and elongated
- Plasticity of fines: nonplastic, low, medium, high
- Color (of wet sample)

- Odor (mention only if organic or unusual)
- Density or consistency
- Reaction with HCI: none, weak, strong

For intact samples:

- Structure: stratified, laminated, fissured, slicken-sided, lensed, homogeneous
- Cementation: weak, moderate, strong
- Local name
- Geologic interpretation
- Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating etc.

3.0 DOCUMENTATION

All descriptions will be clearly stated in the field notebook.

4.0 REFERENCES

Geological Society of American, Rock-Color Chart Committee, "Rock-Color Chart," Boulder, Colorado, 1948.

American Society of Testing and Materials, "Standard Practice for Description and Identification of Soils," ASTM D2488-84.

U.S. Environmental Protection Agency, Office of Waste Programs Enforcement, Office of Solid Waste and Emergency Response, "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document," September, 1986.

U.S. Environmental Protection Agency, "A Compendium Superfund Field Operations Methods," EPA/540/P-87/011, December, 1987.

ATTACHMENT 1-1

GEOLOGIC LOGGING EQUIPMENT AND SUPPLIES CHECKLIST

Soil Sampling Equipment and Supplies:

_____ Stainless steel putty knife
_____ Paper towels
_____ Ruler, tape measure
_____ Color chart (e.g. Munsell)
_____ Appropriate containers and caps
_____ Indelible ink pens and markers
_____ Logbook
_____ Hand lens

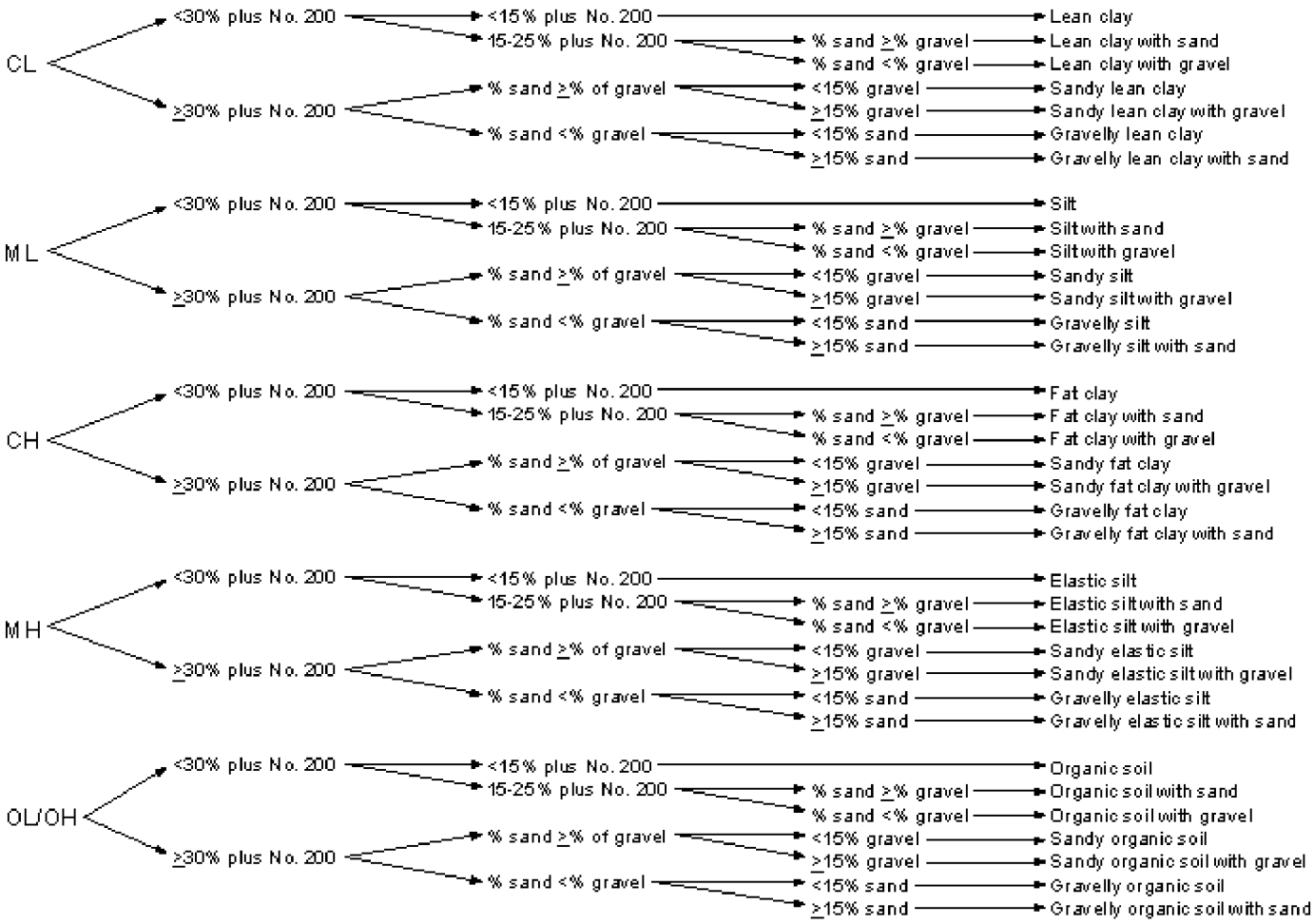
Other Supplies:

