DRAFT

FIELD SAMPLING PLAN

WEST LAKE LANDFILL SUPERFUND SITE OPERABLE UNIT 1

Prepared For:

The United States Environmental Protection Agency Region VII

Prepared on Behalf of:

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LIST OF ACRONYMS

ACRONYM	Definition
ABS	acrylonitrile butadiene styrene
AC	Additional Characterization
ACM	Asbestos-Containing Materials
ASAOC	Administrative Settlement Agreement and Order on Consent
ASTM	American Society for Testing & Materials
B2005GS	Below 2005 Ground Surface
BZ	Buffer Zone
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chain of Custody
cpm	counts per minute
DIO	Design Investigation Objectives
DIWP	Design Investigation Work Plan
DM	Data Manager
DMP	Data Management Plan
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EM	Electromagnetic Induction
FRP	fiberglass-reinforced plastic
FSP	Field Sampling Plan
GIS	Geographic Information System
GPR	Ground-Penetrating Radar
GPS	Global Positioning System
GSMO	Geostatistical Modeling Objective
GWMP	Groundwater Monitoring Plan
HASP	Health and Safety Plan
HEPA	High-Efficiency Particulate Air
HPT	Health Physics Technician
HAS	hollow-stem augering
IDW	Investigation-Derived Waste
MDA	minimum detectable amounts
MDNR	Missouri Department of Natural Resources
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NTU	Nephelometric Turbidity Units
NWB	Northern Surface Water Body
ORP	oxidation-reduction potential, millivolts
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OVM	organic vapor monitor
PB	perimeter boring
pCi/g	picoCurie/gram
PID	photoionization detector
PLS	professional land surveyor
PPE	personal protective equipment
PSHEP	Project Safety, Health, and Environmental Plan
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality assurance/quality control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
Respondents	West Lake Landfill OU-1 Respondents
RIM	Radiologically Impacted Material
RODA	Record of Decision Amendment
RSO	Radiation Safety Officer
RSP	Radiation Safety Plan
RU	Reference Unit
SB	soil boring
SOP	Standard Operating Procedure
SOW	Statement of Work
SPT	Standard Penetration Testing
µR	Micro Roentgen
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

1.1 Project Description

This Field Sampling Plan (FSP) has been prepared on behalf of West Lake Landfill OU-1 Respondents Bridgeton Landfill, LLC, Cotter Corporation (N.S.L), and the U.S. Department of Energy (DOE) (collectively, Respondents) for the upcoming design investigation for the selected Amended Remedy for Operable Unit-1 (OU-1) of the Site. The Site is a United States Environmental Protection Agency (USEPA) Superfund Site (ID # MOD079900932), located in Bridgeton, Missouri. A Record of Decision Amendment (RODA) for OU-1 was issued by USEPA on 27 September 2018 (USEPA 2018). The Respondents entered into a Third Amendment to the Administrative Settlement Agreement and Order on Consent (ASAOC) with USEPA (Docket No. VII-93-F-0005) to perform the design of the Amended Remedy selected in the RODA for OU-1 on 6 May 2019 (USEPA 2019). USEPA is the lead agency for the Site, and the Missouri Department of Natural Resources (MDNR) is the supporting agency.

The Site is located east of the Missouri River in the western portion of the St. Louis metropolitan area in northwestern St. Louis County, with a physical address of 13570 St. Charles Rock Road, Bridgeton, Missouri. The Site consists of an approximately 200-acre parcel of land that includes six inactive waste disposal areas, or units. The six units include Radiological Area 1 (Area 1) and Radiological Area 2 (Area 2), a closed demolition landfill, an inactive sanitary landfill, the North Quarry, and the South Quarry. The North Quarry and the South Quarry are part of the permitted Bridgeton Landfill, a former active sanitary landfill. These six identified units were used for solid and industrial waste disposal at the Site from approximately the 1950s through 2004.

The Site is composed of three Operable Units. OU-1 contains the Radiological Areas 1 and 2, the Buffer Zone (a 1.78-acre parcel of land adjacent to Area 2), and Lot 2A2 of the Crossroads Industrial Park. OU-2 contains areas not identified as containing radiologically impacted material (RIM) and is comprised of the closed demolition landfill, the inactive sanitary landfill, the North Quarry, and the South Quarry. The site-wide groundwater regime has been designated OU-3. While this scope of work is targeting OU-1, there may be overlap with OU-3, since OU-3 wells have been identified for use in the OU-1 groundwater monitoring network.

1.2 Project Objectives

The objective of the design investigation is to collect additional information necessary to design the Amended Remedy selected in the RODA (USEPA 2018) by conducting the field investigations as proposed in the Design Investigation Work Plan (DIWP).

The purpose of this FSP is to standardize the field procedures to be performed during the design investigation activities for OU-1 in accordance with the RODA (USEPA 2018) and the Remedial Design Statement of Work (SOW) attached to the Administrative Settlement Agreement and Order of Consent (ASAOC). This FSP has been developed in accordance with applicable federal and state guidance documents for remedial design for hazardous waste sites (USEPA 1995a, 1995b).

1.3 Scope of Work

The FSP presented for this design investigation was developed in accordance with Section 3.6 of the SOW attached to the Third Amendment to the ASAOC (USEPA 2019). The portions of the SOW applicable to design investigation are summarized below:

- Delineate the extent of waste/RIM along the Area 1 and Area 2 boundaries.
- Further characterize RIM greater than 52.9 picocuries per gram (pCi/g) as related to geostatistical modeling objectives (GSMOs) and design investigation objectives (DIOs).)
- Assess statistically valid background concentrations for the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park.
- Evaluate the extent of RIM above statistically valid background concentrations for the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park.
- Evaluate potential impacts to Site drainage areas including the Northern Surface Water Body and Earth City Flood Control Channel via sediment sampling of historical sample locations and additional proposed sample locations, in addition to the performance of a bathymetric survey of the Northern Surface Water Body.
- Collect geotechnical data needed to advance the design objectives, such as waste density, moisture content, and soil properties in areas projected to be beneath starter berms and future drainage structures.
- Collect data for Site infrastructure assessment and removal.
- Collect data to characterize materials related to waste acceptance criteria of potential waste disposal facilities.
- Evaluate liquid levels within the potential excavation footprint and previously identified seeps.
- Evaluate characteristics of potential leachate that may be present and estimate characteristics/ treatment requirements of water that may contact waste/RIM.
- Assess the impact of the Remedial Action (RA) on wildlife attractiveness.
- Perform a detailed topographic survey of Areas 1 and 2.
- Develop and implement a groundwater monitoring regime to determine current groundwater quality beneath Areas 1 and 2, and quantify impacts of the selected remedy on site groundwater.

2.0 DESIGN INVESTIGATION FIELD ACTIVITIES

Various field activities will be conducted during the design investigation to collect necessary information for design of the Amended Remedy selected in the RODA (USEPA 2018). Field activities are anticipated to include:

- Siting and drill rig access construction.
- Drilling operations.
- Soil (surface, subsurface) sampling.
- Water (groundwater, surface water, leachate) sampling.
- Surveying (topographical and geophysical).

2.1 Mobilization

The Parsons Field Team Leader will notify off-site laboratories associated with this FSP of upcoming sampling events so that the laboratories can prepare the appropriate type and number of sample containers. The anticipated number of samples, sampling media, list of parameters to be analyzed, and the number and type of quality control/quality assurance (QC/QA) samples needed shall be specified to the laboratory managers.

Equipment to be used during sampling will be inspected by the Site Supervisor prior to sampling. Field instrumentation to be used during sampling (i.e., photoionization detector (PID), pH, temperature, water level, specific conductance meters, radiation detection equipment, etc.) will be checked for proper calibration and precision response (see **Section 2.7**).

The following forms to be used in the field are included as attachments to this FSP and will be provided to sampling personnel.

- Pre-Drill Checklist (Attachment 1)
- Boring/Well Construction Log (Attachment 2)
- Missouri Well Installation Form (Attachment 3)
- Well Development Form (Attachment 4)
- Well Decommissioning Form (Attachment 5)
- Missouri Well Abandonment Form (Attachment 6)
- Standard Groundwater Sampling Form (Attachment 7)
- Low-flow Groundwater Sampling Form (Attachment 8)
- Hydraulic Conductivity (K) Test Form (Attachment 9)
- Surface Water/Seep Sampling Record (Attachment 10)
- Sediment Sampling Record (Attachment 11)
- Surface Soil Sampling Record (Attachment 12)

New sample containers, pre-preserved where applicable, will be provided by the laboratories and shipped to the Site or other designated location in coolers or insulated sample shuttles. Sample containers will be examined by sampling personnel upon receipt, and containers will be pre-labeled during the preliminary phase of each sampling event to reduce confusion in the field. Sample identification information (e.g., project name/location, well/borehole number or sample point ID, preservative, analytes, etc.) will be pre-printed on sample labels or entered using indelible marker affixed to empty containers. See the Data Management Plan (DMP) for sample identification nomenclature. Other information (e.g., sample time and date, samplers' names/initials, etc.) may be added to a label after the sample is collected.

2.1.1 Site Preparation and Subsurface Clearance

Parsons' policy requires that the Parsons Project Manager follow all local, state, and federal laws applying to intrusive subsurface work where appropriate under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), i.e., inform agencies or obtain utility clearances and the like. The Parsons Project Manager shall review, as available, current and historical site drawings and plans from the Respondents, facility owner or tenant, utility providers, municipal government offices (i.e., city engineer or building department) and third parties as appropriate.

The Pre-Drilling/Subsurface Checklist for Intrusive Fieldwork (**Attachment 1**) shall be completed prior to initiating fieldwork. It is the responsibility of the Parsons Project Manager to require that the Pre-Drilling/Subsurface Checklist for Intrusive Fieldwork and Utility Clearance Variance Request form is followed. If a variance is sought, it is the responsibility of the Parsons Project Manager to gain written approval of the appropriate Parsons Sector Leader and/or Health and Safety Manager.

The Parsons Project Manager will be responsible for fulfilling the objectives of this protocol by requiring that the procedures are carried out by Parsons employees, subcontractors, and any other person acting on behalf of Parsons. The Parsons Project Manager will require that individuals working on drilling and other subsurface exploration projects are adequately trained and supervised. Parsons will practice sound investigation and work practices and employ necessary measures to avoid damage to subsurface systems and structures. The Parsons Sector Leader will be contacted and advised in advance of beginning field work in the event that a variance to this protocol is requested by the Parsons Project Manager or designee.

In addition to removing vegetation in the vicinity of clearing proposed boring locations shown on **Figure 1** (Area 1) and **Figure 2** (Area 2), there are known on-site utilities that will be located and defined using the geophysical methods detailed below. Utilities to be investigated include a known sewage holding tank, an old fuel underground storage tank (as shown on **Figure 3**), a suspected storm sewer lateral that may extend near or possibly into Area 1, and a septic tank near the corner of Area 1 and the North Quarry road. Underground cable from an electrical panel located inside Area 2 feeds power to air sampling stations located around the Area 2 perimeter, the job trailer located at the main entrance Area 2, and the Conex shipping containers located west of the Area 2 main entrance. Additional details pertaining to infrastructure/utility location data needs can be found in the DIWP. A full utility markout will be completed prior to commencement of intrusive operations.

2.1.2 Pre-Clearance Tasks

The objectives of these tasks include compiling relevant information needed to identify accessibility improvement needs at the planned borehole locations.

One task is to obtain available as-built drawings and/or existing site plans. As-built drawings may not accurately depict the locations of improvements and the most recent subsurface features and should therefore not be solely relied upon to determine subsurface conditions.

Another task is to obtain utility markouts. Outside the landfill area, Parsons project staff will request a utility mark-out via the local utility's one-call system for the work site. Design investigation staff will document efforts to locate subsurface utilities (electrical, gas, communications, sewer, water, cable, etc.). The Parsons Project Manager must be notified of the status of locating underground utilities before fieldwork begins. If locating utilities becomes problematic, the Parsons Project Manager will update the Respondents and discuss potential alternative methods for locating or reducing risk of damage to underground utilities/structures. Such alternatives may include subcontracting a private locating service, re-evaluating risk/reward of specific locations or utilizing intrusive non-destructive methods. Site plans will be updated as appropriate to include utility mark-out information. Detailed coordination with the site owner's representatives for mark-outs, review of as-builts, and other informational reviews will be conducted prior to the start of intrusive work.

Parsons will obtain information needed to prepare a vicinity map of the area that may include significant neighboring addresses, land use, surface water bodies, and other natural as well as manmade features of note, as appropriate. A site visit/walkover will be scheduled concurrent with, or soon after the utility mark-out. The walkover will include inspections and notations of the locations of utility mark-outs and above-ground utilities/ structures, including:

- Light standards
- Communication lines (phone, fiber optic)
- Sewer lines
- Site infrastructure (landfill gas monitoring piping)
- Overhead lines
- Water lines and spigots/hydrants
- Catch basins
- Manholes
- Junction boxes
- Natural gas lines
- Other utilities
- Observe paving scars such as areas of new pavement or saw cuts

2.1.3 Property Systems

The Parsons Field Team Lead will consult with someone having historical site knowledge to gain information about the site (locations of former tanks, lines, etc.), as well as visually inspect the location of above-ground components and note the locations of well manholes, tank risers, etc.

The information collected will be utilized in combination with regulatory requirements and investigation objectives to identify conflicts in planned borehole locations. It is recommended that alternate proximal drilling locations be pre-determined in case utility/infrastructure conflicts exist or obstructions are encountered in the initial planned locations. The effort to investigate a specific proposed drilling location should be to clear utilities within a minimum 25-foot radius around the boring locations proposed inside the waste mass. Proposed borings along the Area 1 and Area 2 perimeters should have all utilities within a 100-foot offset of the area boundary located in the event that additional step-out borings are necessary.

Boring locations will be located using global positioning systems (GPS) and staked in the field. On-site personnel familiar with the locations of underground utilities or infrastructure will inspect the locations to verify the absence of utilities or infrastructure. The proposed drilling locations and a cleared radius of 25 feet will be approved by the Respondents and USEPA prior to the commencement of drilling. Should refusal be encountered, the boring will be relocated as necessary within the 25-foot radius. If relocation of a boring beyond the cleared 25-foot radius is deemed necessary by the Parsons Field Team Lead and Project Manager, the Respondents and USEPA will be contacted for approval prior to proceeding. Respondents and USEPA approvals must be documented. Verbal approval is acceptable if followed up with written approval. Documentation may include a notation in the field book, email or written correspondence.

Gravel access paths and drilling pads will be constructed to the boring locations as necessary. Removal of above-ground portions of vegetation growing within the work area around a borehole location or along the planned route of the access path to it will be required.

Vegetation will be cut near but above the ground surface using a brush hog and/or a skid steer with a forestry cutter/grinder attachment. This attachment can cut and grind woody vegetation without disturbing the underlying ground surface or vegetation roots. The vegetation cuttings will be chipped and placed on the ground surface. Significantly sized woody vegetation of more than approximately 1-inch in diameter that needs to be removed will be cut with tree shears and chipped in a wood chipper. The woody vegetation will be moistened with a water cannon prior to grinding, if necessary, to minimize chipping dust. The chipped woody vegetation will be placed on the road paths prior to geotextile deployment. A geotextile will be laid on top of the cleared area and chipped vegetation, over which approximately 8 inches of gravel material will be placed. It is anticipated that placement of the geotextile and road base material will generally occur the same day as the vegetation removal activities, but should be completed within two days of the vegetation clearing in any particular area. Adherence to these procedures will eliminate, or at the very least greatly minimize, the potential for erosion of the soil beneath the access roads and drill pads. A water truck will be made available during the entire clearing operation to add moisture, if needed, to the vegetation.

Vegetation clearing and road/drill pad construction activities will not be scheduled during periods when severe thunderstorms or major precipitation events are forecast for the Site area or when observations by on-site personnel indicate a potential for a severe thunderstorm or major precipitation event. A major precipitation event is defined as a rainfall rate of more than ½-inch per hour. Additionally, on days when precipitation is forecast or anticipated based on observation of site weather conditions, placement of geotextile and road base will be coordinated to closely follow the vegetation clearing activities and the vegetation clearing will be closely monitored and/or suspended as necessary so that the geotextile and sufficient road base material necessary to anchor the geotextile can be placed prior to the occurrence of thunderstorms.

Particular attention will be paid to activities associated with the few locations with a possible potential for erosion to occur including those borings located on the northern edge/slope of Area 2. Clearing of vegetation and construction of roads and drill pads will not be performed in or around drilling locations that indicate a potential for soil erosion during periods of significant precipitation events, based on field observations by on-site personnel at the time of surveying of the drilling locations or during the site preparation work. Additional geotextile material will be available to temporarily cover exposed areas should a significant precipitation event occur after the vegetation had been cut but before placement of the geotextile and associated road base material. Lastly, hay bales, filter socks, or other surface water best management practices (BMPs) will be placed adjacent to the perimeter drainage such that they can be rapidly installed across the perimeter drainage to restrict erosional transport of soil during an unanticipated precipitation event.

2.1.4 Subsurface Clearance

Parsons staff will ensure that no subsurface utilities, structures, or improvements exist where intrusive subsurface activities will occur. Locations will be cleared using results of historical data research and with geophysical methods at a zone 25 feet in radius around the proposed boring location.

Unless deemed necessary by project staff, intrusive clearance (e.g., hand clearing, air/water knife, or similar techniques) will not be performed. Site knowledge by project staff, non-invasive clearance techniques, and close monitoring of drilling rates will be employed to avoid contact with utilities and anomalies as further detailed below.

Proactive investigative methods to clear specific drilling locations at the Site will include non-invasive geophysical remote sensing. Ground-penetrating radar, electromagnetic detectors, magnetometers, or metal detectors will be used to survey an area around the boring location to a distance of 25 feet to identify potential subsurface utilities or facilities.

Utilities and associated Site infrastructure will be located prior to drilling operations using remote sensing techniques in the event that borings are relocated, or that step-off borings are required.

Subsurface clearance may be performed on multiple sampling points prior to mobilization of the drill rig. To minimize confusion in the field, a survey stake will mark the drilling location as proposed in the DIWP. The survey stake should include the sample point ID, written in black marker. Upon clearing the 5-foot radius using the above techniques, the stake shall be spray painted with pink paint.

Significant anomalies detected by the geophysical remote sensing justifies the relocation of the sample point. Should the point need to be moved the original stake will be painted red and a new stake painted pink will mark the successfully cleared alternative location. The alternative sample point ID should relate to the original sample point ID and new coordinates should be collected on the alternative sample point. Any relocation of sample points shall be communicated to the Parsons Project Manager. Upon approval of the relocation, maps and lists of drilling points will be updated.

The final list and map of drilling points, with GPS coordinates and whether the original point had been moved or not, shall be provided to the drilling team for their reference. The supervisor of the drilling team shall acknowledge through documentation that the final (pink) sample point and, if applicable, the original, relocated point have been positively identified.

Geophysical methods that may be used to find underground infrastructure proposed for use at the site include ground-penetrating radar and electromagnetic induction.

2.1.4.1 Ground Penetrating Radar (GPR)

GPR is similar to other radar systems, in that as the GPR antenna is moved across the surface, it transmits electromagnetic signals into the subsurface and receives reflections from interfaces in the path of the signal at which changes in the electrical properties (dielectric constant) of the subsurface materials occur. The signals are then amplified, processed, and displayed on the field device screen, in addition to being recorded for potential additional post processing. GPR provides a continuous profile of the subsurface.

GPR surveys should be conducted in concurrence with the methods described in the American Society for Testing & Materials (ASTM) D6432 – Standard Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation.

GPR is commonly used in conjunction with other geophysical techniques such as magnetic, electromagnetic induction, and seismic refraction. GPR uses high-frequency electromagnetic waves to provide detailed subsurface cross sections.

GPR emits microwaves into the subsurface which are then reflected back to the receiver. Different materials produce varying electrical results, which are then displayed and interpreted by the operator. Metallic objects produce the strong results, and often allow for determination of precise location, depth, and size. GPR is capable of differentiating between material densities, and as such is useful for delineating the boundaries of landfills, excavations, or other areas where there is a distinct material density difference.

GPR will be used at the site to delineate the footprint of a underground storage tank (UST) in Area 1 (shown on Figure 3) in order to characterize the utility for future removal, and verify that borings proposed in the vicinity of the UST do not come into contact with the utility during drilling operations.

2.1.4.2 Electromagnetic Induction (EM)

The EM (a.k.a., Terrain Conductivity) method measures the conductivity of earth materials, buried objects, and backfill utilizing electromagnetic induction. EM allows for the rapid collection and interpretation of large quantities of data and can be used to detect and locate both metal objects and zones of conductive contamination. It is the only widely available geophysical technique that is sensitive to the presence of both ferrous and non-ferrous metal objects. EM complements both magnetics and GPR.

EM measures the apparent conductivity of the subsurface, including effects of the soil, bedrock fractures, contaminants, metal objects, and groundwater. Variations in conductivity may indicate changes in composition, layer thickness, or moisture content, the presence of buried metal such as drums, or the presence of contamination.

Data are acquired at single stations and/or continuously along lines. EM surveys may not be suitable for examining highly industrialized or urbanized areas where cultural features such as buildings, pipelines and power lines may interfere with the collection of accurate data. By comparing in-phase and quadrature EM data, or EM and magnetic contour maps, ferrous and non-ferrous sources of elevated conductivity (such as drums versus landfill leachate) can be differentiated. EM survey should be performed in concurrence with the methods described in *ASTM D6639 – Standard Guide for Using the Frequency Domain Electromagnetic Method for Subsurface Site Characterization* (ASTM 2018b).

EM may be used at the site to detect and trace buried utilities and infrastructure, particularly within Area 1. This method will be used as backup for UST location/delineation and for boring clearance.

2.1.5 Event Notification

If any portion of a tank, pipe, utility or other subsurface structure is encountered, or if there is any doubt it has been encountered, the work is to cease in that area and the Parsons Project Manager notified immediately. If there is reason to believe that the structure has been damaged, any emergency shut-off switches should be activated (if applicable) and the appropriate regulatory entity, municipality, and Respondents notified immediately. The Parsons Project Manager, in consultation with the Respondents, will decide if additional uncovering by hand is required. If it is confirmed that an underground storage tank system has been encountered, the appropriate regulatory entity should be notified and regulations followed, and a tightness test(s) should be considered. Under no circumstances is the area to be backfilled without notifying the Parsons Project Manager, unless risk of personal injury or damage warrants temporary backfilling.

In case of refusal or if an unknown subsurface object is encountered during intrusive subsurface activities, then the following specified resolution process must take place.

- If the cause CAN be readily and correctly defined as not destructive or hazardous, drilling may proceed ONLY after consultation with the Project Manager.
- Otherwise, drilling MUST STOP so that location re-evaluation can take place. The Respondents, the utility owner (if applicable) and, if required, the appropriate regulatory agency, must be advised of the situation and consulted to determine if (1) the location is necessary, which may require additional effort to clear a new location, or (2) the location is not necessary, and can be deleted from the program.

2.2 Soil Boring Installation

Soil borings will be advanced to facilitate evaluations of Site stratigraphy, the presence/absence of waste, the collection of subsurface soil samples for chemical/radiological and geotechnical analyses, hydrologic conditions, and downhole gamma logging. A Parsons on-site representative will be responsible for overseeing boring installation activities. This representative will monitor that the work is performed with due caution and will be alert for warning signs that could indicate the presence of underground tanks, lines, or other hazards or structures.

Drilling equipment will be in proper working order and inspected to determine if it meets safety requirements, with inspection documentation to be provided by the drilling contractor. Field personnel will be briefed daily on potential hazards including working around moving equipment, physical hazards, biota, and risks associated with radiological or chemical exposures. Health and safety protocol/procedures pertaining to general and radiological aspects of drilling in potentially impacted areas are included in the Project Safety, Health, and Environmental Plan (PSHEP) and the Radiation Safety Plan (RSP).