_____ Camera
_____ 2, 5-gallon plastic buckets
_____ Decontamination fluids and supplies
_____ Large ice chest(s) for cooling samples and for sample shuttle
_____ Label, chain-of-custody seals
_____ Clear cellophane tape
_____ Photo Ionization Detector
_____ Nitrile disposable gloves
_____ Personal protective equipment (see Health and Safety Plan)

ATTACHMENT 1-2

KEY COMPONENTS OF ASTM D2488-90

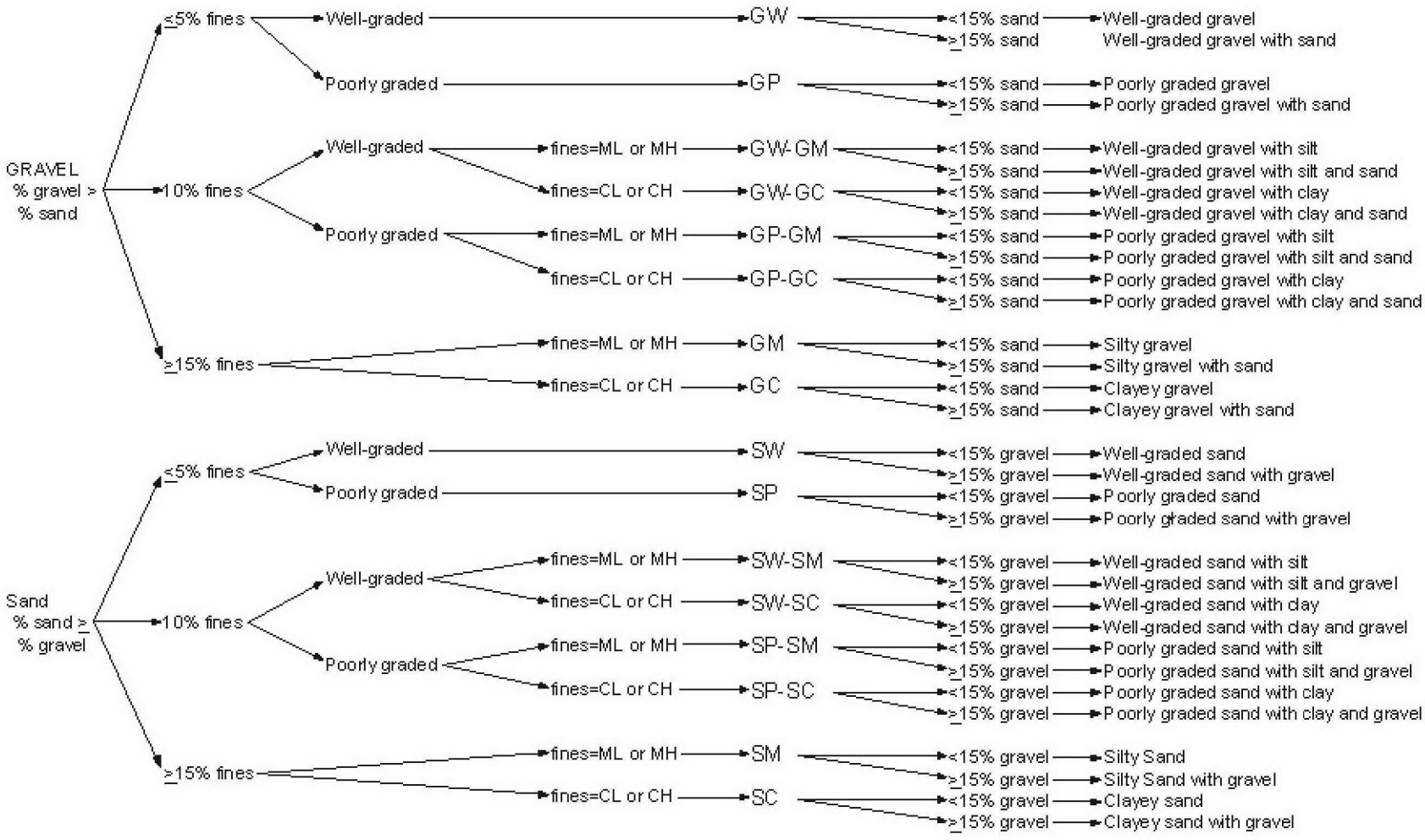
Flow Chart for Identifying Fine-Grained Soil
(after ASTM D2488: Figure 1a and 1b)