It is anticipated that all work will be completed in modified Occupational Safety and Health Administration (OSHA) level D personal protective equipment (PPE), as required by the Radiation Safety Officer (RSO) or his on-site designee. Respirators for protection from radionuclide exposure will not be routinely required but will be made available to workers participating in their employer's respiratory protection program. Respirators for protection from dust inhalation will be used by approved workers if there are continuous plumes of visible dust from the borehole or soil cores; however, this condition is not anticipated to occur. Application of water during drilling or core examination should alleviate this potential situation. A decision to require use of respirators may be made by the RSO if conditions warrant.

Radiologically impacted soils generated during drilling and sampling operations will be archived and stored at an onsite lay-down area for potential sampling while non-radiologically impacted soils generated during the collection of geotechnical samples and determination of waste extent will be disposed of in accordance with **Section 2.9**.

Once the data collection needs of the borehole, including laboratory sample collection and downhole measurements, have been met, the borehole will be decommissioned consistent with the methods described in ASTM D5299 (ASTM 2018a), the regulations in 10 CSR 23-4.080, and **Section 2.2.2** below.

2.2.1 Drilling Methods

Depending on site-specific objectives and/or drilling conditions, soil borings may be advanced using direct-push, sonic drilling, or conventional hollow-stem auger drilling methods. Drill tooling and equipment will be decontaminated as outlined in **Section 2.8.2**. Each boring will be located using a total station GPS device that can provide coordinates with sub-inch accuracy, and will be performed with a Missouri-licensed professional land surveyor (PLS).

Borings will be installed to specific depths as detailed in **Table 1** and **Table 2**. These target depths are derived from the data needs outlined in the GSMOs and DIOs as described in the Quality Assurance Project Plan (QAPP). General boring type and target depth guidelines can be summarized as:

Boring Type	Total Depth	Area 1 Boring Count	Area 2 Boring Count
Interior RIM Boring ("SB" Prefix)	20 ft B2005GS	35	71
Thorium-driven Borings ("TH" Prefix)	20 ft B2005GS	9	32
Perimeter Borings – Waste ("PB" prefix)	60 – 100 ft BGS	2	20
Perimeter Borings – Geotechnical ("PB" Borings)	25 ft BGS	16	19
Hybrid Borings	25 – 60 ft B2005GS	0	3

- Interior borings, identified with the prefix SB or TH, will generally be installed to 20 feet below the 2005 ground surface (B2005GS), with the exception of A2-TH-125, A2-TH-127, and A2-TH-092, which will be installed to 5 feet into native material. This means a depth of approximately 25 feet B2005GS for A2-TH-125 and A2-TH-127, and approximately 60 feet BGS for A2-TH-092. Duplicate borings will be installed at A1-SB-068, A1-SB-070, A2-SB-003, and A2-SB-005 at a 10-foot offset from the parent boring. Boring depths and sample collection strategy will be the same in original and duplicate boring.
- Perimeter borings along the southeastern edge of Area 2 will be installed through the full extent of waste plus 5 feet into the underlying alluvium, or approximately 60 feet BGS.
- Perimeter borings adjacent to the North Quarry will be installed through the full extent of fill/waste plus 5 feet into the underlying alluvium, or approximately 100 feet BGS.
- Remaining perimeter borings for geotechnical investigation will generally be installed through *in situ* soils to a depth of 25 feet BGS.

Drilling methods will vary based on boring location, basis for installation, and expected substrate. Borings installed within the Area 1 and Area 2 boundaries will typically be installed using a sonic rig, while borings installed along the perimeter outside the expected waste footprint will use a hollow-stem auger rig equipped for split-spoon sampling. Perimeter borings proposed within the waste footprint will be installed using a sonic rig.

If refusal is encountered during drilling operations, the Parsons Field Team Lead will evaluate the soils previously collected from the location for evidence of the cause of refusal. The Parsons Field Team Lead will also consider observed penetration rates, blow counts where measured, as well as input from the Field Geologist and Lead Driller. This information will be discussed with the Parsons Project Manager to determine if the borehole should be abandoned and relocated, or if drilling operations should cease and data collection (soil sampling, downhole measurements, etc.) should move forward. Should the boring location be abandoned or relocated, the borehole will be properly decommissioned in accordance with 10 CSR 23-4.080 as discussed in **Section 2.2.2**

Once the data collection needs of the borehole, including laboratory sample collection and downhole measurements, have been met, the borehole will be decommissioned in accordance with 10 CSR 23-4.080 as described in **Section 2.2.2**, and consistent with the methods included in ASTM D5299 (ASTM 2018a) and in accordance with Missouri state regulations (**Attachment 6**).

Once decommissioned the boring location will be surveyed by a Missouri-licensed PLS for the development of an as-drilled topographic survey.

2.2.1.1 Direct Push Method

This drilling method is typically used to collect shallow overburden soil samples and typically allows for the advancement of numerous borings in a relatively short period of time.

Direct push methods may be applied to collect samples from the Buffer Zone and Lot 2A2. Direct push drilling, if utilized, will be conducted in accordance with ASTM Method D6282 (ASTM 2014), which provides guidance and discussion about the technique. If implemented, soil cores will be collecting using 4-foot long Macro-Core samplers with acetate liners.

2.2.1.2 Sonic Drilling

Sonic drilling conducted in accordance with ASTM D6914 (ASTM 2016) may be used for the advancement of a continuous core. ASTM D6914 provides guidance and discussion about the technique.

Sonic drilling offers the benefit of significantly reduced drill cuttings and reduced fluid production. Furthermore, sonic drilling does not entail the use of drilling fluids such as air or water to circulate cuttings, although potable water may be used to cool the downhole equipment and to pressurize the drill string. Since drilling fluids are not required, this technique does not result in emissions at the ground surface. The continuous core sample recovered by the sonic drilling technique provides a representative lithological column for evaluation and sample collection. Applying vibration and rotational forces to the casing string eliminates the complication of backfill bridging common to other drilling methods and reduces the risk of casing lockup.

The cutting action of the sonic drilling bit passing through the subsurface may cause disturbance to the soil structure along the borehole wall. Disturbances to soil structure along the borehole wall are generally expected to be minimal and will be monitored when drilling through landfilled waste via the rates of penetration and recovery.

Soil and waste samples will be extracted from the drill string/core barrel by vibrating the barrel and directing the core sample into an approximately 4-foot length of plastic sleeving. Minimal hydraulic pressure applied to the core barrel is occasionally utilized to facilitate core sample extraction without distortion.

Sonic drilling has been shown to penetrate construction and demolition debris, steel, and other durable waste components at the Site, although its effectiveness decreases with depth as energy dissipates along the drill string. Energy-absorbing materials such as rubber and wood also lessen the effectiveness of sonic drilling. Sonic drilling may require the use of pressurized water to remove drill cuttings from the face of the bit. Any water used to remove drill cuttings will be potable.

Some heat generation may occur within a borehole during use of sonic drilling at depth; potable water may be used to counteract potential heat generation. The use of water during drilling is not currently anticipated for design investigation boreholes.

2.2.1.3 Hollow-Stem Auger Drilling Methods

Hollow-stem augering (HSA) is a drilling method used to penetrate and sample overburden soils, both natural deposits and fill, and create boreholes for monitoring well or standpipe well installation. HSA methods will be used at the Site in accordance with ASTM D6151/D6151M (ASTM 2015b).

HSA drilling methods typically allow for the advancement of borings through most soil types including denser soils (e.g., glacial till), and when coupled with split spoon sampling conducted in accordance with ASTM D1586, can provide geotechnical information via standard penetration testing (SPT).

HSA drilling methods will be used at the Site in areas where geotechnical data collection is necessary, specifically at perimeter borings outside of the expected waste extent. Soil samples will be collected continuously from the ground surface to the bottom of the borings using split-barrel samplers in accordance with ASTM Method D1586. Based on the drilling conditions encountered in a given borehole, thin-walled samplers may be used per ASTM D1587 (ASTM 2015a)) or thick-walled 3-inch diameter samplers may be utilized per ASTM D3550 (ASTM 2017) to collect undisturbed samples. The following procedures will be followed by field personnel:

1. Soil samples will be collected continuously from the ground surface to the bottom of borings using 2-inch or 3-inch (if applicable) diameter split-barrel samples in accordance with ASTM D1586 and/or ASTM D3350 (ASTM 2017).
2. The sampler will not be advanced more than two lengths (4 feet) beyond the lead auger. Once the augers are led by two split spoons the augers should be advanced and split-spoon sampling may proceed.
3. Soil samples retrieved from the borehole will be described in accordance with **Section 2.4.1**, and will include percent recovery. Descriptive information will be recorded on a soil boring log form (**Attachment 2**)
4. Soils will be collected for laboratory analysis according to **Section 2.4.3**, and analyzed for the constituents described in **Section 2.4.5**, and in accordance with the DMP and QAPP.
5. Split spoons will be washed and rinsed between sampling intervals and prior to being used for another boring.

2.2.2 Borehole Decommissioning

Abandonment of monitoring wells and borings will be conducted per 10 CSR 23-4.080. Standpipe wells must be plugged by removing PVC pipe and filling the well or boring from total depth to 2 feet below ground surface with approved grout as defined in 10 CSR 23-4.060, and the remainder of the well or boring filled with compacted uncontaminated native material or grout. The following subsections describe the procedures for abandonment of boreholes that are not used for monitoring well installation. Abandonment of monitoring wells will be conducted per 10 CSR 23-4.080 as described in **Section 2.5.3**

2.2.2.1 Borings for Soil Classification and Sampling

Borings installed to collect soil samples for laboratory and geotechnical analysis only do not require sheeting or casing following borehole advancement. Following collection of subsurface measurements (**Section 2.3**) and soil samples (**Section 2.4**), the borehole will be decommissioned with grout. Grout will consist of a mixture of Portland cement (Type 1) and bentonite in compliance with 10 CSR 23-4.060 (defining approved grout), which will be tremied through the drill string as it is being removed and completed in accordance with the requirements of 10 CSR 23-4.080.

2.2.2.2 Borings for Downhole Gamma Logging

Borings installed to collect downhole gamma data will be cased with 3-inch PVC or acrylonitrile butadiene styrene (ABS) in accordance with 10 CSR-4.060 following the collection of subsurface measurements and soil samples. Once necessary downhole gamma readings have been recorded and the Parsons Field Team Lead provides authorization following discussion with USEPA, the borehole will be decommissioned; the PVC or ABS casing will be pulled, and the borehole will be grouted. Grout will consist of a mixture of Portland cement (Type 1) and bentonite in compliance with 10 CSR 23-4.060 (defining approved grout), which will then be tremied through the casing as it is removed and completed in accordance with the requirements of 10 CSR 23-4.080. If the borehole sidewalls are stable and not subject to caving, the casing may be removed in its entirety and then the borehole will be grouted.

Proposed borings that require installation of standpipe wells will be constructed in accordance with **Section 2.5.1** and 10 CSR 23-4.060 and decommissioned as per **Section 2.5.3** and 10 CSR 23-4.080.

2.3 Subsurface Measurements

2.3.1 Standard Penetration Testing

SPT will be used at select perimeter borings installed outside of the extent of waste to provide geotechnical data for the design and implementation of the RA. This section is summarized from ASTM D1586.

2.3.1.1 Equipment and Supplies

- Hollow-stem continuous flight augers and rig
- Sampling rods
- Split-barrel sampler
- Hammer drop system (automatic hammer)
- Sample containers and labels
- Field forms and/or field log book

2.3.1.2 Drilling Procedure

1. Advance borehole incrementally to continuous sampling using ASTM D1586 and/or ASTM D3350 (ASTM 2017).
2. Casing may not be advanced below the sampling elevation prior to sampling.
3. While the use of drilling fluid is not currently anticipated, if subsurface conditions dictate its use, the fluid level within the borehole or HSA flight shall be maintained at or above the in-situ groundwater level during drilling, removal of drill rods, and sampling. If drilling fluids are necessary, potable water should be used. Any use of fluids should be minimized to the extent practicable to minimize the potential for spreading contamination. Use of any fluids should be approved ahead of time by project management and appropriate regulatory staff.

2.3.1.3 Standard Penetration Testing Procedure

1. Attach split-barrel sampler to the sampling rods and lower into borehole.
2. Attach anvil to sampling rods and move automatic hammer into position. The sampling assembly should be resting at the bottom of the borehole.
3. Mark drill rods in three successive half-foot increments so that the advancing sampler can be easily observed.
4. Drive the sampler with blows from the automatic hammer and count blows needed to advance the sampling assembly through each half-foot increment until one of the following occurs:
   - A total of 50 blows have been applied during any one half-foot increment.
   - A total of 100 blows have been applied over the full 2-foot sampling interval.
   - There is no observed advance of the sampler after 100 blows.
   - The sampler is advanced through three complete half-foot increments.
5. Record the number of blows needed to advance the sampler through each increment. Per ASTM D1586, the sum of number of blows required to advance the sampler through the second and third half-foot increments will be taken and recorded as “standard penetration resistance” or “N-value.”
6. Refence **Section 2.2** in the event that refusal is encountered during drilling operations. Alternatives will be evaluated by the Parsons Field Team Lead and Project Manager in consultation with Respondents.

2.3.2 Downhole Gamma Logging

2.3.2.1 Sampling Strategy

In situ gamma data collection (i.e., downhole, or borehole, gamma logging) will be performed at each proposed boring within Area 1 and Area 2, shown on **Figure 1** and **Figure 2**, and to the specific depths detailed in **Table 1** and **Table 2**. The Field Team Lead and Project Manager will procure a variance from Missouri Geological Survey, if necessary.

2.3.2.2 Equipment and Supplies

- Portable ratemeter-scaler: Ludlum Measurements, Inc. (LMI) Model 2221, or equivalent.
- Sodium iodide (NaI) detector: 2”x 2” Model 44-10, Ludlum Measurements, Inc. or equivalent.
- Cables of sufficient length to reach the bottom of the deepest borehole, currently estimated to be 100 feet B2005GS.
- Light rope or cable of sufficient strength and length to lower detector to the bottom of the deepest borehole and retrieve it. Rope should be clearly marked in 6-inch increments.
- Clamp or tape to secure rope to detector.
- Optional winch assembly for lowering and raising detector in deep boreholes.

- Plastic (PVC or ABS) pipe, as required, of sufficient length and diameter to encase borehole to the desired logging depth.
- One PVC pipe end cap for each planned borehole, plus at least two extra end caps for contingencies.
- PVC pipe cement.
- A saw or plastic pipe cutter to size pipe lengths.
- Plastic bags large enough to cover detector assembly when downhole.
- Record forms and pens.

2.3.2.3 Instrument Assembly and Preparation

1. Assemble instrument/detector combination with long cable for which it is calibrated.
2. Perform daily instrument check on assembled unit, and document that equipment has undergone calibration in accordance with the Ameriphysics Radiation Control Procedures.
3. Securely attach support rope to detector. Use tape or wire ties to secure cable to support rope at approximately 1-meter intervals. Leave about 1 to 2 inches of slack in the cable between the top of the detector and the first piece of tape or wire tie binding the rope to the cable. The weight of the detector should always be supported by a rope or equivalent. The detector should NEVER be lifted or supported by the long instrument cable.

2.3.2.4 Downhole Logging Procedure

1. The borehole will be cased with a 3-inch minimum SCH-40 PVC or ABS pipe. This size pipe requires the installation of a 3.5-inch diameter, or larger, borehole. PVC will be installed to the boring total depth to allow for continuous gamma logging through the entirety of the borehole. A PVC cap will be secured to the top of the pipe when the location is not actively being logged.
2. Prior to inserting the detector downhole, enclose the detector assembly in double plastic bags or tubular sheeting to protect detector against direct contact with water or soil from the borehole.
3. Set the scaler timer to accumulate counts over a period of 1 minute.
4. If using the winch assembly, place it over the borehole. Position the detector over the hole with bottom of the detector level with the ground surface.
5. Record this initial position as the zero centimeter or surface measurement. Collect the first timed measurement and record the results, in counts per minute (cpm), at this position.
6. Lower the detector slowly into the borehole, stopping at 6-inch intervals to collect and record 1-minute measurements in gross counts. Record the depths of these locations.
7. When the detector reaches the bottom of the borehole or borehole liner pipe record the last measurement and depth of the hole.
8. Raise the detector to the surface and inspect the detector for signs of water infiltration into the plastic cover. Clean the cover or replace it, as needed.
9. Once downhole gamma logging has been completed the borehole will be decommissioned, as discussed in Section 2.2.2.2. Downhole gamma casing will be removed in a timely manner following completion of necessary data collection.

2.3.3 Field Density Measurements

Field density measurements will be performed in proposed perimeter borings where geotechnical analysis of waste is being performed (listed under "Perimeter Borings – Waste" in Tables 1 and 2). Field density measurements will be used to evaluate rate of settlement and select handling practices for material being considered for off-site disposal during the implementation of the RA.

2.3.3.1 Equipment and Supplies

- Drill tooling and rig
- Sampling rods
- Core or split-barrel sampler
- Tripod with hanging scale (pounds)
- Measuring tape (inches)
- Sample containers and labels
- Field forms and/or field log book

2.3.3.2 Field Density Measurement Assembly and Preparation

1. Advance borehole incrementally to permit continuous sampling using acceptable methods.
2. Casing may not be advanced below the sampling elevation prior to sampling.
3. The desired interval will be sampled in accordance with the methods outlined in **Section 2.4**.

2.3.3.3 Field Density Measurement Procedure

1. Once sampling rods have be advanced to the desired depth interval, the drill string will be retrieved, and the sample barrel weighed.
2. The difference between the weight of the full barrel and that of the empty barrel will be recorded as the “sample weight.”
3. After the weight of the full barrel has been measured, normal sample processing procedures may be performed in accordance with **Section 2.4**.
4. During sample processing the volume of the sample will be calculated by multiplying the length of recovery (in inches) by pi (π) and the inner radius of the sample barrel (in inches) squared.
5. The resulting density (weight divided by volume) will be recorded as “sample density” in pounds per cubic inch.

2.4 Soil and Sediment Sampling

2.4.1 Soil Description

Site media consisting of soil and soil/waste mixtures are referred to as “soil” for the purposes of this FSP. Soil will be collected at the Site using HSA or sonic drilling methods. Soils will be classified and described according to the methods and procedures outlined in the following sections.

2.4.1.1 Equipment and Supplies

- Digital camera or phone/tablet
- 1-gallon sealable bags
- Field forms and field logbook
- Scissors/knife
- Spray bottles with Alconox phosphate-free detergent solution and water
- Gloves
- Permanent marker for labeling
- Putty knife
- Sample labels
- Sample containers

- Portable ratemeter-scaler: Ludlum Measurements, Inc. (LMI) Model 2221, or equivalent
- Sodium iodide (NaI) detector: 2"x 2" Model 44-10, Ludlum Measurements, Inc. or equivalent
- Ludlum Measurements, Inc. Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta probe, or equivalent
- MiniRAE 3000 portable handheld PID, or equivalent, with 10.6 eV lamp

2.4.1.2 Soil Description Methods

1. A core run will be vibrated out of the core barrel into a plastic sleeve. A health physics technician (HPT) will scan the sleeve and record gamma activity.
2. Cores will be transported to a central processing location for logging and processing.
3. The sample processing crew will cut open the sleeve and photograph the entire core run and wash/rinse the knife used to cut the sleeve with the Alconox phosphate-free detergent, or equivalent, solution and water.
4. The processing geologist/field engineer will review the core samples and log the boring based upon the cores and the corresponding depths. Soil core and grab samples, split spoon, and/or sonic samples will be described using the Burmister Classification System and assigned a Unified Soil Classification System (USCS) designation. Descriptions will be entered on the attached boring log form (**Attachment 2**). The Burmister Classification and USCS are based primarily on grain size. In addition, visual indication of contamination and field screening results are included in environmental soil descriptions. An example of the typical soil boring log form is provided in **Attachment 2**. The following sections are adapted from the Burmister and USCS systems.

2.4.1.3 Burmister Classification System

Samples described based on the Burmister Classification System (Burmister, 1970) include the following components and are reported in the order shown below.

<u>Moisture content</u>

The relative moisture content of the soil at the time of sampling shall be designated as "dry," "moist," or "wet."

<u>Consistency</u>

The consistency of the soil sample shall be described for fine grained soils (silts and clays) as "stiff," "medium stiff," or "soft" and state whether the soil is "plastic" or "non-plastic." Coarse-grained soils (sands and gravels) shall be described as "loose," "medium dense," or "soft" and will include the degree of cementation. The description will also include the shape of the grains ("flat", "angular," or "rounded") and the grading ("Well Graded," "Poorly Graded," or "Uniform").

When applicable, the penetration rate while conducting SPT with split spoons is also an indication of the compaction/density of the material. The table shown below is a penetration guide and will be used to determine the consistency of the material. The SPT values across the middle of the 2-foot split spoon will be used to select a consistency description from the penetration guide below. SPT values are typically recorded in 6-inch intervals, so for example: a 2-foot spoon has values (or blows) of four, three, six, eight for each 6-inch interval. The SPT value used to determine consistency is the sum of the last two values (6+8=14). If the material was sand the consistency from the table is "Medium Dense", if the material was clay the consistency is "Stiff." For materials that are predominantly silt the "clay" section of the guide will be used.

PENETRATION GUIDE			
SAND		CLAY	
Very Loose	0-4 Blows per foot	Very Soft	<2 Blows per foot
Loose	4-10 Blows per foot	Soft	2-4 Blows per foot
Medium Dense	10-30 Blows per foot	Medium Stiff	4-8 Blows per foot
Dense	30-50 Blows per foot	Stiff	8-15 Blows per foot
Very Dense	50+ Blows per foot	Very Stiff	15-30 Blows per foot
		Hard	30+ Blows per foot

Color

The predominant color of the soil sample in the natural state shall be designated as "white," "brown," "yellow," "red," "gray," "blue," or "black." In some cases the sample may be "mottled" (a combination of colors such as red/gray, blue/gray, etc.)

Color codes and designations should follow those provided in Munsell soil color charts. Grain size description is listed in order of predominance starting with the most predominant.

Grain Size

Soils are predominantly classified based on grain size. The four main grain sizes are "gravel," "sand," "silt," and "clay." Sands are further described as coarse, medium, or fine and gravels are described as coarse or fine.

The first entry will be the most predominant grain size in the sample. The entry is fully capitalized (SAND, SILT, CLAY, and GRAVEL) if it comprises 50% or more of the sample. Otherwise the predominant fraction is listed first with only an initial capital.

The second, third, and other entries represent the most predominant grain size materials in order of predominance. The percentages of the constituents are indicated by the following descriptors:

- "and" 50-35%
- "some" 35-20%
- "little" 20-10%
- "trace" 10-1%

For example, a soil description may be SILT, some fine sand, trace clay (50% or more of silt with 20-35% fine sand, 1 to 10% of clay). Other common descriptions might be fine SAND, some silt and clay; SILT, trace of fine sand and clay; SILT, some coarse sand and gravel, trace clay.

The following table lists the breakdown of grain sizes and sieve numbers for each category (modified Burmister system).

GRAIN SIZE AND SIEVES				
SOIL	FROM SIEVE NUMBER	TO SIEVE NUMBER	FROM MM	TO MM
Gravel – coarse	3-inches	¾-inches	75	19.0
Gravel -fine	¾-inches	#4	19.0	4.75
Sand – coarse	#4	#10	4.75	2.0
Sand - medium	#10	#40	2.0	0.425
Sand - fine	#40	#200	0.420	0.075

GRAIN SIZE AND SIEVES				
SOIL	FROM SIEVE NUMBER	TO SIEVE NUMBER	FROM MM	TO MM
Silt	#200	Material passing the No. 200 sieve that is usually non-plastic in character and exhibits little or no strength when air dried.		
Clay	#200	Material passing the No. 200 sieve that can be made to exhibit plasticity within a certain range of moisture contents and which exhibits considerable strength when air dried.		

Vegetable Muck and Peat

Vegetable mucks and peats are soil mixtures with varying percentages of organic and vegetable matter formed by decomposition of leaves, grasses, and other fibrous materials. The color ranges from light brown to black. The soil content of the mixture should be identified and an estimate should be made of the amount of vegetable material present. The vegetable matrix comprising the peat should be identified as "fibrous" or "woody." The sample composition should be further described with respect to texture as "cake-like," "spongy" or predominantly "granular."

Miscellaneous

Certain materials may be incorporated that do not fall under foregoing classifications and require further qualification for proper identification. Additional terms may be used, but should not replace the basic description. These additional terms may be used specifically to designate materials as "rock fragments," "stones," "cobbles," "rock flour," or other qualifying descriptions.

Field Observations to Identify Silt and Clay Characteristics

The field test listed in the table below may be used to distinguish between structural characteristics of a silt or clay soil. For mixtures of silt and clay, the tests indicate the predominant constituent.

FIELD OBSERVATIONS OF SILT AND CLAY CHARACTERISTICS		
CHARACTERISTICS	SILT	CLAY
Plasticity in moist state	Very little or no plasticity.	Plastic and sticky. Can be rolled.
Cohesiveness in dry state	Little or no cohesive strength in dry state and will slake readily.	Has a high dried strength. Crumbles with difficulty, slakes slowly in water.
Visual inspection and feel	Coarse silt grains can be seen. Silt feels gritty when rubbed between fingers.	Clay grains cannot be observed by visual inspection. They feel smooth and greasy when rubbed between fingers.
Settlement in water	Will settle out of suspension within one hour.	Will stay in suspension in water for several days unless it flocculates.
Movement of water in the voids	When a small quantity of silt is shaken in the palm of a hand, water will appear in the surface of the soil. When shaking is stopped, water will gradually disappear.	When a small quantity is shaken in the palm of the hand it will show no signs of water moving out of the voids.

2.4.1.4 Unified Soil Classification System

The USCS is based on textural characteristics. Soils fall into one of fifteen groups, where each group is defined by a two-letter symbol. In general soils are classified as one of two broad categories:

- Coarse-grained soils: Group symbols start with either "G" for gravel or gravelly soils, or "S" for sand or sandy soils.
- Fine-grained soils: Group symbols start with "M" for non-plastic or low plasticity fines (inorganic silt), "C" for plastic fines (inorganic clays), "O" for organic silts and clays, or "Pt" for peat, muck, humus, swamp soils, and other highly organic soils.

2.4.1.5 Field Observations of Contamination, Putrescence or Site-Specific Characteristics

Environmental samples are also screened for visual evidence of contamination. Descriptions of these observations and screening results should be added to the physical descriptions of samples including:

<u>Stain</u>

Stains are discoloration and coatings potentially of non-native materials on or in the sample. The stains can range from light tan to black. When handled, the staining material in the sample may transfer to fingers or gloves.

<u>Sheens</u>

Sheens are films floating on the water in saturated samples. The films may have rainbow colors, an oily appearance, or a silvery appearance.

<u>Odor</u>

Anthropogenic materials may have a distinctive odor. While describing the sample characteristics, note odors present in the sample. Understand that odor classification is a subjective measure; therefore avoid making conclusions about specific chemical character of the sample.

<u>Putrescence</u>

During the sample logging process specific attention will be paid to the identification and description of artifacts indicating putrescence. These include:

- Presence of insects
- Small animal (e.g., rodent) remains
- Decomposing food wastes
- General indicators of putrefaction such as odors and decaying organic materials that may be attractive to wildlife/birds

<u>Screening</u>

Samples will be screened with radiation detectors for alpha, beta, and gamma radiation and with a PID for volatile organic compounds (VOCs) as discussed in **Section 2.4.1.7**. Alpha and beta scanning will be performed with a Ludlum Measurement, Inc. Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta probe or equivalent. Gamma scanning will be performed using a Ludlum Measurements, Inc. 2" NaI detector, Model 44-10 with a Model 2221 portable ratemeter-scaler or equivalent. VOC screening will be performed using a MiniRAE 3000 portable handheld PID with 10.6 eV lamp or equivalent.

Field screening for radiological parameters should be implemented consistent with methods used during previous investigations performed by Feezor Engineering to the extent practicable.

A complete list of symbols is provided below:

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (More than 50% of the material is LARGER than No. 200 sieve size).	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel-sand mixture, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size).	CLEAN SANDS (Little or no fines)	SW	Well-graded sands, gravelly sands little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (More than 50% of material is SMALLER than the No. 200 sieve size).	SILTS AND CLAYS (Liquid limit LESS than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayed 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.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.
BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.				
PARTICLE SIZE LIMITS – see particle size limits in Burmister table (**Section 2.4.1.3**).				

2.4.1.6 Asbestos Inspection

MDNR and the St. Louis County Department of Health require notification of drilling activities and observation of the work by a state-certified asbestos inspector. If suspected asbestos-containing material (ACM) is encountered during drilling or other intrusive activities, the following protocols will be implemented at the direction of the state-certified asbestos inspector:

1. Identify and mark-off an exclusion zone. The exclusion zone will consist of a minimum 25-foot-square (25 feet by 25 feet) area with the borehole located at the center.
2. If work is to continue, all workers within the exclusion zone will wear Tyvek protective disposable suits and don half-face respirators with high-efficiency particulate air (HEPA) filters if trained, fit-tested, and authorized to do so in accordance with their employer's Respiratory Protection Program. Those not so authorized must leave the exclusion zone immediately.
3. If drilling activities are to continue, a ½-inch stream of water will be added to the borehole continuously during the drilling process.
4. Plastic sheeting will be placed on the ground near the borehole and drilling debris exhumed from the hole will be placed on it. A sand or dirt berm approximately 18 inches high shall be erected on three sides of the plastic sheeting. Drilling debris placed on the plastic will be dampened and maintained wet. Drilling debris temporarily placed on plastic sheeting must be relocated into a durable container and covered (secured tarp, hinged lid, etc.) prior to the end of the day's work.
5. All used PPE and drilling debris will be disposed of on site in accordance with site procedures. All equipment coming into contact with ACM shall be pressure washed at a designated area before leaving the site.

2.4.1.7 Field Screening/Scanning of Site Samples

Cores will be scanned with detectors sensitive to alpha, beta, and gamma radiation. Concurrently with borehole gamma logging, core radioactivity will be measured in 1-minute integrated gamma readings at 6-inch intervals using the same type of sodium iodide (NaI) gamma detector used for downhole gamma logging, and consistent with the equipment used during previous investigations. Field radiological readings will be taken along the total length of the core(s). Core scanning and downhole gamma in conjunction with geological evaluation of the cores may be used to select depth intervals for sample collection as discussed in Section 2.4.3.

For all field scanning procedures the core bag should be cut and soils within the core bag should be split, using a putty knife or equivalent, prior to scanning. Alpha particles in particular are easily shielded and therefore care must be taken to ensure that all scanned intervals are homogenized and representative of the 6-inch interval. The alpha/beta detector will be held 0.5 – 1.0 inch away from the scanned media, and the gamma detector will be set directly on top of the scanned media. These methods are consistent with the procedures used during previous investigations.

2.4.1.8 Descriptions of Landfill Waste

Site media consisting of landfill waste will be classified based on moisture content and decomposition status as shown on the tables below.

Moisture Content Scale		
Moisture	**Classification**	**Description**
<15%	Dry Refuse	No trace of moisture. Rock, dirt; paper will be fuzzed up or brittle.
20-25%	Normal	Paper and cardboard, etc., still not noticeably wet. Normal moisture content of material consistent with prior to disposal.
25-35%	Damp	Paper shows dampness, lawn clipping and tree branches are stiff and hold together.
35-50%	Wet	Paper saturated but no free water present. Waste is beginning to get sloppy. Water emanates when squeezed.
>50%	Saturated	Mud or free water present.

Decomposition Scale	
Category	**Description**
Little	Printed material is readable. Refuse looks freshly buried.
Some	Material is at a state of decomposition between “little” and “moderate.”
Moderate	Printed material is not legible, branches are intact.
Much	Material is at a state of decomposition between “moderate” and “severe.”
Severe	Black/brown mucky material.

2.4.2 Surface Soil Sampling

2.4.2.1 Laboratory Analytical Sample Collection Strategy

Samples will be collected from locations in the Buffer Zone and Lot 2A2, as shown on **Figure 4,** in order to delineate the presence of radionuclides above background, if any, in these areas. Additionally, a background study will be performed on samples collected from designated off-site reference units. Sample locations and placement strategy are described in the DIWP. A summary of soil samples proposed for collection in the Buffer Zone and Lot 2A2 is provided below:

Survey Unit	Sample Locations	Samples Per Location(1)	Total Samples (1)
BZ1	21	2	42
BZ2	21	2	42
BZ3	20	2	40
2A2_1	20	2	40
2A2_2	20	2	40
2A2_3	22	2	44
2A2_4	20	2	40
2A2_5	20	2	40
2A2_6	20	2	40
2A2_7	20	2	40
2A2_8	21	2	42

Surface soil samples in the Buffer Zone and Lot 2A2 will be collected from random-start systematic locations in survey units approximately 2,000 square meters in area. Each sample will be collected in 6-inch intervals from 0 to 12 inches below the base of imported gravel, recycled asphalt or other fill material used for parking surfaces or the non-combustible cover, thereby approximating surface samples prior to subsequent development activities and obtaining a representation of concentrations in the potentially impacted areas.. This approach is appropriate because migration of contaminants to the Buffer Zone and Lot 2A2 is thought to have occurred as a consequence of surface runoff from Area 2, and the potential exists for this material to have been disturbed further by anthropogenic activity over time. Surface soils will be screened with radiological detectors in accordance with the procedures outlined in **Section 2.4.1.7**. Additional location-specific details related to sample data needs are detailed in **Table 3**.

In the event that impacts above background are observed via radiological screening instruments in Buffer Zone/Lot 2A2 samples at the 12 inch depth interval, deeper soils will be collected, described, and scanned until radiological responses above background are no longer observed during field scanning. An additional laboratory analytical sample will be collected from the soil interval where radiological responses above background cease.

Samples will also be collected from background reference areas, shown on **Figure 5**. In application, four separate reference units (RU) of approximately 2,000 square meters in area were selected; each unit is strategically located to resemble Site conditions in order to evaluate statistically valid background concentrations for the Site. As shown in **Table 4,** 15 randomly selected locations will be sampled from each reference unit. As it is important that samples are representative of background conditions, samples will be obtained from 0 to 6-inch and 6 to 12-inch intervals. Sampling the two intervals allows an opportunity to evaluate the surface of individual locations, reference units, and the entirety of the reference area for impacts from development or other activities. A discussion of establishment of background reference areas is discussed in the DIWP and QAPP. A summary of samples proposed for collection during the background study is listed below.

Background Area	Sample Locations	Samples Per Location(1)	Total Samples (1)
RU-1	15	2	30
RU-2	15	2	30
RU-3	15	2	30
RU-4	15	2	30

Prior to Buffer Zone, Lot 2A2, and background sample collection, the ground surface at each proposed sample location will be scanned with a gamma detector and the observed response will be recorded in counts per minute.

Surface samples will be collected in accordance with the methods described below, and submitted to a laboratory for analysis as per **Section 2.4.5**.

2.4.2.2 Equipment and Supplies

- Digging implement: hand auger, garden trowel, disposable trowel, shovel, spoons, post-hole digger, etc. (if collecting by hand)
- Sample containers
- Tape
- Indelible pen
- Labels and security seals
- Equipment cleaning supplies, as appropriate
- Record forms and/or logbook

- RKI GX-2009 4-Gas Meter, or equivalent
- Ludlum Measurements, Inc. Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta probe, or equivalent
- Portable ratemeter-scaler: Ludlum Measurements, Inc. (LMI) Model 2221, or equivalent
- Sodium iodide (NaI) detector: 2”x 2” Model 44-10, Ludlum Measurements, Inc. or equivalent
- MiniRAE 3000 portable handheld PID, or equivalent, with 10.6 eV lamp

2.4.2.3 Surface Soil Hand Sampling Method

The soil at the selected sampling location will be loosened to the target depth using a trowel or other digging implement. Large rocks, vegetation, foreign objects, parking surface material, and fill will be removed (these items may also be collected as separate samples, if appropriate). Samples should be collected immediately below the zone of grass cover and associated roots in the background areas, or below the base of asphalt/gravel fill in the Buffer Zone and Lot 2A2.

The remaining soil from each sampling interval (0 - 6 or 6 – 12 inches) will be homogenized in a stainless-steel mixing bowl and scanned with radiological detectors (alpha, beta, and gamma) in accordance with the procedures outlined in **Section 2.4.1.7**. The results of radiological field scanning should be recorded on the surface soil logs (**Attachment 12**). Homogenized soils will then be distributed to the appropriate sample containers. Subsequent depth intervals will be processed in the same manner for each interval collected. The field technician will record the sample identification, location, and other pertinent data on appropriate record forms, maps, drawings, and/or site logbook.

If radiological impacts are detected in the 6 - 12 inch sampling during core scanning, additional soil samples will be collected as described in **Section 2.4.2.1.**

Sampling tools will be cleaned between each boring and sample according to the procedure outlined in **Section 2.8** before proceeding with further sampling.

2.4.2.4 Surface Soil Geoprobe Sampling Method

A direct push Macro-Core will be advanced through the asphalt and/or fill gravel to a depth of 4 feet. Macro-Core tooling will be tripped out of the hole and the core liner will be removed, cut open, and visually inspected. The field geologist will identify the bottom of the reworked asphalt/gravel fill material and continue to describe and screen the full 4-foot soil core using the methods identified in **Section 2.4.1**. The core will be screened using alpha, beta, and gamma radiological detectors as well as a PID, and the information will be recorded on soil boring logs. The field geologist will collect and homogenize 6-inch sampling intervals as described in **Section 2.4.2.1** before placing them in laboratory provided bottleware for radiological analysis.

If radiological impacts are detected in the 6 to 12-inch samples during core scanning, additional soil samples will be collected as described in **Section 2.4.2.1**

Sampling tools will be cleaned between each boring and sample according to the procedure outlined below in **Section 2.8** before proceeding with further sampling.

2.4.3 Subsurface Sampling

2.4.3.1 Laboratory Analytical Sample Collection Strategy

Subsurface sampling strategies will be dictated by data needs outlined in the GSMOs and of the general DIOs as defined in the QAPP. Boring-specific data collection details are shown in **Tables 1** and **Table 2**. Samples may be collected based on the results of core scanning, downhole gamma, and geological evaluation of the contents of the core(s). The sample collection strategy is summarized in the table below.

Boring Type	Total Depth	Lab Rad. Samples	Sampling Rationale
Interior RIM Boring ("SB" prefix)	20 ft B2005GS	5	1 sample per 4-ft core run from within 40,000 – 500,000 cpm gamma range, if applicable. If not samples collected from highest radiological response during core scanning. If no response during core scanning, samples will be collected from bottom of core run.
Thorium-driven Borings ("TH" prefix)	20 ft B2005GS	17	1 grab sample every 1-ft from 0 – 16 ft B2005GS. Additional sample collected from 16 – 20 ft B2005GS from highest radiological response during core scanning.
Perimeter Borings – Waste ("PB" prefix) (1)	60 – 100 ft BGS (2)	3	1 sample from 0 – 1 ft BGS. 2 more samples from 1- 60 (100) ft BGS collected from highest intervals of radiological response during core scanning.
Perimeter Borings – Geotechnical ("PB" prefix)	25 ft BGS	2	1 sample from 0 – 1 ft BGS. Additional 1 sample from 1 – 25 ft BGS collected from highest interval of radiological response during core scanning.
Hybrid Borings	25 - 60 ft B2005GS (2)	17 – 18	1 grab sample will be collected every 1-ft from 0 - 16 ft B2005GS. Additional sample collected from 16 – 25 ft B2005GS based on elevated radiological response during core scanning. Another sample will be collected from 25 – 60 ft B2005GS from A2-TH-092 from highest radiological response.

Notes:
(1) Perimeter borings in waste will be installed through the total extent of waste and 5-feet into native/in-situ soils. Total depths listed are estimates of waste thicknesses, depths may change based on field observation of waste thickness.
(2) Total depth of perimeter borings is below ground surface (BGS) NOT below 2005 ground surface (B2005GS).

Interior RIM Borings ("SB" prefix)

Borings proposed to delineate RIM within the Area 1 and Area 2 boundaries will be installed to a depth of 20 feet B2005GS. Laboratory analytical samples will be collected with a frequency of one sample per 4-foot core run. for a total of five (5) per boring.

Once the core has been opened and screened with alpha, beta, and gamma detectors (as described in **Section 2.4.1**) a laboratory analytical sample should be collected from the 6-inch interval within the 40,000 – 500,000 cpm gamma range, if applicable. In the event that core readings are outside of this gamma range, a laboratory analytical sample will be collected from the 6-inch interval with the highest observed radiological core scan response, including from alpha, beta, and gamma scanning. If no elevated radiological readings are observed during core scanning a laboratory analytical sample will be collected from the bottom of the soil core. The field team lead will coordinate with the data manager and geostatistician to track samples collected from specified gamma ranges, and will provide guidance in the event that specific sub-sets of the 40,000 – 500,000 cpm should be targeted.

Thorium-driven Borings ("TH" prefix)

Borings proposed for the delineation of RIM in areas where RIM greater than 52.9 pCi/g is expected to be composed of predominantly thorium (as estimated by the geostatistical model and discussed in the DIWP) will be installed to a depth of 20 feet B2005GS, with three exceptions. A2-TH-125, A2-TH-127 and A2-TH-092 will be installed 5 feet into the native material, to depths of approximately 25 feet for A2-TH-125 and A2-TH-127 and 60 feet for A2-TH-092.

Laboratory analytical samples will be collected with a frequency of one sample per 1-foot interval (0zero to 1-foot B2005GS, 1 to 2 feet B2005GS, etc.) to a depth of 16 feet B2005GS. An additional laboratory sample will be collected from the 16- to 20 -feet B2005GS core run from the 6-inch interval exhibiting the highest core scanning response. If there is no elevated radiological core scan response, a sample will be collected from the bottom of the soil core (e.g., 19.5 to 20.0 feet B2005GS). A total of 17 soil samples will be collected and submitted for laboratory analysis from the thorium-driven boring locations.

Perimeter Borings In Waste ("PB" Prefix)

Perimeter borings proposed to delineate the extent of waste extent will be installed through the total depth of waste and 5 feet into native alluvium. Generally these borings will be installed from 0 to 60 feet BGS, except for A1-PB-117 and A1-PB-118 (adjacent to North Quarry) which are expected to be installed to 100 feet BGS. One laboratory sample will be collected from 0 to 1 foot BGS, and two more laboratory samples may be collected from 1 to 60 feet based on elevated alpha, beta, and/or gamma readings during core scanning. If radiological readings are elevated to the point that RIM is suspected to be present, additional samples may be required to characterize and delineate the RIM in that boring, and step-out borings (offset up to 100 feet from the original location) and samples may be required if RIM is identified. In total a minimum of three (3) samples will be collected from perimeter borings in waste.

Perimeter Borings for Geotechnical Investigation ("PB" Prefix)

Borings proposed for the collection of geotechnical data will be installed to 25 feet BGS. Two (2) soil samples will be collected from these borings, one laboratory analytical sample will be collected from 0zero to 1 foot BGS, and a second sample may be collected between 1 and 25 feet BGS based on elevated alpha, beta, and/or gamma core scan readings.

Borings Fulfilling Multiple DIOs

Proposed borings A2-TH-125 and A2-TH-127 are located along the expected RIM boundary of Area 2 and will also fulfill data collection needs associated with perimeter borings. Within these borings laboratory analytical samples will be collected in 1-foot intervals from 0 to 16 feet B2005GS, and an additional laboratory sample may be collected from 16 to 25 feet B2005GS based on elevated alpha, beta, and/or gamma core scan readings. A total of 17 samples will be collected from A2-TH-125 and A2-TH-127.

Proposed boring A2-TH-092 is located along the expected RIM boundary of Area 2 and will fulfill data collection needs associated with perimeter borings. Within this boring laboratory analytical samples will be collected in 1-foot intervals from 0 to 16 feet B2005GS, and two additional laboratory analytical samples may be collected from 16 to 60 feet B2005GS based on elevated alpha, beta, and/or gamma core scan readings. A total of 18 samples will be collected from A2-TH-092.

2.4.3.2 Geotechnical Sample Collection Strategy

Geotechnical samples will be collected from perimeter borings in soil to evaluate areas under consideration for construction of future drainage features as well as from proposed borings installed in waste to evaluate settlement and provide an understanding of behavior characteristics (e.g., moisture content and density). This information may prove useful when planning and implementing the remedial action, specifically for estimating trucking volumes.

A geotechnical sample may be collected from each perimeter boring installed in non-waste areas. See **Table 1** (Area 1) and **Table 2** (Area 2) for boring-specific sampling details. Samples will be submitted for the laboratory analyses listed in **Section 2.4.6.1**.

Up to two geotechnical samples may be collected from each perimeter borings installed in waste areas. See **Table 1** (Area 1) and **Table 2** (Area 2) for boring-specific sampling details. Samples will be submitted for the laboratory analyses listed in **Section 2.4.6.2**.

Up to two geotechnical samples may be collected from waste samples collected for waste disposal characterization. See **Table 1** (Area 1) and **Table 2** (Area 2) for boring-specific sampling details. Samples will be submitted for the laboratory analyses listed in **Section 2.4.6.**

During geotechnical sampling in waste, the sample density will be measured and recorded (see **Section 2.3.3.3**).

2.4.3.3 Equipment and Supplies

- Cooler with ice
- Digital camera or phone/tablet
- Vacuum sealer and vacuum bags
- 1-gallon sealable bags
- Notepad
- Scissors/knife
- Spray bottles with Alconox phosphate-free detergent solution and water
- Gloves
- Permanent marker for labeling
- Tripod and hanging scale
- RKI GX-2009 4-Gas Meter, or equivalent
- Ludlum Measurements, Inc. Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta probe, or equivalent
- Portable ratemeter-scaler: LMI Model 2221, or equivalent
- Sodium iodide (NaI) detector: 2”x 2” Model 44-10, Ludlum Measurements, Inc. or equivalent
- MiniRAE 3000 portable handheld PID, or equivalent, with 10.6 eV lamp

2.4.3.4 Subsurface Sampling Method

1. A core run will be vibrated out of the core barrel into a plastic sleeve. An HPT will scan the sleeve and record gamma activity.
2. The core will be transferred to a central sample processing location, where the sample processing crew will cut open the sleeve and photograph the entire core run. The knife used to cut the sleeve should be washed and rinsed with Alconox, or equivalent, phosphate-free detergent solution and water prior to reuse.
3. The sample processing geologist/engineer will review the core samples and log the cores and the corresponding depths in accordance with **Section 2.4.3**. In addition, cores will be screened with an alpha, beta, and gamma detector and a PID to allow field measurements of radiation and volatile organics concentration of each core. Soils will be described in accordance with the **Section 2.4.1** These screening measurements and soil description information will be recorded on a soil boring log form. An example of the typical soil boring log form is provided in **Attachment 2**.

4. When sampling, the associated interval of sample collected will be identified in the field notes for a given core run and the sample associated with that interval will be sent for analysis at the analytical laboratory. The depth of the sample will be determined by measuring from both the B2005GS and current day (2020) ground surface. Approximate variation between current day and 2005 ground surfaces is included in **Table 5**.
5. The volume of sample, type of sample container, and preservation requirements are provided in the QAPP. Samples will be analyzed via alpha and gamma spectroscopy for radiological constituents and waste acceptance criteria in accordance with the location specific data needs summarized in the DIWP. Laboratory analytical parameters including methods and detection limits are detailed in the QAPP.
6. Field duplicate samples and other laboratory QA/QC samples will be collected at a frequency of 1one for every 20 investigative samples or one sample per sampling event if less than 20 investigative samples are collected.
7. Once the requisite samples are collected and transported to the sample processing location, the driller can proceed with installing PVC or ABS casing for downhole gamma logging.