ATTACHMENT 1-2 (continued)

KEY COMPONENTS OF ASTM D2488-90

Identifying Coarse-Grained Soil
(after ASTM D2488: Figure 2)



Standard Operating Procedure (SOP)
for Soil Sampling
(SOP-2)

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1.0 SCOPE OF PROCEDURE

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-2 (SOP-2) describes the minimum acceptable requirements for obtaining surface soil, subsurface soil, and waste samples as stated in the Sampling and Analysis Plan (SAP) or as otherwise specified for the purpose of chemical and physical analysis to evaluate surface and subsurface soil conditions.

1.2 SCOPE COVERED BY SOP-2

- General Requirements
- Selection of Borehole Advancement Methods
- Sampling Equipment and Methods
- Sampling Procedures
- Decontamination

1.3 RELATED PROCEDURES AND DOCUMENTS

- Health and Safety Plan (HASP)
- Geologic Logging and Material Classification (SOP-1)
- Equipment Decontamination (SOP-3)
- SAP

1.4 WORK SPECIFICATIONS

Soil, sediment, and waste sampling as described herein will be conducted at the frequency and locations which are specified in the SAP or other document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different. Unless otherwise justified, all borehole installation procedures are to follow the applicable state regulations.

1.5 DEFINITIONS OF STANDARDS

Definitions of terms and standards are consistent with those used or implied in the SAP or other parent document referencing this SOP, unless otherwise stated.

1.6 HEALTH AND SAFETY CONSIDERATIONS

This procedure potentially involves exposure to impacted soils, sediments, or wastes via routes of dermal contact and inhalation. Accordingly, sampling personnel shall follow the precaution procedures and use the appropriate personal protective equipment described in the approved Site HASP.

2.0 EXECUTION

2.1 BOREHOLE ADVANCEMENT

2.1.1 General

Boreholes used to obtain subsurface soil may be advanced with multiple objectives, including to:

- Provide geological data on subsurface conditions; namely stratigraphy; and
- Obtain representative samples for identification and laboratory testing

Prior to drilling, the following steps shall be taken:

- Follow the subsurface clearance protocol specified in the site HASP to check for buried utilities at all planned drilling locations. For reasons of safety and liability, no drill hole will be advanced if this step has not been completed.
- Implement the approved HASP, adhering to all of its provisions for protection of the field crew.
- Make provisions for disposal of all cuttings in accordance with the SAP.
- Have a technician, a hydrogeologist or engineer was present (on-site) during drilling.

2.2 SAMPLING EQUIPMENT AND METHODS

2.2.1 Unconsolidated Soils and Sediment

2.2.1.1 *Hand Auger*

This method involves the use of a steel rod and cross bar attached to an auger bucket, typically 1 to 3 inches in diameter, 1 foot long and open at the top and bottom with blades at the bottom to carve out soil as the auger is turned. When the auger bucket is full, the tool is removed from the borehole and the sample is collected. The sample is a disturbed soil sample. Depending on soil type, this method is limited to a maximum of 20 to 30 feet below ground surface (bgs) and more typically is used to advance boreholes less than 10 feet bgs.

2.2.1.2 *Stainless Steel Trowel/Shovel*

This manual sampling method will be used to collect surface soil and sediment. Soil is scooped from the sampling location using the stainless steel trowel and placed into a stainless steel bowl where the sample is mixed prior to placing the soil or sediment into a laboratory provided sample container.

2.2.2 *Drilling Methods*

Hand Auger

Hand augured boring methods will be used for shallow borings (generally five feet or less). In this method, the auger will be hand rotated into the ground in six-inch intervals. The auger is then removed from the borehole and the soil removed from the bucket. The auger is cleaned and then reinserted into the borehole and hand rotated until another six inches of soil have been removed. A stainless steel hand auger will be used at all times.