2.4.4 Sediment Sampling

Sediment samples will be collected from locations in and adjacent to the Northern Surface Water Body and Earth City Flood Control Channel, as shown on **Figure 6,** in order to evaluate the presence of radionuclides above background, if any, in these areas. Sample locations and placement strategy are described in the DIWP. A summary of location-specific data collection needs is included in **Table 6**.

A bathymetric survey of the Northern Surface Water Body (approximately 1 acre in areal extent) will be performed during the design investigation, and will include the surveying of as-built sediment sampling locations.

2.4.4.1 Laboratory Analytical Sample Collection Strategy

Sediment samples from the Northern Surface Water Body and perimeter drainage ditch will be collected from six (6) historically sampled locations (SED4, AC-SED-06, AC-SED-07, AC-SED-08, AC-SED-09, and AC-SED-10) and from five (5) newly proposed locations (NWB-SED-01 through NWB-SED-05). It is anticipated that historically sampled locations will be accessible by foot and will be sampled in a manner consistent with previous investigations, while the newly proposed sediment locations in the Northern Surface Water Body may require access via jon boat. The precise methods of sample collection will depend upon water depth and sediment surface conditions (presence of macrophytes, woody debris, etc.). Proposed collection methods include hand coring, hand augering, and grab sampling via Ponar dredge. The Parsons Field Team Lead will make the final decision regarding sediment sample collection methodology at new locations based on visual inspection of water body conditions and approximate water depth measurements.

Two (2) sediment samples adjacent to the Earth City Flood Control Channel will be collected from historically sampled locations (SEDIMENT-2016-03-16A and SED-11). It is anticipated that these locations will be accessible by foot, and sampled using methods consistent with previous investigation, but the Parsons Field Team Lead will assess site conditions prior to the commencement of sampling. All sampling will be performed safely and in accordance with the PSHEP.

Sediment samples will be measured as below ground surface (BGS) at historical locations, and as measured below sediment surface (BSS) at proposed new locations. Borings installed in the drainage area and Northern Surface Water Body will be proposed to the depth necessary to evaluate the depositional history of these areas and determine an appropriate sediment sampling depth. Sample locations may be shifted based on the results of the bathymetric survey and the identification of prominent erosional/depositional features, as discussed in the DIWP.

A sediment grab sample will be collected from each boring in the 0 to 6-inch interval, and a second grab sample will be collected from 6 to 24-inches, based on elevated radiological response. If elevated radiological responses are observed down to 24-inches a third sample may be collected at the deepest interval exhibiting an elevated response.

Sediment samples will be collected in accordance with the methods described below, and submitted to a laboratory for analysis as per Section 2.4.5.

2.4.4.2 Equipment and Supplies

- Sediment sampler (Lexan core tube, hand auger, Ponar dredge, Ekman dredge, or equivalent)
- Winch (if necessary)
- Boom arm (if necessary)
- PVC pipe greater than 4 inches in diameter
- Core catchers, liner caps, etc.
- Pounding block
- Sledge hammer
- Saw, knife, cutters to open or split core liners
- Sampling vessel or floating platform
- Propulsion method for sampling vessel or floating platform
- Containers, buckets, tubs
- Small trays
- Calibration bucket
- Wash box
- Glaswater
- Log book, indelible pens/markers
- Labels
- Coolers
- Duct table
- Spoons
- Gloves
- Meter wheel/measuring devise (tape measure, yard stick/meter stick)
- Hanna HI9025C portable meter with HI1230 and HI3230 probes, or equivalent
- RKI GX-2009 4-Gas Meter, or equivalent
- Ludlum Measurements, Inc. Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta probe, or equivalent
- Portable ratemeter-scaler: LMI Model 2221, or equivalent
- Sodium iodide (NaI) detector: 2”x 2” Model 44-10, Ludlum Measurements, Inc. or equivalent
- MiniRAE 3000 portable handheld PID, or equivalent, with 10.6 eV lamp

2.4.4.3 Land-Based Sediment Soil Sampling Method

In areas where sediment sampling locations are accessible by foot, the sediment will be loosed to the target depth using a hand auger, Ekman dredge (if applicable), or other digging implement. Large rocks, vegetation, and foreign objects will be removed (these items may also be collected as separate samples, if appropriate). Samples should be collected immediately below any grass or root zones that may be present.

The remaining sediment from each interval will be homogenized in a stainless-steel mixing bowl and distributed to the appropriate sample containers. Subsequent depth intervals will be processed in the same manner for each interval collected. The sample identification, location, and other pertinent data will be recorded on appropriate record forms, maps, drawings, and/or site logbook.

Sampling tools will be cleaned, as necessary, according to the procedure outlined below in **Section 2.8,** and in the QAPP, before proceeding with further sampling.

2.4.4.4 Water-Based Sediment Soil Sampling Method (Hand Coring)

In areas where the total depth of the water body is less than 8 feet, hand coring methods using Lexan may be appropriate for sediment collection. The following procedure should be followed when collecting sediment samples via hand coring methods:

1. Navigate the sampling vessel to the target location; use anchors to maintain vessel position.
2. Position and anchor the vessel perpendicular to the current (if present).
3. Deploy Lexan tube from upriver side of vessel down into sediment.
4. Once the water level has settled, using a permanent marker or ink pen mark the Lexan at water level.
5. Measure 12 inches (desired sample interval) up from the previous mark and make an additional mark. This mark indicates the total depth of the sampling interval.
6. Apply a pounding block to the top of the Lexan and strike repeatedly using a sledge hammer. This can be done relatively gently and care should be taken not to damage or break the top of the Lexan tube.
7. Repeatedly strike the pounding block until the mark indicating the desired sample depth has been driven into the water level.
8. Remove the pounding block and fill the top of the Lexan tube with water, then apply a core liner cap to the top of the Lexan tube. Mark the top of the cap with the sample location, depth interval, and time of collection. Tape the seams cap to create an air-tight seal. This is necessary for creating a vacuum during core removal and maximizing recovery.
9. Once the top of the tube is sealed rock the core side to side and back to forth while attempting to rotate the Lexan tube. This should shear the sediment sample from the surrounding sediment.
10. Slowly raise the Lexan tube until sediment is visible in the bottom of the tube. Once the bottom of the tube is above the water level apply the bottom liner cap, and secure with tape.
11. Once the bottom of the tube has been sealed the excess Lexan may be cut, drained, and removed to allow for easier handling and transportation of the sediment core. The core should be recapped once excess Lexan is removed.
12. The sediment core should be transported to the processing location upright and with care taken to minimize any disturbance/jostling of the sample.
13. Record all required fields in the field database/on applicable sediment sampling forms (**Attachment 11**).

2.4.4.5 Water-Based Sediment Soil Sampling Method (Hand Auger through Casing)

In areas where the total depth of the water body is greater than 8 feet, or if hand coring methods using Lexan are unsuccessful, hand-augering through casing may be appropriate for sediment collection. The following procedure should be followed when collecting samples on the water using hand auger methods:

1. Navigate the sampling vessel to the target location; use anchors to maintain vessel position.
2. Position and anchor the vessel perpendicular to the current (if present).
3. Deploy PVC pipe from up-river side of vessel down into sediment. Prior to sampling, verify that PVC inner diameter is wider than the outer diameter of the hand-auger (generally 4 inches).
4. Using straps and/or clamps secure the PVC pipe to the side of the sampling vessel.
5. If necessary use a saw to cut PVC pipe to one foot above surface of water.

6. Manually advance sections of the hand auger into the PVC pipe until the sediment is encountered.
7. Mark the handle of the hand auger at the mouth of the PVC pipe. Measure 6 inches (0zero to 6-inch sampling interval) up from the first mark using a measuring tape and make a second mark with tape – this shows the depth of the first sampling interval.
8. Rotate the hand auger while applying downward force until the second tape mark is advanced to the mouth of the PVC.
9. Slowly raise the hand auger, disconnecting auger sections as necessary, until the sample is obtained.
10. Place contents of sampler into suitable container. Visually examine the sample to determine whether it is acceptable.
11. Pick large objects such as wood debris, vegetation, and living organisms (clams, etc.) from the sediment and discard.
12. Decontaminate the sampler using an Alconox, or equivalent, phosphate-free detergent wash and rinse until no visible sediment remains on the auger head.
13. Redeploy the hand auger until the second (6-inch) tape mark is flush with the mouth of the PVC pipe. Using a measuring tape, make an third tape mark 6 inches above the second tape mark, this is the second (6 to 12-inch) sampling interval.
14. Rotate the hand auger while applying downward force until the third tape mark is flush with the mouth of the PVC.
15. Slowly raise the hand auger, disconnecting auger sections as necessary, until the 6 to 12 inch sample is obtained.
16. Place contents of sampler into suitable container. Visually examine the sample to determine whether it is acceptable.
17. Pick large objects such as wood debris, vegetation, and living organisms (clams etc.) from the sediment and discard.
18. Measure the pH and ORP of the sediment (if required) by inserting the instrument probe into the soft sediment. Record the readings in a field notebook and in the database after the meter has stabilized.
19. Record all required fields in the field database/on applicable sediment sampling forms (**Attachment 11**).
20. Once required sediment samples have been collected remove clamps/straps fastening the casing to the side of the sampling vessel and removal the PVC casing.
21. Decontaminate the sampler using an Alconox, or equivalent, phosphate-free detergent wash and rinse until no visible sediment remains on the auger head.
22. Transport the samples to the processing areas.

2.4.4.6 Water-Based Sediment Soil Sampling Method (Ponar Dredge)

If the bottom of the water body is relatively free of macrophytes and woody debris a Ponar dredge sampler may be used to secure sediment samples. Ponar dredges are generally used to collect samples from zero to seven inches below the sediment surface but it is possible to collect deeper samples by redeploying the dredge. Samples collected using the Ponar dredge are often significantly disturbed and the associated depth interval of the sample is often unable to be determined. The following procedure should be followed when utilizing a Ponar dredge for grab sample collection:

1. Navigate the sampling vessel to the target location; use anchors to maintain vessel position.
2. Securely attach a decontaminated Ponar dredge sampler to a winch with cable or line of sufficient strength to accommodate the weight of the sampler and sample.
3. Set the mechanism on the sampler so the jaws are held in the open position.
4. Slowly lower the sampler using a winch and boom arm through a moon pool or over the side of the vessel. Maintain tension on the sampler to keep the jaw mechanism from prematurely closing.

5. After the sampler contacts the sediments on the bottom, relax the tension on the sampler to allow the jaw locking mechanism to release.
6. Place tension on the cable/line and slowly lift. This should cause the sampler jaws to close trapping the sample inside.
7. Slowly and steadily retrieve the sampler.
8. Hang the sampler above a pre-cleaned container of suitable size and composition (an inert material that will not interfere with or cause cross contamination).
9. Siphon off free water from the top of the sediment sample in a manner that avoids loss of sediment.
10. Inspect volume of retrieved sediment; should the jaw mechanism become jammed open (i.e., via contact with debris/larger sediment causing it to incompletely close, the volume of retrieved sediment will be significantly less than expected based on the size of the Ponar. In the event that an incomplete sample is retrieved, material will be discarded and the sampling process will be repeated.
11. Once a sufficient volume of sample has been collected, manually homogenize the sediment with a large, long-handled, clean stainless steel spoon. The mixing should be done quickly to minimize oxidation within the sample.
12. Place contents of sampler into suitable container. Visually examine the sample to determine whether it is acceptable.
13. Pick large objects such as wood debris, vegetation, and living organisms (clams etc.) from the sediment and discard.
14. Measure the pH and ORP of the sediment (if required) by inserting the instrument probe into the soft sediment. Record the readings in a field notebook and in the database after the meter has stabilized.
15. Record all required fields in the field database/on applicable sediment sampling forms (**Attachment 11**).
16. Repeat the process until requisite soil volume is collected.
17. Transfer sediments to a sealed designated container and transport the samples to the processing areas.

2.4.5 Laboratory Analytical Constituents

2.4.5.1 Surface Sample Analytical Parameters (Buffer Zone/Lot 2A2)

Surface samples collected from the Buffer Zone and Lot 2A2, as well as the reference areas for the investigation, will be collected in accordance with the methods described in **Section 2.4.2** and submitted to a laboratory for the following analyses, in accordance with the QAPP and Table 1 from the RODA:

Uranium Series	Actinium Series	Thorium Series
Uranium-238	Uranium-235	Thorium-232
Thorium-234	Thorium-231	Radium-224
Proactinium-234	Proactinium-231	Actinium-228
Uranium-234	Actinium-227	Radium-224
Thorium-230	Thorium-227	Lead-212
Radium-226	Radium-223	Bismuth-212
Lead-214	Lead-211	Thallium-208
Bismuth-214	Bismuth-211	Thorium-228

2.4.5.2 Subsurface Sample Analytical Parameters

Subsurface soil samples collected from proposed borings not related to the Buffer Zone and Lot 2A2 investigation will be collected in accordance with the methods described in **Section 2.4.3** and submitted to a laboratory for the following analyses in accordance with the specific test methods outlined in the QAPP:

Radium-226
Radium-228
Thorium-230
Thorium-232

2.4.5.3 Sediment Sample Analytical Parameters

Sediment samples collected from the Northern Surface Water Body and the banks of the Earth City Flood Control Channel will be collected in accordance with the methods described in **Section 2.4.4.** Samples will be submitted to a laboratory for the following analyses in accordance with the specific test methods outlined in the QAPP:

Actinium-228	Lead-214	Thorium-232
Bismuth-214	Radium-226	Uranium-234
Potassium-40	Radium-228	Uranium-235
Proactinium-231	Thorium-234	Uranium-238
Lead-210	Thallium-208	
Lead-212	Thorium-230	

Analytes were selected for consistency with previous investigations, with the addition of Thorium 232.

2.4.6 Geotechnical Sample Constituents

2.4.6.1 Geotechnical Analyses in Non-Waste Areas

Subsurface samples from borings along the perimeter of Area 1 and Area 2 that are not in waste will be collected in accordance with **Section 2.4.3.4** and submitted to a geotechnical laboratory for the following analyses:

Moisture Content – ASTM D2216
Grain-Size (Sieve Analysis) – ASTM D6913
Grain-Size (Hydrometer) – ASTM D7928
Atterberg Limits (if plastic) – ASTM D4318
Organic Content (loss on ignition) (if notable organics) – ASTM D2974 (Method C 440°C)

2.4.6.2 Geotechnical Analyses in Waste Areas

Subsurface samples from waste characterization borings, or from borings along the perimeter of Area 1 and Area 2 that are located within waste, will be collected in accordance with **Section 2.4.3.4** and submitted to a geotechnical laboratory for the following analyses:

Moisture Content – ASTM D2216

Grain-Size (Sieve Analysis) – ASTM D6913
Grain-Size (Hydrometer) – ASTM D7928
Atterberg Limits (if plastic) – ASTM D4318
Organic Content (loss-on-ignition) – ASTM D2974 (Method C 440°C)
Specific Gravity – ASTM D854

2.4.7 Waste Acceptance Criteria

Subsurface samples will be collected from a small subset of proposed borings, as shown on **Table 1** and **Table 2**, for laboratory submission and analysis for the following parameters in accordance with the specific test methods outlined in the QAPP:

Radium-226	pH Screen	TCLP VOCs
Radium-228	Water Reactivity	TCLP SVOCs
Thorium-230 (no progeny)	Flammability Potential	TCLP Pesticides
Lead-210	Cyanide Screen	TCLP Herbicides
Potassium-40	Sulfides Screen	Physical Description
Uranium	TCLP Metals(+Hg)	
Paint Filter	PCBs	

Test parameters for waste acceptance criteria were determined through review of previous investigations. In the event that further parameters are required for waste disposal characterization additional sample volume will be collected from soil archives and submitted for laboratory analysis in accordance with the requests of the waste disposal facility.

2.5 Leachate Monitoring and Evaluation

One of the design investigation objectives is to evaluate liquid levels within the proposed excavation area; therefore, seven standpipe wells will be installed at selected locations, as shown on Figure 15 of the DIWP. These standpipe wells will be used for non-regulatory purposes to evaluate treatability of fluids generated from material excavation during implementation of the RA.

Typical drilling methods used to collect shallow and deeper overburden soils and create boreholes for standpipe wells are discussed in **Section 2.2** of this document. The drilling methods typically allow for the advancement of borings through most soil types including denser soils (e.g., glacial till), and, when coupled with split spoon sampling conducted in accordance with ASTM Method D1586 (or other appropriate methods), provide geotechnical information.

2.5.1 Leachate Standpipe Well Installation

Seven (7) standpipe wells will be installed in areas of the proposed excavation and in the vicinity of previously observed seeps to determine the existence, and if present quantity, of liquid levels within the waste mass.

Subsurface samples will be collected in accordance with Section 2.4.3. Standpipe wells will be constructed of 2-inch diameter threaded PVC screen connected to flush joint PVC casing. The screen will be factory slotted with 0.010-inch openings. The well screen will be 15-17 feet in length and will be set at the top of the waste mass to the extent possible while maintaining 3 – 5 feet of surface seal (bentonite and grout).

The standpipe well will be installed once necessary soil cores, laboratory samples, and field analytical data are collected. The 3-inch PVC or ABS casing used for downhole gamma will be pulled, and the hole will be re-drilled using a sonic drilling rig. Depending on rig availability and sub-surface composition, alternate drilling methods for well installation may be considered (e.g. hollow-stem auger rig).

The standpipe well will be constructed in the following manner: The 2-inch-diameter PVC casing will be installed to a depth of 20 feet B2005GS within a 6-inch minimum borehole. At the termination depth, a 2-inch diameter PVC screen connected to flush joint PVC casing will be installed and a PVC cap will be installed at the bottom. The screen will be factory slotted with 0.010-inch diameter openings. Each standpipe will be properly labeled with an identification (ID) plate, painted ID number and/or ID tag.

A filter pack will be placed around the screened portion of the standpipe well up to a height of at least 1 foot above the screened section of casing. A minimum of 2 feet of bentonite will be placed above the filter pack. If the bentonite seal is placed above the unsaturated zone, approximately 5 to 10 gallons of potable water will be added for hydration purposes. The standpipe well will then be grouted from the land surface to the top of the bentonite seal. Note that since bentonite is expected to exhibit a small degree of natural radioactivity (up to 2x background), bentonite bags will be screened with radiological detectors prior to their inclusion in annular seal/grout mixtures, and the measured responses should be recorded on the well construction logs.

Standpipe well will generally be completed with locking protective covers and concrete pads. However, in locations where site-specific conditions directly related to business activities, such as vehicle traffic, would endanger the physical integrity of the standpipe well, a flush-mounted completion (completed in such a manner to preclude stormwater runoff or surficial contaminants from entering the standpipe well) may be installed. Final installation details will depend upon site conditions, technical requirements and the direction of the onsite geologist.

During drilling, borings will be monitored with a RKI GX-2009 4-gas meter, as well as a Ludlum Measurements, Inc Model 2221 scaler/ratemeter, a and 2" Model 44-10 NaI detector, and MiniRAE 3000 PID equipped with 10.6 eV lamp. These specific instruments, or their approved equivalents, will be used for workspace screening as specified in the PSHEP and RSP. LMWs are expected to be installed in previously analyzed soil borings, however if a new location is chosen it must be logged and sampled in accordance with **Section 2.4.3**. Use and calibration of these devices is detailed in **Section 2.7** of this document. Other monitoring equipment will be used as required in the site-specific PSHEP.

Grout will be allowed to cure for at least 72 hours in standpipe wells prior to development. Standpipe wells will be developed after construction using bailing, pumping, air surging, air-lift pumping, jetting and/or mechanical surge block techniques. Development shall continue until clear, sediment-free water is consistently produced, if possible. Ideally, the standpipe wells should be developed until the turbidity is less than 5 nephelometric turbidity units (NTUs), however since proposed standpipe wells will be installed directly into leachate attaining a turbidity of less than 5 NTUs may not be possible. Development parameter measurements as specified in **Section 2.5.2** will be documented.

After development, new standpipe wells will be accurately land-surveyed for elevation control. Horizontal locations will be determined by direct measurement from physical locations (i.e., benchmarks) at the Site. To reduce the effects of chemical changes caused by formation damage that occurs during drilling operation, standpipe wells will not be sampled until at least 24 hours after installation and development.

2.5.2 Leachate Standpipe Well Development

After installation, standpipe wells will be developed to remove the fine material which may have settled within the filter pack, and to improve/restore hydraulic communication with the surrounding formation. Standpipe well development should be performed or overseen by a field geologist, and in concurrence with the methods described in *ASTM D5521 – Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers*.

- Development will be performed by surging and purging the well, as appropriate, using a submersible pump and surge block. Prior to surging the well will be pumped to observe that the well yields water.
- Water quality parameters will be recorded before, during, and after well development. Parameters will include turbidity, pH, temperature, and specific conductance.
- Total well depth and water depth will be measured before, during, and after development. Depths will be measured to the nearest 0.01 foot prior to development.
- Standpipe wells will be developed until the water quality parameters (pH, temperature, and specific conductivity) stabilize, or until a maximum of 10 borehole volumes of water have been removed. If the standpipe well goes dry during development, it will be allowed to recharge to 80% of initial water level and pumped again. The standpipe well will be considered developed after pumping the well dry three times.
- Well development information will be recorded on a Well Development Log. An example of the Well Development Log is provided as **Attachment 4**.
- Ideally, dedicated and/or disposable equipment will be used for well development. However, if non-dedicated well-development equipment is used, it will be decontaminated after use in accordance with **Section 2.8.**
- Development water will be staged in a tote on site and sampled in accordance with **Section 2.9**.
- Following development, the standpipe wells will be allowed to equilibrate for a minimum of 24 hours prior to groundwater sampling.

2.5.3 Well Decommissioning

Preexisting monitoring wells and proposed standpipe wells that are currently located within Areas 1 and 2 will need to be abandoned prior to RA. Information from this section is modified from *ASTM D5299 – Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and other Devices for Environmental Activities*. Monitoring well abandonment will be performed in accordance with 10 CSR 23-4.080 of the MDNR Monitoring Well Construction Code.

2.5.3.1 Equipment and Supplies

- Drilling rig with hydraulic lift and/or winch
- Portland cement (Type 1)
- Bentonite hole plug
- Tremie pipe (enough length to reach maximum borehole depth)
- Drum or bucket to mix grout
- Cement mixer
- Clean potable water
- Accelerators (calcium chloride) and retarders (sodium chloride) as necessary

2.5.3.2 Field Procedure

1. Monitoring and standpipe wells should be decommissioned once the data collection needs have been fulfilled.
2. Decommissioning work performed at the site should be completed by competently trained and licensed drillers under the direction of a geological or engineering professional who is qualified to certify that the decommissioning is completed according to planned procedures and is consistent with applicable regulations.
3. Remove casing from the ground by either pulling or overdrilling (ASTM D5781, D5782, D5784, D5872, D6167, D6286) using hollow-stem auger or sonic drilling methods.
4. If the casing, filter pack and annular seal materials cannot be removed, it may be necessary to leave the casing in place. The casing left in place may require perforation or puncturing to allow proper placement of sealing materials and eliminate potential flow paths through the annular space (additional discussion in ASTM D5299). Attempts should be made to verify the integrity of grout sealing through depth measurements and volumetric considerations of materials and water used. Once verified that the annular space is sealed, the casing may be cut at the surface.
5. Cuttings extracted during creation of a standpipe well may not be used to backfill the boring regardless of depth due to the various contaminants present at the landfill that may not be detected visually or with the available field screening equipment. Backfilling the borings with cuttings would also create a potential conduit for vertical migration of contamination. Instead, a cement/bentonite grout will be used to backfill the borehole. The grout will be tremied through the auger string as the auger string is removed, or similar state-approved practice. Cuttings that exhibit "gross" contamination, as evidenced by screening measurement (radiological or PID), waste materials, staining, presence of free-phase product, or any visual or olfactory observations will be managed in accordance with **Section 2.9**. Pursuant to 10 CSR 23-4.080: Temporary, temporary monitoring wells 10 feet or greater in depth must be plugged by removing any casing and filling the well from total depth to surface with approved grout (10 CSR 23-04060). This abandonment method will also be applied to the standpipe wells installed for liquid level evaluation.
6. The project geologist will provide final technical direction on abandonment methods.

2.6 Water Sampling and Hydrologic Measurements

It is currently anticipated that groundwater sampling related to the Groundwater Monitoring Plan (GWMP) tasks will be performed by OU-3 contractors, while standpipe wells installed to evaluate leachate, if encountered, will be sampled as a part of the OU-1 design investigation.

2.6.1 Groundwater Sampling

2.6.1.1 Equipment and Supplies

- Clean/new sample bottles and preservatives will be provided by the analytical laboratory
- Dedicated and disposable tubing
- Peristaltic pump and dedicated bladder pump
- Dedicated/disposable bailers
- Nylon rope
- Water level indicator
- Calibrated flow rate measurement device (graduated measuring cup)
- Disposable nitrile gloves and PPE in accordance with the PSHEP
- Decontamination chemicals and supplies
- Dedicated, clean cooler with water ice
- Sample logs
- Tape
- Indelible pen
- Labels and security seals
- Field notes and forms
- Stopwatch, or timekeeping device
- Digital camera
- RKI GX-2009 4-gas meter, or equivalent
- Horiba U-52 multi-parameter water meter (calibrated), or equivalent
- Hach 2100Q handheld portable turbidimeter (calibrated), or equivalent
- MiniRAE 3000 portable handheld PID with 10.6 eV lamp, or equivalent

2.6.1.2 Groundwater Sampling Method

Groundwater samples will be obtained using low-flow groundwater sampling techniques. However, if necessary, conventional well sampling methods (e.g., three well volume purging) may also be used. The collection and disposal of purge water accumulated during sampling will be performed in accordance with the procedures in **Section 2.9**. Field forms for groundwater sampling are included in **Attachment 8.** The standard procedures to be used for obtaining and handling groundwater samples are described below.

1. Chemically inert tubing will be placed into the well water column to the midpoint of the screened interval. This tubing will be connected to flexible chemically inert tubing through the peristaltic pump head.
2. Water will then be removed from the well with the peristaltic pump into a bottom-filling flow-through cell that houses the field parameter probes.
3. The following parameters will be measured every three minutes until stabilization:
    - Elapsed time (minutes)
    - Depth to water (feet)
    - Temperature (°C)

- pH
- Conductivity (millisiemens per centimeter)
- Oxygen Reduction Potential (ORP)
- Dissolved Oxygen (milligrams per liter)
- Turbidity (NTU)
- Flow Rate (milliliters per minute)

4. Field stabilization will be achieved once three successive measurements are observed to be within the following thresholds:
   - Temperature +/- 10%
   - pH +/- 0.1
   - Conductivity +/- 3%
   - ORP +/- 10mV
   - Dissolved Oxygen +/- 10%
   - Turbidity +/- 10%
5. To provide a representative sample, the water intake position at the midpoint of the screened interval will remain constant throughout the sampling process. Sampling flow rate will not exceed purging flow rate.
6. Once field parameter stabilization has been achieved, the sample containers will be filled directly from the pump discharge tubing.
   - It is possible that ORP may not stabilize due to setting within a landfill. The Parsons Field Team Lead will make a judgement-based decision on whether sampling should be completed in the event that ORP does not stabilize. Generally if all other parameters are stable sampling may proceed.
7. If the well becomes dry during purging activities, it will be noted in the logbook, and samples will be collected as quickly as recharge will allow, preferably within the next 24 hours.

Groundwater samples may also be collected using hand-bailing techniques as follows:

1. A disposable bailer will be lowered using new cord/string into the well until the bailer reaches the bottom.
2. The bailer will be allowed to fill and then will be removed from the well and emptied into a waste container.
3. This will be repeated until three well-bore volumes have been purged from the well or until the well is dry. Field parameters will be collected after one half of a well volume has been removed.
4. Sample containers will then be filled directly from the bailer. If the well has been purged dry, it will be allowed to recharge before samples are collected. Wells with a slow recharge will be noted in the log and sampled as quickly as recharge will allow.
5. Regardless of sampling method used, individual sample aliquots will be collected in the following order: volatile organics, semi-volatile organics, and inorganics. The analytical laboratory will supply the necessary sample containers with appropriate preservatives along with shipping containers. Samples will be shipped in coolers packed with wet ice (if necessary) so that temperature preservation requirements are met.
6. Any non-dedicated equipment will be decontaminated prior to use at each location as described in Section 2.8.

2.6.2 Surface Water Sampling

At this time, the Standard Operating Procedure (SOP) for surface water sampling is included for review in case it is necessary in the future. Surface water samples from site drainage areas may be collected during heavy precipitation events where water ponds excessively or originates from on-site seeps, if deemed necessary by the Parsons Project Manager and in discussion with USEPA. Field forms for surface water sampling are included in **Attachment 10**.

2.6.2.1 Equipment and Supplies

- Clean/new sample bottles (and preserved if necessary) will be provided by the analytical laboratory
- Dedicated or decontaminated containers to collect (sample cup) and composite sample water (bucket or large sampling cup)
- Peristaltic pump and inert tubing
- Nitrile gloves and PPE in accordance with the PSHEP
- Water quality meter with probe cage/cover for protection of probes when placing meter probes into a bucket
- Decontamination chemicals and supplies
- Dedicated, clean cooler with water ice
- Sample logs
- Tape
- Indelible pen
- Labels and security seals
- Field notes and forms
- Digital camera

2.6.2.2 Surface Water Sampling Method

Surface water sampling activities near the water source will be performed in a manner to prevent disturbance of sediment, shoreline soil or other variables that could affect water quality of the water being sampled.

- Decontamination of equipment that might contact sampled water will be performed.
- Fill a decontaminated large cup or bucket with surface water using a sample collection cup (or sampling cup on an extension rod).
- Use a sampling cup to fill jars/bottles.
- Water quality measurements will be taken from the water body before sample collection if it can be done without disturbing the water quality. Otherwise, to prevent possible cross-contamination, after water samples are collected into sample containers, water quality measurements can be measured. These measurements can be taken in the water body if it can be done without affecting water quality, or they will be collected on the water remaining in the large cup or bucket after sample collection. The following water quality parameters will be collected during surface water sampling:
  - Temperature (°C)
  - pH
  - Conductivity (ms/cm)
  - Oxygen Reduction Potential (ORP)
  - Dissolved Oxygen (mg/L)
  - Turbidity (NTU)
- All other sampling and sample handling procedures will follow those for Groundwater Sampling in **Section 2.6.1** above.

2.6.3 Leachate Sampling

Leachate samples will be obtained from standpipe wells installed during the design investigation. Sampling techniques will mirror the groundwater sampling procedures (**Section 2.6.1**). Leachate samples will be collected once following standpipe well installation. The standpipe wells will be gauged on a monthly basis to evaluate liquid levels within the proposed excavation. Additional laboratory analytical samples may be collected, as determined in conjunction with USEPA.

2.6.4 Laboratory Analytical Parameters

2.6.4.1 Groundwater Analytical Constituents

Groundwater samples will be collected in accordance with the methods described in **Section 2.6.1.**, and submitted to a laboratory for the following analyses. A description of specific analytes and methods is included in the QAPP. It is anticipated that these will be conducted under OU-3.

Radium-226 (Dissolved and Total)	Ammonia as Nitrogen	Total Dissolved Solids (TDS)
Radium-228 (Dissolved and Total)	Chemical Oxygen Demand (COD)	Sulface
Thorium-228, -230, -232 (Total)	Chloride	Total Organic Carbon (TOC)
Uranium-234, -235, -238 (Total)	Fluoride	Metals
VOCs	Hardness (Total)	Field Parameters (listed in **Section 2.6.1.2**)
SVOCs	Nitrate+Nitrite as Nitrogen	
Alkalinity (Total)	Phosphorus (Total)	

2.6.4.2 Leachate Analytical Constituents

Leachate samples will be collected in accordance with the methods described in **Section 2.6.3** and submitted to a laboratory for the following analyses; specific test methods are discussed in the QAPP. Leachate analytes were selected based on the Bridgeton Landfill Metropolitan St. Louis Sewer District (MSD) permit, based on the Industrial Effluent Guidelines contained in 40 CFR 405 through 40 CFR 471 as well as Toxic and Priority Pollutants under the Clean Water Act listed in 40 CFR 401.14.

Gross Alpha	Uranium-234, -235, -238	Oil Grease
Gross Beta	Total Dissolved Solids	Total Phenol
Gross Gamma (incl. Bi-212 and U-235)	Total Suspended Solids	Iron
Radium-226	Tritium	Manganese
Radium-228	Ammonia	COD
Total Uranium by KPA	BOD	

2.6.5 Hydraulic Conductivity Testing

Standpipe wells installed within the waste extent of Area 1 and Area 2 to evaluate liquid levels within the proposed excavation will be tested to measure hydraulic conductivity and recharge rates in order to approximate the volume of liquid requiring treatment/disposal during the implementation of the remedy. Due to currently unknown liquid volumes, the possibility exists that liquid levels will be sufficiently low such that the performance of these tests are not practical.

2.6.5.1 Equipment and Supplies

- Well gauging and sampling logs
- Project plans
- PPE in accordance with the PSHEP
- Water level probe
- Slug made of inert material
- Pressure transducer(s) and cables
- Rugged reader or laptop
- Rope/bailing twine
- Graduated 5-gallon buckets
- Decontamination supplies
- Plastic sheeting
- Clear tape, duct tape

2.6.5.2 Testing Procedures

These tests involve observing the recovery of liquid levels toward an equilibrium level after an initial perturbation. The perturbation may be either a sudden rise or fall in liquid level. During a slug test an inert rod of known volume will be quickly introduced into the well to cause a liquid level rise. Following equilibration of the liquid level the slug is removed, thereby lowering the liquid level. Procedures and equipment requirements may vary depending on the rate of the liquid level recovery. Each well will be tested in accordance with the following procedures to determine the type of test to be performed:

- If the screened interval of the well straddles the water (leachate) table, only use a rising head test.
- If the screened interval of the well is submerged within the water (leachate), then both a rising head and falling head test will be conducted.
- Record appropriate data on the K-Test Log. An example is provided in Attachment 9.
- Clean the downhole equipment (e.g. pressure transducer, associated cable, bailer/slug, and associated line) following the decontamination procedures provided in Section 2.8 before initiating test(s) at each well.
- Measure and record the static liquid level in the standpipe well. Only standpipe wells which have fully recovered to static level conditions after drilling and development should be tested.
- Connect the pressure transducer to the data logger and lower the transducer into the well to a depth that will not interfere with the insertion of the slug but does not exceed the operating range of the transducer. Secure the position of the transducer by clamping the transducer cable to the well casing using a rubber-covered clamp. If the edges of the well casing are sharp, cover them with cloth or duct tape to protect the transducer cable.
- Quickly create the liquid level perturbation by inserting the slug into the well. While there is no fixed requirement for the magnitude of the change in water level, it is suggested that a minimum of 20% instantaneous hydraulic head differential be created to allow collection of suitable data points.
- If another test is to be performed, allow the well to re-equilibrate prior to performing the next test. Repeat the procedures, change settings as appropriate.

2.7 Field Meter Calibration

The Site Supervisor is responsible for documenting that quality control and the approach to calibrating adhere to the procedures described below. Site workers are responsible for following the procedures. Field measurement equipment will be calibrated according to the manufacturers' recommended guidelines. If a meter exhibits unacceptable error according to manufacturer specifications, it will be recalibrated. If after recalibration, the meter still exhibits unacceptable error, it will be replaced. Field equipment will be supplied and maintained by a manufacturer-approved supplier.

2.7.1 Calibration of Radiological Survey Equipment

Instruments to be used for quantitative measurements shall be calibrated per the Ameriphysics Radiation Control Procedures included in the RSP. Calibration is to be performed with standards traceable to the National Institute of Standards and Technology (NIST) or other industry-recognized standards organizations. The Radiation Control Supervisor is responsible for maintaining, calibrating and performing quality control checks on radiological equipment used in monitoring site conditions, personnel monitoring, and scanning of boreholes and environmental media. Calibration documentation detailing the calibration and maintenance history shall be maintained at the on-site project office.

2.7.2 Calibration of Organic Vapor Monitors

The purpose of this guideline is to provide general standards for the use and calibration of air quality monitoring equipment, designated as organic vapor monitors (OVMs) such as the PID, used to detect and quantify specific organic vapors. These instruments can be used for headspace gas analysis of collected soil samples as well as for site safety.

Proper implementation of these guidelines relies upon the following special considerations, requirements and equipment. The OVMs will be charged nightly prior to field use the next day. Instrument life span between charges is approximately 8 hours. The instruments will be turned off between readings to conserve battery life. Operating instructions issued by the manufacturer will be used, as they are regularly updated.

The field instrument will be calibrated daily in accordance with the manufacturers operating instructions and procedures, which will be provided on site with the instrument. Organic vapor monitors should be calibrated using a two-point calibration system consisting of both zero and span gasses, and will then be compared to an ambient air baseline. Instrument calibration readings will be recorded in field notes an on a record of calibration. Calibration documentation will be maintained in an on-site project office.

2.7.3 Calibration of Water Quality Meter

The purpose of this guideline is to provide general standards for the use and calibration of the water quality meter, which is used to take field measurements of turbidity, dissolved oxygen (DO), pH, specific conductivity, oxidation-reduction potential (ORP), and temperature.

Proper implementation of these guidelines relies upon the following special considerations, requirements and equipment. Operating instructions and procedures issued and updated by the manufacturer will be used for field calibration and will be provided with the instruments. Instrument sensors (except temperature) will be calibrated daily and recorded in field notes. Calibrated parameters should read within the manufactures specification. If calibrated values do not fall within the manufacturer-specified threshold troubleshooting will be performed as outlined in the equipment manual or the equipment will be replaced. Calibration documentation detailing the calibration and maintenance history will be maintained at the on-site project office.

Prior to calibration, instrument probes should be cleaned and decontaminated in accordance with **Section 2.8** below.

2.8 Decontamination

To prevent cross-contamination of the sample locations, field instruments to be re-used (electronic water level indicator, submersible pump, slug, etc.) will be thoroughly decontaminated after use at each location. Drilling equipment (i.e., hollow stem augers, sonic drill rods) will be decontaminated by steam cleaning and/or pressure washing after use at each sample location. Decontamination activities will be performed over a temporary pad for rinse water collection. Rinse water from the decontamination activities will be collected, drained into drums, and labeled for appropriate waste management.

Field instruments will be decontaminated in the following manner:

1. Tap water rinse
2. Scrub with tap water containing non-phosphate detergent (i.e. Alconox)
3. Tap water rinse
4. De-ionized water rinse (for in-situ monitoring equipment)
5. Air dry

Disposable equipment (e.g., bailers, tubing, and soil sampler liners) will not be reused.

The potential to spread contamination will be mitigated by establishing readily identifiable areas around activities having the potential to encounter radiological materials. Access to these areas will be controlled and limited to properly trained individuals who have read, understood, and signed the daily Radiation Work Permit governing activities in an area or areas. Equipment and personnel leaving these Permitted Areas will be surveyed as described below. If contamination is identified, the contamination will be removed by decontamination and the equipment rechecked. This is an iterative process that will continue until equipment and personnel meet exit criteria as established in the RSP.

2.8.1 Radiological Surveys

Surveys will be used to monitor and control exposures and the potential spread of contamination. The following subsections describe the surveys to be used and their requirements.

2.8.1.1 Baseline Entry Survey – Equipment

Vehicles and large equipment entering OU-1 for the Design Investigation will be surveyed by the HPT for fixed alpha and beta contamination before their initial entrance into OU-1. The survey will be conducted using a Ludlum Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta detector probe (or equivalent), as described in the RSP.

2.8.1.2 Permitted Area Exit Survey - Personnel

Personnel exiting a Permitted Area will have soles of their boots and clothing scanned upon leaving the area, as described Section 5.2 of the RSP.

2.8.1.3 Permitted Area Exit Survey - Equipment

Heavy equipment working inside a Permitted Area will be surveyed by the Radiological Control Technician (RCT) before leaving the area, and will include a scan of vehicle tires. Surfaces in contact with soil will be scanned for alpha and beta-gamma surface activity with a Ludlum Model 12 survey meter coupled to a Model 44-9 alpha/beta/gamma pancake detector (or equivalent) as described in Section 5.2 of the RSP.

Sections of the downhole drilling equipment will be sampled with a swipe between sampling locations to detect removable activity on the surface of the tool string. The swipe samples will be screened in the field with a Ludlum Model 12 survey meter coupled to a Model 43-5 alpha detector, or equivalent. Alpha and beta activity on the smear will be measured using a Ludlum Model 2929 scaler coupled to a Ludlum Model 43-10-1 alpha/beta counter or a low-background alpha/beta counter such as an XLB-5 before the equipment may leave the permitted area.

2.8.1.4 Final Release Survey - Equipment

Equipment working inside a Permitted Area and equipment that might inadvertently contact RIM outside a cleared easement will be surveyed by the HPT before leaving OU-1. Surfaces in contact with soil will be scanned for alpha and beta contamination with a Ludlum Model 2360 scaler/ratemeter coupled with a Model 43-93 probe (or equivalent) as described in the RSP.

Sampling for removable contamination will be performed by swiping 100-square-centimeter areas on parts of the equipment that were in contact with soil surfaces as described in Section 5.2 of the RSP. These smear samples will be counted with a Ludlum Model 2929 scaler coupled to a Ludlum 43-10-1 detector.

If contamination is found, the vehicle will be decontaminated until it meets final release standards listed in Table 3 of the RSP (*Acceptable Surface Contamination Levels for Uncontrolled Release of Equipment*). The equipment identification and the final results will be recorded on the appropriate equipment release form and the equipment will be unconditionally released from OU-1.

2.8.2 Equipment Decontamination

All equipment (including but not limited to the drill rig) will be surveyed. If radioactive contamination is detected, the equipment will be decontaminated. A phased approach to decontamination will be employed to minimize the generation of solid waste and wastewater.

2.8.2.1 Dry Decontamination

It is expected that contamination will be associated with loose, removable dirt and mud that may attach to equipment surfaces during operations. If contamination is detected on equipment after operations are completed in a boring location, the equipment will be decontaminated before moving from one radiological area to the other. Visual patches of dirt and mud will be removed from the contaminated surfaces of the equipment using damp wipes, brushes, and scrapers. Used decontamination supplies will be placed in marked containers or bags. The remainder of material removed during dry decontamination will be placed in a separate container with hard plastic or metal sides and staged for retrieval and sampling. Solid radioactive waste generated will be packaged and characterized for handling as discussed in the Loading, Transportation, and Off-site Disposal Plan (LTODP).

2.8.2.2 Wet Decontamination of Equipment

If dry decontamination is not sufficient to meet release levels, the equipment will be moved to the radiological decontamination pad. Contaminated surfaces will be scrubbed with brushes and soapy water until they are visually clean. The equipment will be surveyed again for both alpha and beta surface activity. If fixed or removable activity exceeding the release limits is found, the contaminated surface will be decontaminated using more aggressive methods such as pressure washing or abrasive blasting until the release criteria are met.

2.8.2.3 Waste/Water Management

Water used to decontaminate equipment will be placed in marked holding tanks and/or drums, sampled, and packaged and shipped to a licensed, managed disposal site. Decontamination water will be evaluated for off-site disposal. If the gross alpha results are greater than 15 pCi/L, then the sample(s) will be analyzed further for Radium-226 and isotopic thorium. Analytical methods and minimum detectable amounts (MDAs) are included in the QAPP. Additional analyses may be performed in accordance with the off-site disposal facility's requirements.

Any solid radioactive waste generated will be collected, sampled, and stored on site until the implementation of the remedy where it will be assessed for disposal.

2.8.2.4 Final Housekeeping Wash-down

Any equipment released from OU-1 will be washed with water to remove visible dirt from its surfaces prior to its removal from the Site. This final housekeeping can be performed in an uncontrolled area and any water generated from this final cleaning of previously released equipment will be considered unimpacted.

2.9 Management of Investigation-Derived Waste

Field activities may generate waste materials that will require management. This section describes management procedures for investigation-derived waste (IDW).

Generally waste will be managed in a manner consistent with historical site operations as described in the *Revised Work Plan for Additional Characterization of Extent of Radiologically-Impacted Material in Areas 1 and 2* (EMSI 2015) for solids and consistent with the *Core Sampling (Phase 1B, 1C, and 2) Work Plan-Revision 1* (FEI 2014) for liquids.

Evaluation of site-derived waste management procedures will be ongoing, in particular with regard to potential waste generated during hollow-stem auger drilling operations in areas where RIM may be present. Soils will be archived throughout the design investigation and finalization of the design, in the event that additional samples are required. Following the completion of the design the soil archives will be disposed of during the implementation of the RA. It is expected that material greater than 52.9 pCi/g will be disposed of offsite, while material less than 52.9 pCi/g will be used as fill material in accordance with the RODA.

Purge water from standpipe well development and leachate sampling will be handled consistent with Section 2.8.2.3.

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3.0 SAMPLE MANAGEMENT

3.1 Field Sampling Records

Information will be recorded in field notebooks to document the procedures used and the prevailing conditions during the field investigation. Previous field records will be reviewed at each Site visit, and any unusual site conditions encountered during the field investigation will be described. Field documentation of activities will be comprehensively recorded. For example, when sampling is conducted, the following types of information will be recorded:

- Name of sampler
- Purpose of sampling
- Date and time of sampling
- Sample type
- Sampling location description and/or grid coordinates (including photographs, if needed)
- Sampling method, sample containers, and preservatives used
- Sample weight or volume (if applicable)
- Number of samples taken
- Unique sample identification number (Location ID on Tables 1 through 3)
- Amount of water purged (for groundwater sampling)
- Field observations (prevailing weather conditions and other relevant factors that might influence sample integrity)
- Field measurements conducted
- Name/initials of person responsible for observation

The sample nomenclature system for the Site was developed in the DMP to provide consistency in field sample ID. Three identification labels will be associated with field samples:

- Chain of Custody (COC) Number (#)
- Location ID
- Field Sample ID

3.1.1 COC

The COC # is a numeric designation that will be assigned by the Data Manager (DM) and provided to field team in advance of field operations

3.1.2 Location ID

The Location ID represents the physical location where samples are collected, and are shown on **Figure 1, Figure 2**, **Figure 4, Figure 5,** and **Figure 6**; as well as listed in **Table 1**, **Table 2**, and **Table 3, Table 4,** and **Table 6**. Each unique field sample will be associated with a Location ID and identified on the COC form at the time of sample collection. The Location ID consists of a description of the area (Area ID), the sample location type (such as well or boring), and a three-digit sample location number:

A # - * * # # #

Area ID - Location type Location number

For Buffer Zone and Lot 2A2 locations, instead of an Area ID, a survey unit number will be assigned (1,2,3 etc.).

For groundwater locations, an aquifer code (A for Alluvial, S for St Louis Bedrock) and an "S" (for shallow), an "I" (for intermediate), or a "D" (for deep) will be added to the end of the Location ID.