2.3 *SAMPLING PROCEDURES*

The sampling procedures common to disturbed sampling are described in this section. At each soil boring location, one to two soil samples will be collected based on conditions encountered. Visual inspection of the soil core and PID headspace readings will used to evaluate sample intervals. However, at most locations, one sample will be collected from the zero to 6-inch bgs interval and a second sample collected from 12 to 18-inch bgs interval. A summary of the procedures are listed below:

- Sampler Preparation
- Sample Interval
- Sample Identification
- Sample Collection and Management

Sample and Borehole Identification

Each sample will be identified by borehole number and by consecutive sample number. The consecutive sample number should correspond to the sample numbers recorded on the borehole logs and in compliance with labeling criteria in the SAP.

Sample Collection and Management

Once the sampling device has been advanced over the desired sampling interval, the sampler is removed from the borehole. Once the sample is exposed, it will be described by the on-site geologist or hydrogeologist (SOP-1). Samples may be retained or split for chemical tests.

The following procedures will be used in collection of samples with a hand auger:

1. Remove soil from the hand auger bucket and place a portion immediately into a resealable plastic bag.
2. Measure the sample recovery and record in the field notebook.
3. Using a stainless steel putty knife, shave the outer surface of the soil core. This shaved soil will be discarded and not used in the sample collection.

4. The geologist will then describe the lithology and record the description in the field notebook.
5. The core will then be split lengthwise with a stainless steel putty knife (down the center), thus dividing the core in half.
6. Samples will be collected as described in the SAP referencing this SOP.
7. A composite soil sample, if collected for analysis, will be collected from the exposed soil sample by compositing equal amounts from the specified sample interval. This sample will be placed in clean laboratory containers and submitted to the laboratory for analysis.
8. Fill all laboratory containers leaving minimal headspace in the sample container. Samples for volatile organic analyses will be collected first, followed by semi-volatile analyses, then total petroleum hydrocarbons, and finally metal samples. The sample container will be labeled, and then immediately placed in an ice-filled cooler.
9. All samples will be prepared for shipment according to procedures described in the SAP.

The following procedures will be used in collection of samples with a hand trowel or shovel:

1. Containerize recovered soil into a clean stainless-steel bowl and perform the steps 4-10 as above.
2. A composite soil sample, if collected for analysis, will be collected from the exposed soil sample by compositing equal amounts from the specified sample interval. This sample will be placed in clean laboratory containers and submitted to the laboratory for analysis.
3. If soil or sediment is collected using a hand auger or a stainless-steel trowel, the sample will be placed in a stainless-steel bowl, mixed and placed in a laboratory supplied container as described in step 9 above.

3.0 *DOCUMENTATION*

Record sample data and field observations in accordance with requirements specified in the SAP for labeling and custody control.

Specified procedures for describing the samples and logging the subsurface sampling are presented in SOP-1.

Boring documentation should include:

- Project and field activity identification information
- Drilling data
- Field personnel
- Dates of activity
- Sample descriptions
- Log of subsurface sampling (SOP-1)
- Site or location description
- Vapor readings

4.0 REFERENCES

ASTM Standards on Groundwater and Vadose Zone Investigations, 2nd Edition, American Society for Testing and Materials, Philadelphia, PA, 1994.

Driscoll, Fletcher G., Groundwater and Wells, Second Edition, St. Paul, Minnesota, 1986.

U. S. EPA, "Compendium of Superfund Field Operations Methods", Publication EPA/540/P-87/001, December 1987.

Standard Operating Procedure (SOP) for Equipment Decontamination (SOP-3)

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1.0 SCOPE OF PROCEDURE

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-3 (SOP-3) describes the requirements for decontamination of personnel and equipment during investigation field activities as specified in the Sampling and Analysis Plan (SAP) or as otherwise specified.

1.2 SCOPE COVERED BY SOP-3

- General decontamination requirements
- Required site facilities and supplies
- Decontamination procedures for vehicles, and drilling and sampling equipment
- Disposal procedures
- Typical decontamination solutions

1.3 RELATED PROCEDURES AND DOCUMENTS

- Health and Safety Plan (HASP)
- SAP
- Soil and Sediment Sampling (SOP-2)

1.4 WORK SPECIFICATIONS

Equipment decontamination procedures as described herein shall be conducted as specified in the SAP or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.5 DEFINITIONS OF STANDARDS

Definitions of terms and standards are consistent with those used or implied in the SAP or other parent document referencing this SOP, unless otherwise stated.