A # - * * # # # - * *

Area ID - Location type Location number - Aquifer Code

For example: An alluvial shallow well located on A1 = A1-MW001-AS. A soil boring located on A1 = A1-SB014. A list of valid Area IDs, Location Types, and Location Numbers will be available to the field team from the DM.

3.1.3 Field Sample ID

The Field Sample ID is the unique label assigned to each individual sample. For groundwater samples, the Field Sample ID will consist of the Location ID, 6 digit date (MMDDYY), and an N or D added to the end for normal or field dup sample.

A # - * * # # # - * * - M M D D Y Y *

Location ID- Date sample type

For soil samples, the Field Sample ID will consist of the Location ID, sample depth interval (d1-d2) and an N or D added to the end for normal or field dup sample.

A # - * * # # # - d 1 - d 2 *

Location ID- Depth sample type

For blanks, the Field Sample ID will consist of the sample type (TB, EB, FB), 6 digit date, and a cooler number. For example, a trip blank collected on 02/26/2020 for cooler 1 would be TB-022620-1.

Upon collection of the sample(s), a field team member will affix an identification label to the sample container(s). A label provided by the laboratory may be used or any other label that includes the information provided herein.

For groundwater samples, nomenclature will be modified to be consistent with the format used by OU-3.

3.2 Sample Handling

Samples will be collected into the laboratory-supplied pre-preserved sample containers. Each individual sample container will be sealed according to laboratory specifications after sampling. Clean, disposable nitrile gloves will be worn during the handling of all samples and sampling devices.

3.2.1 Preservation of Samples

Each containerized sample will be labeled and placed as soon as possible into an insulated sample cooler. The cooler will serve as a shipping container and should be provided by the laboratory along with the appropriate sample containers. Wet ice will be placed directly in contact with the sample containers within a heavy-duty polyethylene bag. Samples will be maintained at a cool temperature (optimum 4°C ± 2°C) from the time of collection until the coolers arrive at the laboratory (if required). Plastic “bubble wrap” and/or polystyrene foam will be used to protect glass sample jars during shipping.

3.2.2 Field Custody Procedures

The custody of samples collected during the field investigation will be traceable at all times. Prior to shipment of the samples to the laboratory, a COC form will be completed by the field sample custodian. Sample locations, sample identification numbers, description of samples, number of samples collected, and specific laboratory analyses to be run on each sample will be recorded on the sample COC form. The field sample custodian will sign and date the sample COC form and will retain a copy for the project records (if available). The sample COC form will record possession of the samples from the time of collection until disposing or archiving the sample. A sample is considered under custody if:

- It is in the investigator’s possession.
- It is in the investigator’s view after possession has been established.
- The investigator locks up the sample after possession.
- It is in a designated secure area.

The sample COC must be maintained at all times prior to analysis.

Prior to shipment by a registered courier, the sample shipping container (cooler, box, etc.) will be sealed with signed sample COC inside. The authorized laboratory custodian that receives the samples will sign the sample COC forms, thus terminating custody of the field sample custodian.

3.2.3 Sample Shipment Preparation

3.2.3.1 Required Paperwork

Packaging samples containing potentially radioactive materials always requires the following components, as per the Nuclear Regulatory Commission (NRC):

- UN Identification number (generally UN2910)
- Proper shipping name
- Hazard Class (Class 7 for radioactive material)
- Total activity contained in each package
    - If unknown, refer to U.S. Department of Transportation (DOT) guidance 49 CFR 172, or summarized “… a material for which the hazard class is uncertain and must be determined by testing may be assigned a tentative proper shipping name, hazard class, identification number, and packing group, if applicable, based on the shipper’s tentative determination according to the defining criteria contained in 49 CFR and the shippers knowledge of the material.”
- Number and type of packages

3.2.3.2 Shipping Preparation Procedure

Based on historical investigations it is expected that all coolers will be below 500 microroentgen (μR) per hour. If a cooler has an exposure level greater than 500 μR/hr the site HPT and Parsons Field Team Lead will be contacted. Generally, splitting the shipment into multiple coolers will sufficiently decrease the exposure levels.

The following process will be followed for preparing samples for transportation:

1. Samples will be placed inside a lined sturdy container, typically a standard cooler.

2. The outside of the container will be scanned with a Ludlum Model 19 miroR exposure meter. At the area of maximum response, the detector will be held 30 centimeters (11.8 inches) from the container, and the maximum exposure level will be recorded on the sample COC.
3. This measurement will be compared to exposure rate action levels in the RSP, generally 500 µR/hr.
4. The cooler lining will be marked with the UN identification number UN2910 using a black marker, and a “radioactive” label will be placed above cooler contents.
5. The cooler will be packed such that samples are secure and immobilized to the extent practicable, and adequate absorbent material used to soak up liquid samples in the event a sample container/jar breaks.
6. The inner liner will be sealed.
7. The signed COC will be placed in a sealable plastic bag and then placed inside the cooler, and the cooler will be sealed.

3.2.4 Laboratory Custody Procedures

Sample custody at the analytical laboratory is maintained through systematic sample control procedures composed of the following items:

- Sample receipt
- Sample log-in
- Sample storage
- Sample archival/disposal

As samples are received by the laboratory, they will be entered into a sample management system. The following minimum information will be provided:

- Laboratory sample number/identification
- Field sample designation
- List of analyses requested for each sample container

Immediately after receipt, samples will be transferred to a secure storage area with appropriate temperature control to await preparation and analysis. The laboratory’s COC procedures are documented in the laboratory’s quality assurance plan, which will be provided upon request.

3.2.5 Quality Control Checks

Equipment blanks, method/preparation blanks, field duplicates, matrix spike/matrix spike duplicates (MS/MSD)/replicate (REP) samples, and laboratory control samples (LCS) will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. The QAPP dictates the frequency of duplicate and blank collection.

Field QA/QC samples are handled, transported, and analyzed in the same manner as the actual field samples. If possible, the QA/QC samples should not be held on site for more than four calendar days. If sample preservation includes cooling, the temperature of the blanks, except the trip blanks, must be maintained at 4°C while on site and during shipment. The trip blank is not shipped to the Site on ice but must be maintained at 4°C when accompanying collected samples requiring cooling. Holding times for individual parameters are dictated by the specific analytical method used.

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TABLES

Table 1
Area 1 Sample Collection Detail

Area	Location ID	General RIM Borings	Thorium - Driven Borings	Perimeter Borings Waste	Perimeter Borings Geotechnical	Waste Characterization Samples	Estimated Total Boring Depth (feet B2005GS)	Total Laboratory Analytical Samples	Total Geotechnical Samples	Core Scan Interval (feet B2005GS)	Downhole Gamma Interval (feet B2005GS)
1	A1-SB052	X					20	5	0	0 - 20	0 - 20
1	A1-SB053	X					20	5	0	0 - 20	0 - 20
1	A1-SB054	X					20	5	0	0 - 20	0 - 20
1	A1-SB055	X					20	5	0	0 - 20	0 - 20
1	A1-SB056	X					20	5	0	0 - 20	0 - 20
1	A1-SB057	X					20	5	0	0 - 20	0 - 20
1	A1-SB058	X					20	5	0	0 - 20	0 - 20
1	A1-SB059	X				X	20	6	0	0 - 20	0 - 20
1	A1-SB060	X					20	5	0	0 - 20	0 - 20
1	A1-SB061	X					20	5	0	0 - 20	0 - 20
1	A1-SB062	X					20	5	0	0 - 20	0 - 20
1	A1-SB063	X					20	5	0	0 - 20	0 - 20
1	A1-SB064	X					20	5	0	0 - 20	0 - 20
1	A1-SB065	X					20	5	0	0 - 20	0 - 20
1	A1-SB066	X					20	5	0	0 - 20	0 - 20
1	A1-SB067	X					20	5	0	0 - 20	0 - 20
1	A1-SB068	X					20	5	0	0 - 20	0 - 20
1	A1-SB068-DUP	X					20	5	0	0 - 20	0 - 20
1	A1-SB069	X					20	5	0	0 - 20	0 - 20
1	A1-SB070	X				X	20	6	2	0 - 20	0 - 20
1	A1-SB070-DUP	X					20	6	2	0 - 20	0 - 20
1	A1-SB071	X					20	5	0	0 - 20	0 - 20
1	A1-SB072	X					20	5	0	0 - 20	0 - 20
1	A1-SB073	X					20	5	0	0 - 20	0 - 20
1	A1-SB074	X					20	5	0	0 - 20	0 - 20
1	A1-SB075	X					20	5	0	0 - 20	0 - 20
1	A1-SB076	X					20	5	0	0 - 20	0 - 20
1	A1-TH081		X				20	17	0	0 - 20	0 - 20
1	A1-TH082		X				20	17	0	0 - 20	0 - 20
1	A1-SB083	X					20	5	0	0 - 20	0 - 20
1	A1-TH084		X				20	17	0	0 - 20	0 - 20
1	A1-TH085		X				20	17	0	0 - 20	0 - 20
1	A1-TH086		X				20	17	0	0 - 20	0 - 20
1	A1-TH087		X				20	17	0	0 - 20	0 - 20
1	A1-TH088		X				20	17	0	0 - 20	0 - 20
1	A1-TH089		X				20	17	0	0 - 20	0 - 20
1	A1-TH090		X				20	17	0	0 - 20	0 - 20
1	A1-SB128	X					20	5	0	0 - 20	0 - 20
1	A1-SB129	X					20	5	0	0 - 20	0 - 20
1	A1-SB141	X					20	5	0	0 - 20	0 - 20
1	A1-SB142	X					20	5	0	0 - 20	0 - 20
1	A1-SB143	X					20	5	0	0 - 20	0 - 20
1	A1-SB144	X					20	5	0	0 - 20	0 - 20
1	A1-SB145	X					20	5	0	0 - 20	0 - 20
1	A1-PB-101				X		25	2	1	0 - 25	0 - 25
1	A1-PB-102				X		25	2	1	0 - 25	0 - 25
1	A1-PB-103				X		25	2	1	0 - 25	0 - 25
1	A1-PB-104				X		25	2	1	0 - 25	0 - 25
1	A1-PB-105				X		25	2	1	0 - 25	0 - 25
1	A1-PB-106				X		25	2	1	0 - 25	0 - 25
1	A1-PB-107				X		25	2	1	0 - 25	0 - 25
1	A1-PB-108				X		25	2	1	0 - 25	0 - 25
1	A1-PB-109				X		25	2	1	0 - 25	0 - 25
1	A1-PB-110				X		25	2	1	0 - 25	0 - 25
1	A1-PB-111				X		25	2	1	0 - 25	0 - 25

Table 1

Area 1 Sample Collection Detail

Area	Location ID	General RIM Borings	Thorium - Driven Borings	Perimeter Borings Waste	Perimeter Borings Geotechnical	Waste Characterization Samples	Estimated Total Boring Depth (feet B2005GS)	Total Laboratory Analytical Samples	Total Geotechnical Samples	Core Scan Interval (feet B2005GS)	Downhole Gamma Interval (feet B2005GS)
1	A1-PB-112				X		25	2	1	0 - 25	0 - 25
1	A1-PB-113				X		25	2	1	0 - 25	0 - 25
1	A1-PB-114				X		25	2	1	0 - 25	0 - 25
1	A1-PB-115				X		25	2	1	0 - 25	0 - 25
1	A1-PB-116				X		25	2	1	0 - 25	0 - 25
1	A1-PB-117			X			100*	3	2	0 - 100	0 - 100
1	A1-PB-118			X			100*	3	2	0 - 100	0 - 100
TOTAL BORING/ SAMPLE COUNT	**62**	**35**	**9**	**2**	**16**	**2**	**-**	**369**	**24**	**-**	**-**

Note: Total depth of perimeter borings proposed within waste will ultimately be determined in the field based on observations of waste thickness. Borings will be installed through the full extent of waste and 5-feet into native soils

Table 2
Area 2 Sample Collection Detail

Area	Location ID	General RIM Borings	Thorium - Driven Borings	Perimeter Borings Waste	Perimeter Borings Geotechnical	Waste Characterization Samples	Estimated Total Boring Depth (feet B2005GS)	Total Laboratory Analytical Samples	Total Geotechnical Samples	Core Scan Interval (feet B2005GS)	Downhole Gamma Interval (feet B2005GS)
2	A2-SB001	X					20	5	0	0 - 20	0 - 20
2	A2-SB002	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB003	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB003-DUP	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB004	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB005	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB005-DUP	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB006	X					20	5	0	0 - 20	0 - 20
2	A2-SB007	X					20	5	0	0 - 20	0 - 20
2	A2-SB008	X					20	5	0	0 - 20	0 - 20
2	A2-SB009	X					20	5	0	0 - 20	0 - 20
2	A2-SB010	X					20	5	0	0 - 20	0 - 20
2	A2-SB011	X					20	5	0	0 - 20	0 - 20
2	A2-SB012	X					20	5	0	0 - 20	0 - 20
2	A2-SB013	X					20	5	0	0 - 20	0 - 20
2	A2-SB014	X					20	5	0	0 - 20	0 - 20
2	A2-SB015	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB016	X					20	5	0	0 - 20	0 - 20
2	A2-SB017	X					20	5	0	0 - 20	0 - 20
2	A2-SB018	X					20	5	0	0 - 20	0 - 20
2	A2-SB019	X					20	5	0	0 - 20	0 - 20
2	A2-SB020	X					20	5	0	0 - 20	0 - 20
2	A2-SB021	X					20	5	0	0 - 20	0 - 20
2	A2-SB022	X					20	5	0	0 - 20	0 - 20
2	A2-SB023	X					20	5	0	0 - 20	0 - 20
2	A2-SB024	X					20	5	0	0 - 20	0 - 20
2	A2-SB025	X					20	5	0	0 - 20	0 - 20
2	A2-SB026	X					20	5	0	0 - 20	0 - 20
2	A2-SB027	X					20	5	0	0 - 20	0 - 20
2	A2-SB028	X					20	5	0	0 - 20	0 - 20
2	A2-SB029	X					20	5	0	0 - 20	0 - 20
2	A2-SB030	X					20	5	0	0 - 20	0 - 20
2	A2-SB031	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB032	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB033	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB034	X					20	5	0	0 - 20	0 - 20
2	A2-SB035	X					20	5	0	0 - 20	0 - 20
2	A2-SB036	X					20	5	0	0 - 20	0 - 20
2	A2-SB037	X					20	5	0	0 - 20	0 - 20
2	A2-SB038	X					20	5	0	0 - 20	0 - 20
2	A2-SB039	X					20	5	0	0 - 20	0 - 20
2	A2-SB040	X					20	5	0	0 - 20	0 - 20
2	A2-SB041	X					20	5	0	0 - 20	0 - 20
2	A2-SB042	X					20	5	0	0 - 20	0 - 20
2	A2-SB043	X					20	5	0	0 - 20	0 - 20
2	A2-SB044	X					20	5	0	0 - 20	0 - 20
2	A2-SB045	X					20	5	0	0 - 20	0 - 20
2	A2-SB046	X					20	5	0	0 - 20	0 - 20
2	A2-SB047	X					20	5	0	0 - 20	0 - 20
2	A2-SB048	X					20	5	0	0 - 20	0 - 20
2	A2-SB049	X					20	5	0	0 - 20	0 - 20
2	A2-SB050	X					20	5	0	0 - 20	0 - 20
2	A2-SB051	X				X	20	6	0	0 - 20	0 - 20
2	A2-SB077	X					20	5	0	0 - 20	0 - 20
2	A2-SB078	X					20	5	0	0 - 20	0 - 20

Table 2
Area 2 Sample Collection Detail

Area	Location ID	General RIM Borings	Thorium - Driven Borings	Perimeter Borings Waste	Perimeter Borings Geotechnical	Waste Characterization Samples	Estimated Total Boring Depth (feet B2005GS)	Total Laboratory Analytical Samples	Total Geotechnical Samples	Core Scan Interval (feet B2005GS)	Downhole Gamma Interval (feet B2005GS)
2	A2-SB079	X					20	5	0	0 - 20	0 - 20
2	A2-SB080	X					20	5	0	0 - 20	0 - 20
2	A2-TH091		X				20	17	0	0 - 20	0 - 20
2	A2-TH092		X	X			20	17	2	0 - 20	0 - 20
2	A2-SB093	X					20	5	0	0 - 20	0 - 20
2	A2-TH094		X				20	17	0	0 - 20	0 - 20
2	A2-TH095		X				20	17	0	0 - 20	0 - 20
2	A2-TH096		X				20	17	0	0 - 20	0 - 20
2	A2-TH097		X				20	17	0	0 - 20	0 - 20
2	A2-TH098		X				20	17	0	0 - 20	0 - 20
2	A2-TH099		X				20	17	0	0 - 20	0 - 20
2	A2-TH100		X				20	17	0	0 - 20	0 - 20
2	A2-TH101		X				20	17	0	0 - 20	0 - 20
2	A2-TH102		X				20	17	0	0 - 20	0 - 20
2	A2-SB103	X					20	5	0	0 - 20	0 - 20
2	A2-TH104		X				20	17	0	0 - 20	0 - 20
2	A2-TH105		X				20	17	0	0 - 20	0 - 20
2	A2-TH106		X				20	17	0	0 - 20	0 - 20
2	A2-TH107		X				20	17	0	0 - 20	0 - 20
2	A2-TH108		X				20	17	0	0 - 20	0 - 20
2	A2-TH109		X				20	17	0	0 - 20	0 - 20
2	A2-TH110		X				20	17	0	0 - 20	0 - 20
2	A2-TH111		X				20	17	0	0 - 20	0 - 20
2	A2-TH112		X				20	17	0	0 - 20	0 - 20
2	A2-TH113		X				20	17	0	0 - 20	0 - 20
2	A2-TH114		X				20	17	0	0 - 20	0 - 20
2	A2-TH115		X				20	17	0	0 - 20	0 - 20
2	A2-TH116		X				20	17	0	0 - 20	0 - 20
2	A2-TH117		X				20	17	0	0 - 20	0 - 20
2	A2-TH118		X				20	17	0	0 - 20	0 - 20
2	A2-TH119		X				20	17	0	0 - 20	0 - 20
2	A2-TH120		X				20	17	0	0 - 20	0 - 20
2	A2-TH121		X				20	17	0	0 - 20	0 - 20
2	A2-TH122		X				20	17	0	0 - 20	0 - 20
2	A2-TH123		X				20	17	0	0 - 20	0 - 20
2	A2-TH124		X				20	17	0	0 - 20	0 - 20
2	A2-TH125		X	X			25	17	2	0 - 20	0 - 20
2	A2-TH126		X				20	17	0	0 - 20	0 - 20
2	A2-TH127		X	X			25	17	2	0 - 20	0 - 20
2	A2-SB130	X					20	5	0	0 - 20	0 - 20
2	A2-SB131	X					20	5	0	0 - 20	0 - 20
2	A2-SB132	X					20	5	0	0 - 20	0 - 20
2	A2-SB133	X					20	5	0	0 - 20	0 - 20
2	A2-SB134	X					20	5	0	0 - 20	0 - 20
2	A2-SB135	X					20	5	0	0 - 20	0 - 20
2	A2-SB136	X					20	5	0	0 - 20	0 - 20
2	A2-SB137	X					20	5	0	0 - 20	0 - 20
2	A2-SB138	X					20	5	0	0 - 20	0 - 20
2	A2-SB139	X					20	5	0	0 - 20	0 - 20
2	A2-SB140	X					20	5	0	0 - 20	0 - 20
2	A2-SB146	X					20	5	0	0 - 20	0 - 20
2	A2-PB-119				X		25	2	1	0 - 25	0 - 25
2	A2-PB-120				X		25	2	1	0 - 25	0 - 25
2	A2-PB-121				X		25	2	1	0 - 25	0 - 25
2	A2-PB-122				X		25	2	1	0 - 25	0 - 25

Table 2
Area 2 Sample Collection Detail

Area	Location ID	General RIM Borings	Thorium - Driven Borings	Perimeter Borings Waste	Perimeter Borings Geotechnical	Waste Characterization Samples	Estimated Total Boring Depth (feet B2005GS)	Total Laboratory Analytical Samples	Total Geotechnical Samples	Core Scan Interval (feet B2005GS)	Downhole Gamma Interval (feet B2005GS)
2	A2-PB-123				X		25	2	1	0 - 25	0 - 25
2	A2-PB-124				X		25	2	1	0 - 25	0 - 25
2	A2-PB-125				X		25	2	1	0 - 25	0 - 25
2	A2-PB-126				X		25	2	1	0 - 25	0 - 25
2	A2-PB-127				X		25	2	1	0 - 25	0 - 25
2	A2-PB-128				X		25	2	1	0 - 25	0 - 25
2	A2-PB-129				X		25	2	1	0 - 25	0 - 25
2	A2-PB-130				X		25	2	1	0 - 25	0 - 25
2	A2-PB-131				X		25	2	1	0 - 25	0 - 25
2	A2-PB-132				X		25	2	1	0 - 25	0 - 25
2	A2-PB-133				X		25	2	1	0 - 25	0 - 25
2	A2-PB-134			X			25	2	2	0 - 25	0 - 25
2	A2-PB-135				X		25	2	1	0 - 25	0 - 25
2	A2-PB-136				X		25	2	1	0 - 25	0 - 25
2	A2-PB-137				X		25	2	1	0 - 25	0 - 25
2	A2-PB-138				X		25	2	1	0 - 25	0 - 25
2	A2-PB-139			X			60	3	2	0 - 60	0 - 60
2	A2-PB-140			X			60	3	2	0 - 60	0 - 60
2	A2-PB-141			X			60	3	2	0 - 60	0 - 60
2	A2-PB-142			X			60	3	2	0 - 60	0 - 60
2	A2-PB-143			X			60	3	2	0 - 60	0 - 60
2	A2-PB-144			X			60	3	2	0 - 60	0 - 60
2	A2-PB-145			X			60	3	2	0 - 60	0 - 60
2	A2-PB-146			X			60	3	2	0 - 60	0 - 60
2	A2-PB-147			X			60	3	2	0 - 60	0 - 60
2	A2-PB-148			X			60	3	2	0 - 60	0 - 60
2	A2-PB-149			X			60	3	2	0 - 60	0 - 60
2	A2-PB-150			X			60	3	2	0 - 60	0 - 60
2	A2-PB-151			X			60	3	2	0 - 60	0 - 60
2	A2-PB-152			X			60	3	2	0 - 60	0 - 60
2	A2-PB-153			X			60	3	2	0 - 60	0 - 60
2	A2-PB-154			X			60	3	2	0 - 60	0 - 60
2	A2-PB-155			X			60	3	2	0 - 60	0 - 60
2	A2-PB-156			X			60	3	2	0 - 60	0 - 60
2	A2-PB-157			X			60	3	2	0 - 60	0 - 60
TOTAL BORING/ SAMPLE COUNT	**145**	**71**	**35**	**23**	**19**	**11**	**-**	**1058**	**65**	**-**	**-**

Note: Total depth of perimeter borings proposed within waste will ultimately be determined in the field based on observations of waste thickness. Borings will be installed through the full extent of waste and 5-feet into native soils

Table 3
Buffer Zone and Lot 2A2 Sample Collection Detail

Survey Unit	Location ID	Sampling Interval (inches)*	Core Scan Interval (inches)*
BZ1	**1-BZ-001**	**0 - 6 ; 6 - 12**	**0 - 12**
BZ1	1-BZ-002	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-003	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-004	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-005	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-006	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-007	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-008	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-009	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-010	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-011	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-012	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-013	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-014	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-015	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-016	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-017	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-018	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-019	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-020	0 - 6 ; 6 - 12	0 - 12
BZ1	1-BZ-021	0 - 6 ; 6 - 12	0 - 12
BZ2	**2-BZ-022**	**0 - 6 ; 6 - 12**	**0 - 12**
BZ2	2-BZ-023	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-024	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-025	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-026	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-027	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-028	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-029	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-030	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-031	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-032	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-033	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-034	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-035	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-036	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-037	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-038	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-039	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-040	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-041	0 - 6 ; 6 - 12	0 - 12
BZ2	2-BZ-042	0 - 6 ; 6 - 12	0 - 12
BZ3	**3-BZ-043**	**0 - 6 ; 6 - 12**	**0 - 12**
BZ3	3-BZ-044	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-045	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-046	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-047	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-048	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-049	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-050	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-051	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-052	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-053	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-054	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-055	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-056	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-057	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-058	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-059	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-060	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-061	0 - 6 ; 6 - 12	0 - 12
BZ3	3-BZ-062	0 - 6 ; 6 - 12	0 - 12
2A2_1	**1-2A2-001**	**0 - 6 ; 6 - 12**	**0 - 12**