1.6 HEALTH AND SAFETY CONSIDERATIONS

This procedure may involve exposure to impacted waters or soils via routes of dermal contact and inhalation. Accordingly, field personnel should follow the precautions and procedures, and use the appropriate personal protective equipment described in the approved HASP.

2.0 EXECUTION

2.1 GENERAL REQUIREMENTS AND CONSIDERATIONS

A decontamination plan should be developed and sufficiently scoped to address all the expected types and levels of contaminants at the site, and the methods used to investigate them.

This SOP covers decontamination of equipment used in investigation sampling efforts. Procedures for personal decontamination of field personnel should be specifically addressed in the site-specific HASP. These procedures should be followed and incorporated with the equipment decontamination procedures contained in this SOP to mitigate exposure and cross-contamination potential.

Decontamination activities should be documented to verify that proper procedures are followed. Documentation shall be in accordance with the requirements specified in the SAP.

2.2 SITE FACILITIES AND SUPPLIES

2.2.1 *Site Selection*

The equipment decontamination site should be in an area where contaminants can be controlled and at the boundary of a "clean" zone. The location should also be selected to prevent equipment from being exposed to additional or other contamination.

The decontamination area should have adequate storage area for storing unused drums, used drums containing spent decontamination fluids and waste, and trash containers, until such time that they can be relocated or disposed offsite in accordance with applicable regulations.

2.2.2 *Decontamination Pad*

Pad construction may include using planking to form a curb and covering the entire area with plastic sheeting. Numerous other methods can be utilized; key elements are containment, flexibility and the capability of improvising to meet specific site conditions. Where only hand samplers or other small equipment work is being conducted, several small wash tubs (filled with soap and potable water) may be sufficient for decontamination.

2.2.3 *Water Supply*

Water will be required for cleaning. The water used for equipment decontamination must be clean, potable water; municipal water supplies are generally adequate and may be stored in tanks on site.

2.2.4 *Cleaning Equipment and Supplies*

On some small projects, garden sprayers may be utilized for final rinsing or cleaning. Typically, these sprayers are for use with small hand tools or sampling equipment.

Decontamination solutions, other than potable water, may be required to adequately clean the equipment or neutralize some contaminants. These solutions vary from "normal", low sudsing detergent and water to various organic solvents and acids. It is expected that only detergents will be needed to decontaminate equipment utilized.

Miscellaneous items typically required for decontamination efforts include some of the following:

- Brushes - to remove heavy mud, dust, etc.;
- Paper Towels - to dry off equipment; and
- Drums - to store contaminated materials

Attachment 4-1 to this SOP presents a checklist of decontamination equipment typically used for hazardous waste investigations. Supplies may also be needed other than shown on this checklist.

2.2.5 *Personnel Protection*

Personnel involved in the decontamination process can be exposed to concentrations of various contaminants. The level of protection for decontamination personnel must be addressed in the HASP. Typically, those personnel are equipped with the same protective equipment as those conducting the on-site investigation until a lower level of risk can be confirmed.

2.3 *SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES*

All sampling equipment which may contribute to the potential contamination of a sample must be thoroughly decontaminated prior to its initial use, unless specific documentation exists that the sampling equipment has been decontaminated.

Generally, sampling equipment can be cleaned by hand. The following procedure is given as a typical sequence which should be modified to be consistent with on-site conditions:

- Scrub with potable water to remove mud and residue;
- Scrub with a non-phosphate detergent-potable water solution using a hard bristle brush;
- Rinse with clean potable water;
- Rinse with distilled water; and
- Air dry

3.0 REFERENCES

U.S. EPA, "Technical Methods for Investigating Sites Containing Hazardous Substances," Technical Monograph No. 23, draft, June, 1981.

U.S. EPA, (Region VII) and Union Pacific Railroad, "Hazardous Materials First Responder Course."

Practical Guide for Ground-Water Sampling, U. S. EPA, EPA/600/2-85/104, September 1985.

ATTACHMENT 4-1

CHECKLIST OF DECONTAMINATION EQUIPMENT

_____ Potable Water Supply

_____ Decontamination Solution(s)
- _____ detergent:

_____ Cleaning Accessories
- _____ water supply hoses with proper couplings
- _____ wire-bristle brushes
- _____ buckets
- _____ soft cloths, sponges

_____ Decontamination/Storage Facilities
- _____ sampling equipment