Table 3
Buffer Zone and Lot 2A2 Sample Collection Detail

Survey Unit	Location ID	Sampling Interval (inches)*	Core Scan Interval (inches)*
2A2_1	1-2A2-002	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-003	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-004	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-005	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-006	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-007	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-008	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-009	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-010	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-011	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-012	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-013	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-014	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-015	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-016	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-017	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-018	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-019	0 - 6 ; 6 - 12	0 - 12
2A2_1	1-2A2-020	0 - 6 ; 6 - 12	0 - 12
2A2_2	**2-2A2-021**	**0 - 6 ; 6 - 12**	**0 - 12**
2A2_2	2-2A2-022	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-023	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-024	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-025	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-026	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-027	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-028	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-029	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-030	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-031	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-032	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-033	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-034	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-035	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-036	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-037	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-038	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-039	0 - 6 ; 6 - 12	0 - 12
2A2_2	2-2A2-040	0 - 6 ; 6 - 12	0 - 12
2A2_3	**3-2A2-041**	**0 - 6 ; 6 - 12**	**0 - 12**
2A2_3	3-2A2-042	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-043	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-044	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-045	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-046	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-047	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-048	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-049	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-050	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-051	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-052	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-053	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-054	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-055	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-056	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-057	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-058	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-059	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-060	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-061	0 - 6 ; 6 - 12	0 - 12
2A2_3	3-2A2-062	0 - 6 ; 6 - 12	0 - 12
2A2_4	**4-2A2-063**	**0 - 6 ; 6 - 12**	**0 - 12**
2A2_4	4-2A2-064	0 - 6 ; 6 - 12	0 - 12

Table 3
Buffer Zone and Lot 2A2 Sample Collection Detail

Survey Unit	Location ID	Sampling Interval (inches)*	Core Scan Interval (inches)*
2A2_4	4-2A2-065	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-066	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-067	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-068	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-069	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-070	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-071	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-072	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-073	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-074	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-075	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-076	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-077	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-078	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-079	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-080	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-081	0 - 6 ; 6 - 12	0 - 12
2A2_4	4-2A2-082	0 - 6 ; 6 - 12	0 - 12
2A2_5	**5-2A2-083**	**0 - 6 ; 6 - 12**	**0 - 12**
2A2_5	5-2A2-084	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-085	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-086	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-087	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-088	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-089	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-090	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-091	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-092	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-093	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-094	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-095	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-096	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-097	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-098	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-099	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-100	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-101	0 - 6 ; 6 - 12	0 - 12
2A2_5	5-2A2-102	0 - 6 ; 6 - 12	0 - 12
2A2_6	**6-2A2-103**	**0 - 6 ; 6 - 12**	**0 - 12**
2A2_6	6-2A2-104	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-105	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-106	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-107	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-108	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-109	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-110	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-111	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-112	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-113	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-114	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-115	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-116	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-117	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-118	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-119	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-120	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-121	0 - 6 ; 6 - 12	0 - 12
2A2_6	6-2A2-122	0 - 6 ; 6 - 12	0 - 12
2A2_7	**7-2A2-123**	0 - 6 ; 6 - 12	**0 - 12**
2A2_7	7-2A2-124	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-125	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-126	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-127	0 - 6 ; 6 - 12	0 - 12

Table 3
Buffer Zone and Lot 2A2 Sample Collection Detail

Survey Unit	Location ID	Sampling Interval (inches)*	Core Scan Interval (inches)*
2A2_7	7-2A2-128	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-129	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-130	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-131	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-132	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-133	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-134	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-135	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-136	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-137	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-138	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-139	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-140	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-141	0 - 6 ; 6 - 12	0 - 12
2A2_7	7-2A2-142	0 - 6 ; 6 - 12	0 - 12
2A2_8	**8-2A2-143**	**0 - 6 ; 6 - 12**	**0 - 12**
2A2_8	8-2A2-144	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-145	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-146	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-147	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-148	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-149	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-150	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-151	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-152	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-153	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-154	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-155	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-156	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-157	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-158	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-159	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-160	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-161	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-162	0 - 6 ; 6 - 12	0 - 12
2A2_8	8-2A2-163	0 - 6 ; 6 - 12	0 - 12
Total Proposed Locations/Samples	**225**	**450**	**-**

Note: Samples to be collected from interval below gravel/asphalt layer as described in DIWP, FSP, and QAPP. **Emboldened** rows indicate randomly selected starting locations. If radiological impacts are observed at 12 inches deeper samples will be collected as per FSP.

Table 4
Background Study Sample Collection Detail

Reference Unit	Location ID	Sampling Interval (inches)	Core Scan Interval (inches)
1	1-RU-001	0 - 6 , 6 - 12	0 - 12
1	1-RU-002	0 - 6 , 6 - 12	0 - 12
1	1-RU-003	0 - 6 , 6 - 12	0 - 12
1	1-RU-004	0 - 6 , 6 - 12	0 - 12
1	1-RU-005	0 - 6 , 6 - 12	0 - 12
1	1-RU-006	0 - 6 , 6 - 12	0 - 12
1	1-RU-007	0 - 6 , 6 - 12	0 - 12
1	1-RU-008	0 - 6 , 6 - 12	0 - 12
1	1-RU-009	0 - 6 , 6 - 12	0 - 12
1	1-RU-010	0 - 6 , 6 - 12	0 - 12
1	1-RU-011	0 - 6 , 6 - 12	0 - 12
1	1-RU-012	0 - 6 , 6 - 12	0 - 12
1	1-RU-013	0 - 6 , 6 - 12	0 - 12
1	1-RU-014	0 - 6 , 6 - 12	0 - 12
1	1-RU-015	0 - 6 , 6 - 12	0 - 12
2	2-RU-001	0 - 6 , 6 - 12	0 - 12
2	2-RU-002	0 - 6 , 6 - 12	0 - 12
2	2-RU-003	0 - 6 , 6 - 12	0 - 12
2	2-RU-004	0 - 6 , 6 - 12	0 - 12
2	2-RU-005	0 - 6 , 6 - 12	0 - 12
2	2-RU-006	0 - 6 , 6 - 12	0 - 12
2	2-RU-007	0 - 6 , 6 - 12	0 - 12
2	2-RU-008	0 - 6 , 6 - 12	0 - 12
2	2-RU-009	0 - 6 , 6 - 12	0 - 12
2	2-RU-010	0 - 6 , 6 - 12	0 - 12
2	2-RU-011	0 - 6 , 6 - 12	0 - 12
2	2-RU-012	0 - 6 , 6 - 12	0 - 12
2	2-RU-013	0 - 6 , 6 - 12	0 - 12
2	2-RU-014	0 - 6 , 6 - 12	0 - 12
2	2-RU-015	0 - 6 , 6 - 12	0 - 12
3	3-RU-001	0 - 6 , 6 - 12	0 - 12
3	3-RU-002	0 - 6 , 6 - 12	0 - 12
3	3-RU-003	0 - 6 , 6 - 12	0 - 12
3	3-RU-004	0 - 6 , 6 - 12	0 - 12
3	3-RU-005	0 - 6 , 6 - 12	0 - 12
3	3-RU-006	0 - 6 , 6 - 12	0 - 12
3	3-RU-007	0 - 6 , 6 - 12	0 - 12
3	3-RU-008	0 - 6 , 6 - 12	0 - 12
3	3-RU-009	0 - 6 , 6 - 12	0 - 12
3	3-RU-010	0 - 6 , 6 - 12	0 - 12
3	3-RU-011	0 - 6 , 6 - 12	0 - 12

Table 4
Background Study Sample Collection Detail

Reference Unit	Location ID	Sampling Interval (inches)	Core Scan Interval (inches)
3	3-RU-012	0 - 6 , 6 - 12	0 - 12
3	3-RU-013	0 - 6 , 6 - 12	0 - 12
3	3-RU-014	0 - 6 , 6 - 12	0 - 12
3	3-RU-015	0 - 6 , 6 - 12	0 - 12
4	4-RU-001	0 - 6 , 6 - 12	0 - 12
4	4-RU-002	0 - 6 , 6 - 12	0 - 12
4	4-RU-003	0 - 6 , 6 - 12	0 - 12
4	4-RU-004	0 - 6 , 6 - 12	0 - 12
4	4-RU-005	0 - 6 , 6 - 12	0 - 12
4	4-RU-006	0 - 6 , 6 - 12	0 - 12
4	4-RU-007	0 - 6 , 6 - 12	0 - 12
4	4-RU-008	0 - 6 , 6 - 12	0 - 12
4	4-RU-009	0 - 6 , 6 - 12	0 - 12
4	4-RU-010	0 - 6 , 6 - 12	0 - 12
4	4-RU-011	0 - 6 , 6 - 12	0 - 12
4	4-RU-012	0 - 6 , 6 - 12	0 - 12
4	4-RU-013	0 - 6 , 6 - 12	0 - 12
4	4-RU-014	0 - 6 , 6 - 12	0 - 12
4	4-RU-015	0 - 6 , 6 - 12	0 - 12
Total Proposed Locations/ Samples	**60**	**120**	**-**

Table 5
Comparison of 2005 - 2019 Ground Surface Elevation

Proposed Location	2005 Ground Elevation (feet)	2019 Ground Elevation (feet)	Overburden Thickness (feet)
A1-SB-052	465.11	462.57	-2.54
A1-SB-053	469.59	466.14	-3.45
A1-SB-054	471.15	466.78	-4.37
A1-SB-055	462.39	461.63	-0.76
A1-SB-056	463.99	462.57	-1.43
A1-SB-057	466.51	464.65	-1.85
A1-SB-058	458.75	459.48	0.73
A1-SB-059	466.69	465.39	-1.30
A1-SB-060	467.18	470.07	2.89
A1-SB-061	468.39	473.20	4.81
A1-SB-062	467.65	465.32	-2.32
A1-SB-063	468.65	478.52	9.86
A1-SB-064	463.28	464.46	1.17
A1-SB-065	467.35	466.29	-1.06
A1-SB-066	456.99	456.52	-0.47
A1-SB-067	460.38	463.93	3.55
A1-SB-068	467.83	466.19	-1.65
A1-SB-069	472.91	470.38	-2.53
A1-SB-070	466.92	465.49	-1.43
A1-SB-071	470.90	468.73	-2.17
A1-SB-072	458.42	457.84	-0.58
A1-SB-073	457.84	458.97	1.12
A1-SB-074	468.91	476.06	7.15
A1-SB-075	467.23	465.92	-1.31
A1-SB-076	467.60	467.32	-0.28
A1-SB-081	466.88	465.58	-1.31
A1-TH-082	461.73	462.44	0.70
A1-SB-083	462.40	464.44	2.04
A1-TH-084	471.00	477.91	6.91
A1-TH-085	469.88	470.71	0.83
A1-TH-086	465.47	464.92	-0.56
A1-TH-087	468.34	478.45	10.11
A1-TH-088	470.18	474.41	4.23
A1-TH-089	469.00	467.70	-1.30
A1-TH-090	458.75	458.63	-0.12
A1-SB-128	464.68	463.13	-1.55
A1-SB-129	466.44	463.93	-2.52
A1-SB-140	465.15	464.47	-0.69
A1-SB-141	465.04	464.42	-0.62
A1-SB-142	470.76	465.04	-5.72
A1-SB-143	462.89	461.94	-0.96
A1-SB-144	464.31	463.15	-1.17
A1-SB-145	463.64	465.31	1.66
A1-PB-101	459.49	463.01	3.52

Table 3
Comparison of 2005 - 2019 Ground Surface Elevation

Proposed Location	2005 Ground Elevation (feet)	2019 Ground Elevation (feet)	Overburden Thickness (feet)
A1-PB-102	460.80	460.85	0.05
A1-PB-103	459.62	459.58	-0.04
A1-PB-104	458.46	456.87	-1.59
A1-PB-105	458.54	458.89	0.35
A1-PB-106	459.03	459.66	0.63
A1-PB-107	458.92	459.77	0.85
A1-PB-108	458.97	459.64	0.67
A1-PB-109	460.52	460.84	0.32
A1-PB-110	458.10	458.56	0.46
A1-PB-111	455.13	454.86	-0.27
A1-PB-112	452.99	453.14	0.16
A1-PB-113	448.44	450.42	1.98
A1-PB-114	449.67	450.11	0.44
A1-PB-115	461.40	460.95	-0.46
A1-PB-116	472.58	471.32	-1.26
A1-PB-117	528.53	523.83	-4.69
A1-PB-118	507.01	499.74	-7.27
A2-SB-001	475.92	476.69	0.77
A2-SB-002	475.70	475.57	-0.13
A2-SB-003	476.21	475.02	-1.18
A2-SB-004	475.79	477.17	1.38
A2-SB-005	473.55	474.43	0.88
A2-SB-006	474.24	476.23	2.00
A2-SB-007	483.91	487.08	3.17
A2-SB-008	474.79	476.52	1.73
A2-SB-009	472.11	473.49	1.37
A2-SB-010	464.20	466.82	2.62
A2-SB-011	473.57	473.52	-0.05
A2-SB-012	459.32	457.05	-2.27
A2-SB-013	488.40	487.51	-0.89
A2-SB-014	474.73	475.34	0.61
A2-SB-015	475.84	475.44	-0.40
A2-SB-016	471.71	471.50	-0.21
A2-SB-017	468.97	468.48	-0.49
A2-SB-018	470.59	470.64	0.05
A2-SB-019	460.97	463.18	2.20
A2-SB-020	465.96	463.72	-2.24
A2-SB-021	463.92	463.48	-0.44
A2-SB-022	467.58	474.34	6.76
A2-SB-023	468.45	467.48	-0.97
A2-SB-024	468.09	466.38	-1.71
A2-SB-025	461.12	461.07	-0.05
A2-SB-026	463.61	463.91	0.30
A2-SB-027	465.68	466.57	0.89

Table 5
Comparison of 2005 - 2019 Ground Surface Elevation

Proposed Location	2005 Ground Elevation (feet)	2019 Ground Elevation (feet)	Overburden Thickness (feet)
A2-SB-028	459.28	459.12	-0.16
A2-SB-029	458.99	456.65	-2.34
A2-SB-030	463.91	462.71	-1.20
A2-SB-031	467.95	467.69	-0.26
A2-SB-032	467.18	467.66	0.48
A2-SB-033	467.42	467.13	-0.30
A2-SB-034	465.69	465.21	-0.47
A2-SB-035	468.44	469.18	0.73
A2-SB-036	484.64	484.46	-0.18
A2-SB-037	478.58	495.46	16.88
A2-SB-038	477.03	474.79	-2.24
A2-SB-039	480.48	480.84	0.36
A2-SB-040	467.22	470.17	2.96
A2-SB-041	463.41	467.30	3.89
A2-SB-042	463.62	460.71	-2.91
A2-SB-043	464.32	471.79	7.46
A2-SB-044	462.86	462.99	0.13
A2-SB-045	463.22	462.81	-0.41
A2-SB-046	465.70	465.40	-0.30
A2-SB-047	470.16	469.98	-0.18
A2-SB-048	460.77	463.90	3.14
A2-TH-049	459.65	458.37	-1.28
A2-TH-050	469.41	469.33	-0.08
A2-SB-051	475.89	475.52	-0.38
A2-TH-077	469.36	471.26	1.90
A2-SB-078	469.97	472.33	2.36
A2-SB-079	472.79	485.25	12.46
A2-SB-080	483.40	482.79	-0.61
A2-TH-091	474.73	474.99	0.26
A2-TH-092	470.35	472.23	1.88
A2-TH-093	457.07	457.05	-0.02
A2-TH-094	468.56	467.19	-1.37
A2-TH-095	469.79	469.68	-0.12
A2-TH-096	470.83	471.63	0.80
A2-TH-097	469.61	469.71	0.10
A2-TH-098	469.16	468.73	-0.43
A2-TH-099	468.87	468.45	-0.41
A2-TH-100	470.82	470.44	-0.37
A2-TH-101	469.55	471.10	1.56
A2-TH-102	469.59	470.60	1.01
A2-TH-103	446.58	445.58	-1.00
A2-TH-104	469.49	469.98	0.49
A2-TH-105	470.41	470.65	0.24
A2-TH-106	469.23	468.92	-0.30

Table 5

Comparison of 2005 - 2019 Ground Surface Elevation

Proposed Location	2005 Ground Elevation (feet)	2019 Ground Elevation (feet)	Overburden Thickness (feet)
A2-TH-107	469.35	469.84	0.50
A2-TH-108	447.44	449.53	2.09
A2-TH-109	450.28	461.06	10.78
A2-TH-110	462.19	462.50	0.31
A2-TH-111	468.79	468.84	0.06
A2-TH-112	467.27	465.67	-1.60
A2-TH-113	460.62	458.39	-2.23
A2-TH-114	459.06	459.12	0.06
A2-TH-115	460.25	460.75	0.50
A2-TH-116	464.00	463.33	-0.67
A2-TH-117	458.68	456.03	-2.65
A2-TH-118	459.44	458.00	-1.44
A2-TH-119	465.30	463.88	-1.42
A2-TH-120	458.68	455.55	-3.13
A2-TH-121	460.79	460.70	-0.10
A2-TH-122	460.56	461.60	1.05
A2-TH-123	459.78	458.17	-1.61
A2-TH-124	462.18	462.95	0.78
A2-TH-125	446.90	443.31	-3.59
A2-TH-126	459.20	456.46	-2.74
A2-TH-127	451.83	449.26	-2.56
A2-SB-130	472.55	473.99	1.44
A2-SB-131	485.09	485.12	0.03
A2-SB-132	473.23	472.84	-0.38
A2-SB-133	471.93	472.12	0.20
A2-SB-134	466.40	466.05	-0.35
A2-SB-135	461.47	461.45	-0.02
A2-SB-136	466.52	471.73	5.21
A2-SB-137	462.63	465.62	2.99
A2-SB-138	461.69	461.07	-0.62
A2-SB-139	462.17	461.30	-0.88
A2-PB-119	448.48	449.99	1.51
A2-PB-120	448.77	450.17	1.41
A2-PB-121	447.82	448.42	0.60
A2-PB-122	446.37	446.73	0.37
A2-PB-123	450.83	449.01	-1.81
A2-PB-124	443.27	444.87	1.60
A2-PB-125	451.46	453.69	2.22
A2-PB-126	450.30	452.45	2.16
A2-PB-127	444.67	445.15	0.47
A2-PB-128	453.70	454.81	1.11
A2-PB-129	446.68	445.01	-1.67
A2-PB-130	446.03	445.68	-0.35
A2-PB-131	445.42	448.68	3.26

Table 5
Comparison of 2005 - 2019 Ground Surface Elevation

Proposed Location	2005 Ground Elevation (feet)	2019 Ground Elevation (feet)	Overburden Thickness (feet)
A2-PB-132	447.67	447.85	0.17
A2-PB-133	445.85	445.02	-0.83
A2-PB-134	444.21	448.09	3.89
A2-PB-135	442.19	449.26	7.07
A2-PB-136	445.14	446.66	1.52
A2-PB-137	462.60	463.58	0.99
A2-PB-138	463.46	462.70	-0.75
A2-PB-139	462.28	463.37	1.10
A2-PB-140	468.12	467.87	-0.26
A2-PB-141	470.43	469.99	-0.44
A2-PB-142	477.16	476.53	-0.64
A2-PB-143	481.65	481.24	-0.41
A2-PB-144	473.39	473.53	0.14
A2-PB-145	473.98	474.70	0.72
A2-PB-146	479.99	479.32	-0.67
A2-PB-147	492.12	492.17	0.05
A2-PB-148	492.01	492.77	0.76
A2-PB-149	493.40	492.39	-1.01
A2-PB-150	492.77	492.66	-0.11
A2-PB-151	496.45	494.96	-1.49
A2-PB-152	490.48	488.08	-2.39
A2-PB-153	490.27	489.86	-0.41
A2-PB-154	468.88	468.68	-0.20
A2-PB-155	486.66	486.34	-0.32

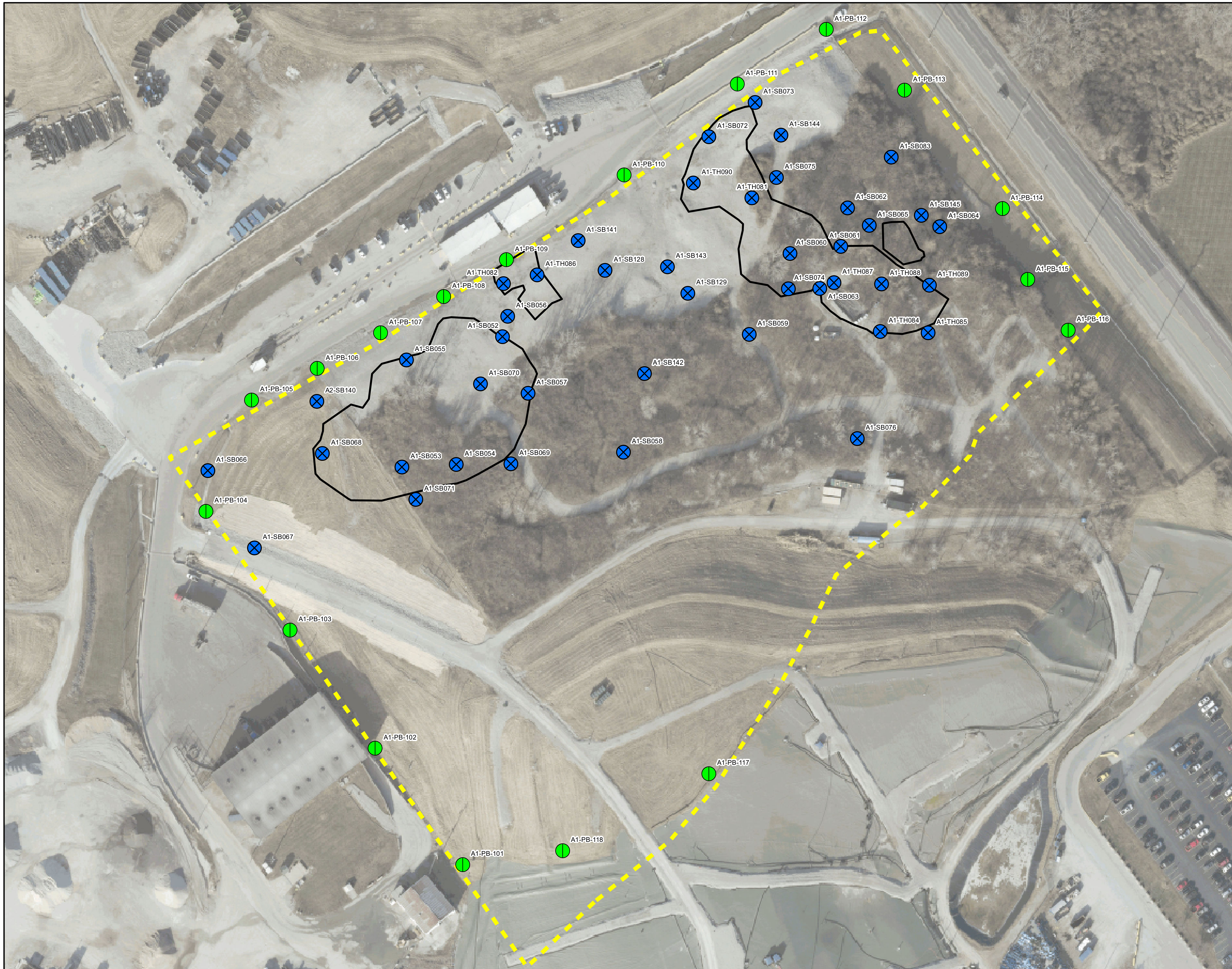
Note: Negative thicknesses indicate a decrease in elevation from 2005, positive thicknesses indicate an increase in elevation from 2005.

Table 6
Drainage Areas Sediment Sample Collection Detail

Area	Location ID	Sampling Interval (inches)	Core Scan Interval (inches)
Historical Area 2	SEDIMENT 2016-03-16A	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	SED4	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	AC-SED-8	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	AC-SED-7	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	AC-SED-6	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	AC-SED-9	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	AC-SED-10	0 - 6 ; 6 - 24	0 - 24
Historical Area 2	AC-SED-11	0 - 6 ; 6 - 24	0 - 24
NWB	NWB-SED-01	0 - 6 ; 6 - 24	0 - 24
NWB	NWB-SED-02	0 - 6 ; 6 - 24	0 - 24
NWB	NWB-SED-03	0 - 6 ; 6 - 24	0 - 24
NWB	NWB-SED-04	0 - 6 ; 6 - 24	0 - 24
NWB	NWB-SED-05	0 - 6 ; 6 - 24	0 - 24
Total Proposed Locations/ Samples	**13**	**26**	**-**

Note: A sediment sample will be collected from 0 - 6", and then from the 6" interval exhibiting elevated radiological readings during core scanning. If impacts are detected at 24" deeper samples may be collected.

FIGURES



Proposed Borings

Proposed Perimeter Borings

Maximum extent of RIM >52.9 pCi/g 0-16 ft B2005GS

OU-1 Area Boundary

PRELIMINARY DRAFT - For Discussion Purposes Only

0 75 150 300 Feet

N

Figure 1

Proposed Area 1 Borings

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 6/4/2020

Document Path: P:\West Lake\10.0 Technical Categories\10.19 Geodata\Boring Summary w labels and topo.mxd

Proposed Borings

Proposed Perimeter Borings

Maximum extent of RIM >52.9 pCi/g 0-16 ft B2005GS

OU-1 Area Boundary

PRELIMINARY DRAFT - For Discussion Purposes Only

0 112.5 225 450 Feet

N

Figure 2

Proposed Area 2 Borings

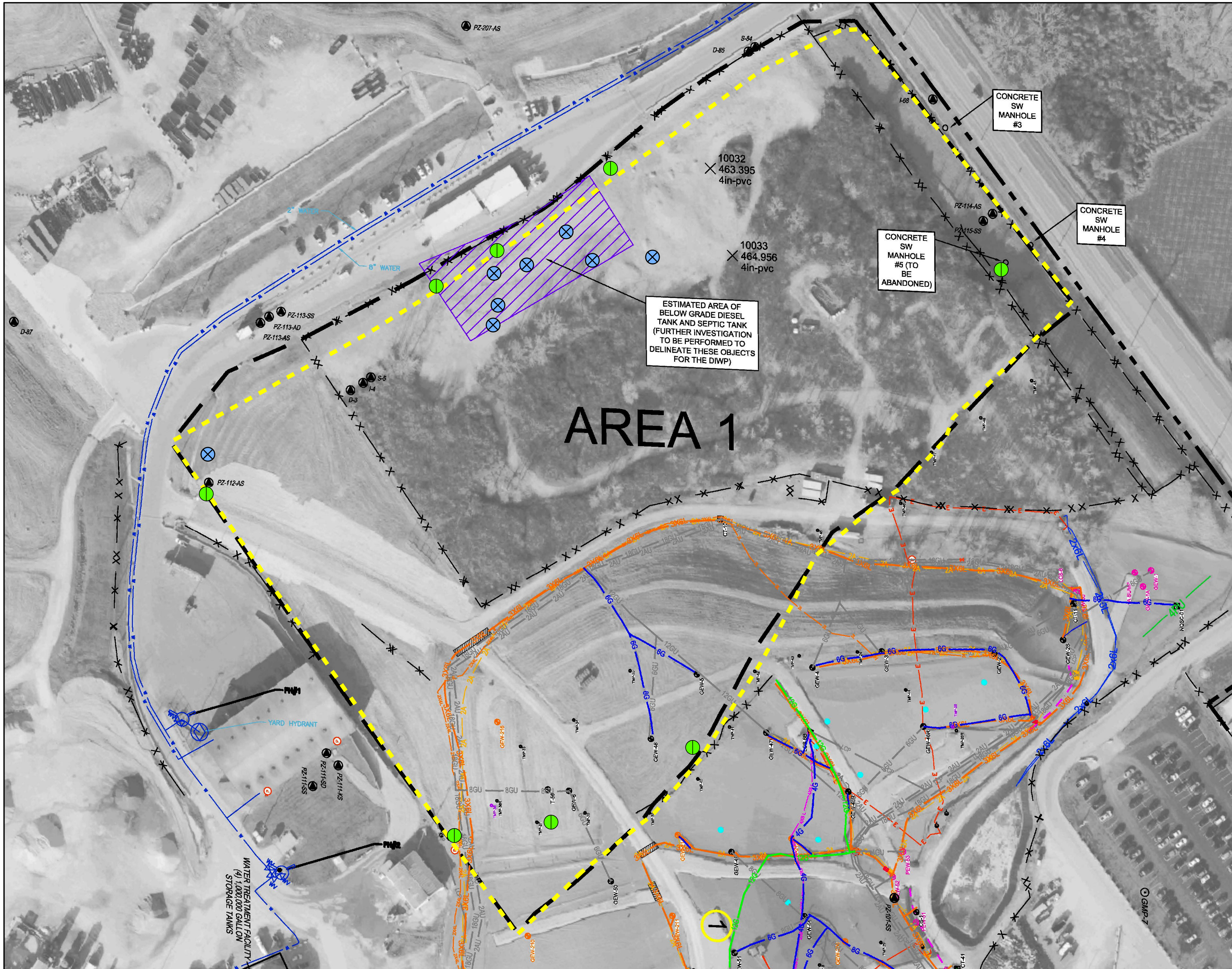
PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 6/4/2020

Document Path: P:\West Lake\10.0 Technical Categories\10.19 Geodata\Boring Summary w labels and topo.mxd



Proposed Perimeter Borings Adjacent to Utilities/Infrastructure

Proposed Borings Adjacent to Utilities/ Infrastructure

Maximum extent of RIM >52.9 pCi/g 0-16 ft B2005GS

OU-1 Area Boundary

PRELIMINARY DRAFT - For Discussion Purposes Only

0 75 150 300 Feet

N

Figure 3

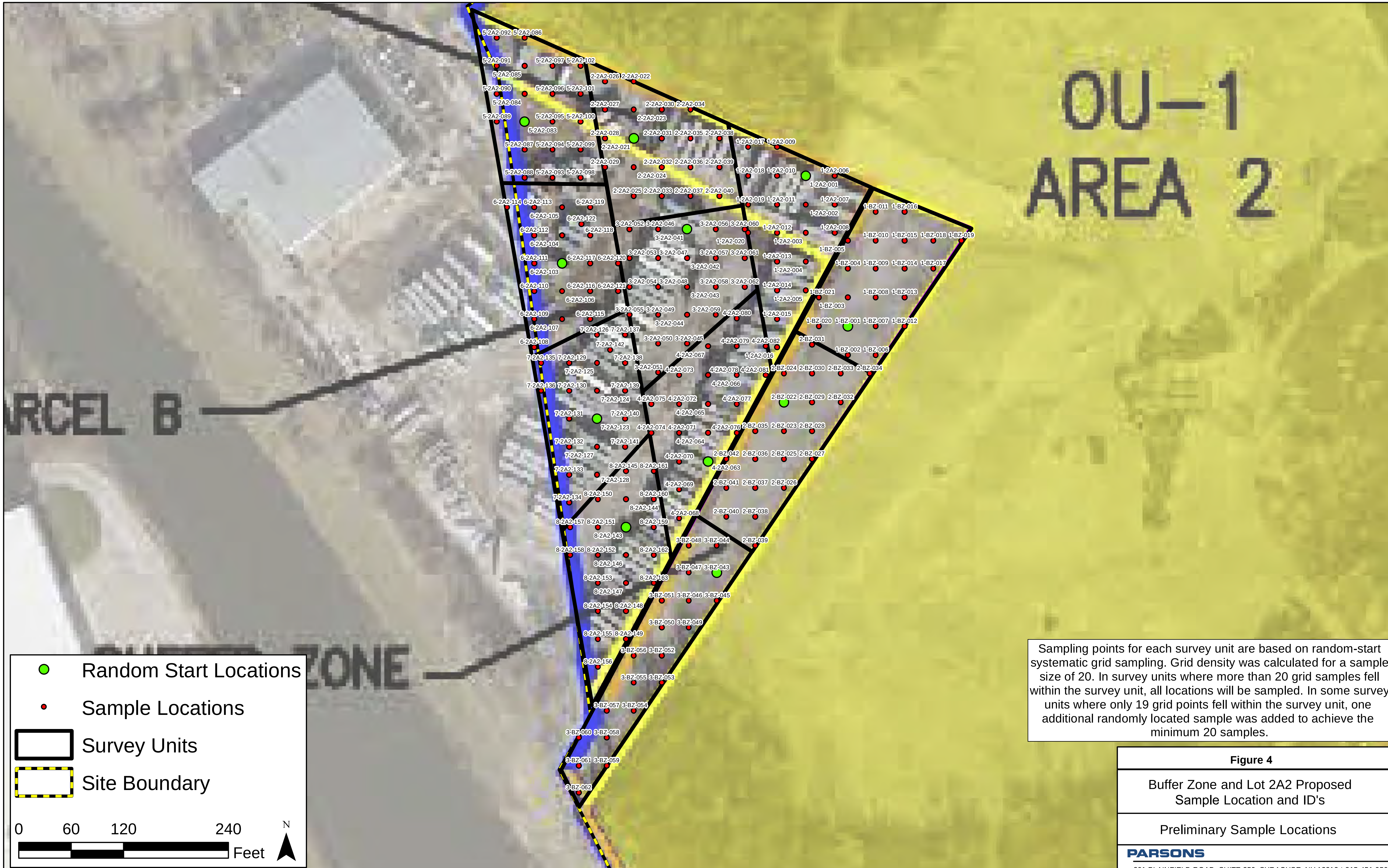
Areas 1 Utilities Overlay (with Proposed Borings Adjacent to Utitlities)

PARSONS
301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 3/3/2020

Document Path: P:\West Lake\10.0 Technical Categories\10.19 Geodata\ArcMap Data\Geostat figures.mxd



Sampling points for each survey unit are based on random-start systematic grid sampling. Grid density was calculated for a sample size of 20. In survey units where more than 20 grid samples fell within the survey unit, all locations will be sampled. In some survey units where only 19 grid points fell within the survey unit, one additional randomly located sample was added to achieve the minimum 20 samples.

Figure 4

Buffer Zone and Lot 2A2 Proposed Sample Location and ID's

Preliminary Sample Locations

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plot Date: 3/11/2020 Plotted By: CS

Document Path: P:\West Lake\10.0 Technical Categories\10.19 Geodata\ArcMap Data\Buffer Zone and Lot 2A2\Sample Areas 2A2 and Buffer.mxd

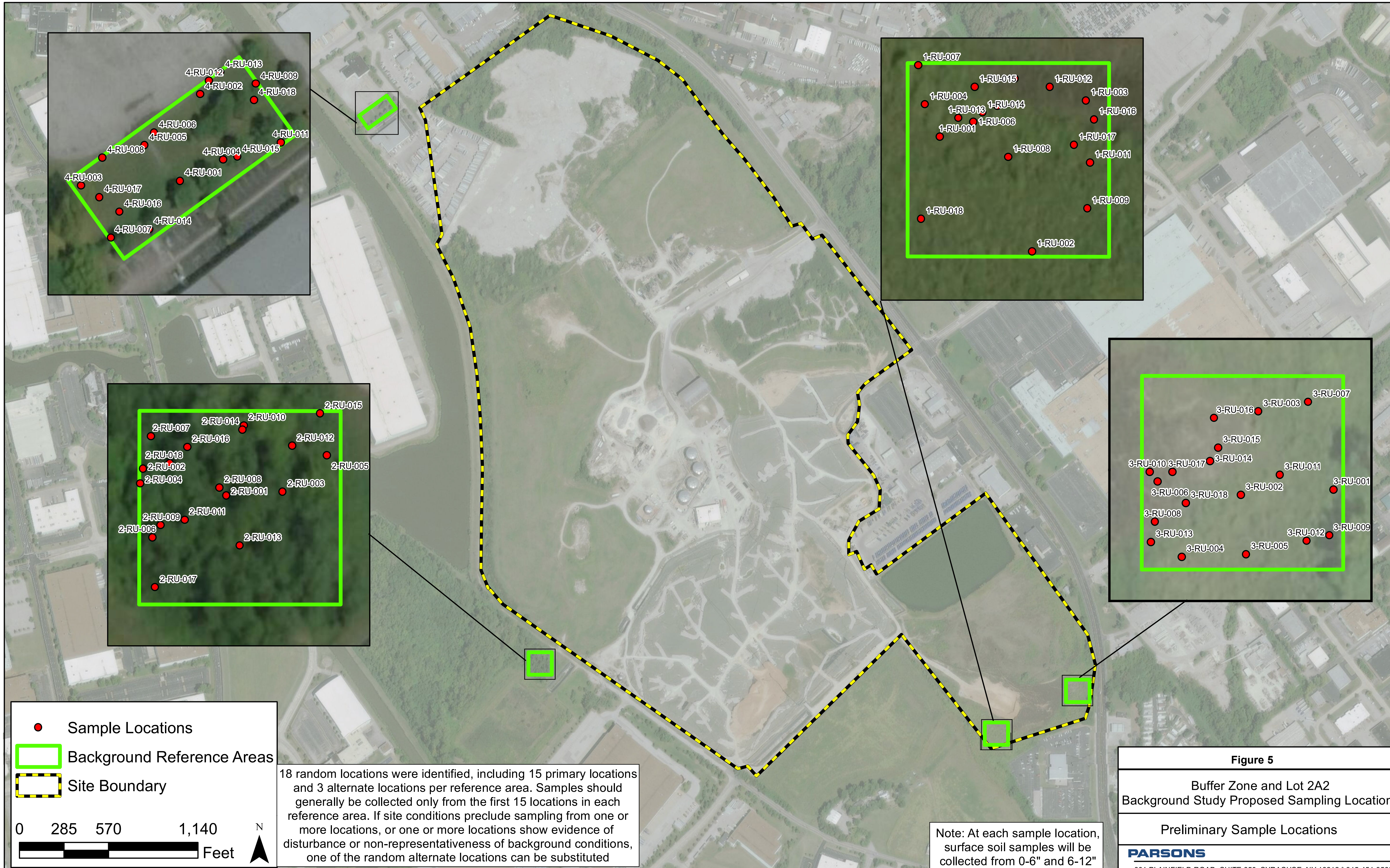


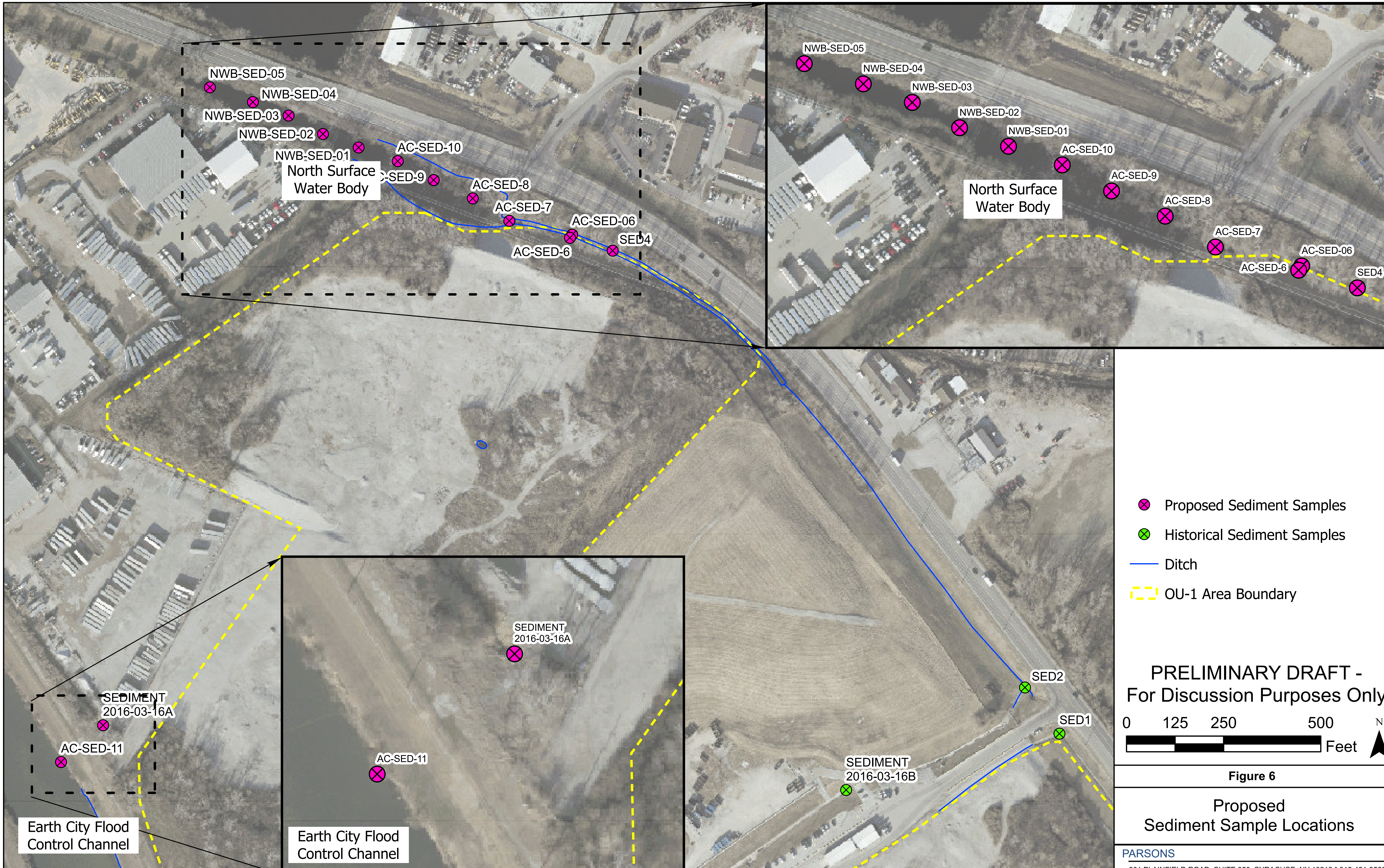
Figure 5

Buffer Zone and Lot 2A2
Background Study Proposed Sampling Locations

Preliminary Sample Locations

Plot Date: 3/30/2020 Plotted By: CS

Document Path: C:\Users\p002737e\Documents\West Lake\ArcMap Data\Buffer Zone and Lot 2A2\Sample Areas.mxd



Plot Date: 5/22/2020 Plotted By: TS

Document Path: C:\Users\p003308E\Documents\West Lake local\West_Lake_Local.aprx

ATTACHMENT 1 – PRE-SAMPLING CHECKLIST

PREDRILLING/SUBSURFACE CHECKLIST FOR INTRUSIVE FIELDWORK

Site Name: ______________________ **Job Number:** __________
Site Phone Number: ______________________
Site Address: ______________________ **County:** __________
Client Proj. Mgr.: ______________________ **Phone:** __________
Site Manager Contacted Date: ______________ **By:** __________
Site Drawings (yes / no / NA) ________ (please attach) **Historical Drawings (yes / no / NA)** ________
Third Party Construction/Redevelopment Plans (Yes/No/NA)

***ATTACH SITE FIGURE WITH PROPOSED BORING LOCATIONS

Subcontractor's (drillers, concrete, etc…) **Company** ______________________
Subcontractor's Contact Person ______________________ **Phone** __________
Meeting / Start Date ______________________ **Time** __________

1) **Health and Safety Signoff Form Completed? (Yes/No)** **Date** __________

2) **Utility Protection Services (Minimum 48 Hrs. Advance Notice, State Specific Notification Period Supercedes)**
Called: Date __________ **Time** __________ **Initials** __________
Reference # ______________________
Proposed Drilling Locations Premarked for Locating Service. **Y / N**

3) **Private or In-House Utility Locating Service Performed?** **Y / N** __________
Called: Date __________ **Time** __________ **Initials** __________
Name of Locating Service: ______________________
Telephone #/ contact: ______________________
Name of Supplier Locating Technician: ______________________
Type of sensing equipment used: ______________________
Proposed Drilling Locations Premarked **Y / N**

4) **Other Potential Underground Structures**
Name of City Engineer/Utility Representative: ______________________
Telephone #: ______________________
Date Notified ______________________ **Maps: Y / N**
Cleared: Y / N

5) **COMPLETED SITE WALKOVER W/ SITE MANAGER/DESIGNEE OR OWNER/TENANT REP.** **Y / N**
Name of Site Manager: ______________________
Name of Property Owner/Tenant Representative:______________________
Cleared: Yes / No
Building Utility Service Line Connections Identified: **Y / N**
(Hand sketch on site map w/proposed boring locations and most likely utility trench locations)

6) **Utility Inventory:** **Y / N**

Utility	Name	Depth (ft) (If Available)	Phone	Notified	Date	Marked
Above Ground Services						
Electric		NA		Y / N		Y / N
Telephone		NA		Y / N		Y / N
Cable		NA		Y / N		Y / N
Overhead Supports		NA		Y / N		Y / N
Traffic light cables		NA		Y / N		Y / N

PREDRILLING/SUBSURFACE CHECKLIST FOR INTRUSIVE FIELDWORK

6) Utility Inventory Continued:

Below Ground Services:

Electric				Y / N		Y / N
Telephone				Y / N		Y / N
Cable				Y / N		Y / N
Gas				Y / N		Y / N
Water				Y / N		Y / N
UST System				Y / N		Y / N
Storm				Y / N		Y / N
Sanitary				Y / N		Y / N
Steam				Y / N		Y / N
Pipeline Companies				Y / N		Y / N

Other:

				Y / N		Y / N
				Y / N		Y / N
				Y / N		Y / N

7) Site-Specific Emergency Contingency Plan Incorporated in Health & Safety Plan Y / N

8) Drilling Locations Approved by Client Project Manager Named Above? Y / N

9) Signature of Parsons' Project Mgr. (required to begin fieldwork):

Name of Project Manager   **Signature of Project Manager**

Name of Parsons Field Personnel   **Signature of Field Personnel**

(This document to be included with the site H&S Plan and should be available upon request.)

ADDITIONAL COMMENTS / NOTES:

ATTACHMENT 2 – BORING/WELL CONSTRUCTION

PARSONS

DRILLING RECORD

BORING/ WELL NO. Pg ____ of ____

Contractor: ____________________

Driller: ____________ **Oversight:** ____________

Rig Type:

PROJECT NAME:

PROJECT Location:

Location Description:

GROUNDWATER OBSERVATIONS

Depth to Water during Drilling:		ft bls
Measured Static Water Level:		ft bls
Final Depth of Hole/Well Casing:		ft bls
Additional Comments:		

Date/Time Start:

Date/Time Finish:

Location Map

Sample Type	SPT	Run #	Recovery (%)	Alpha Scan (cpm)	Beta Scan (cpm)	Gamma Scan (uR/hr)	USCS Symbol	Depth (ft bls)	FIELD DESCRIPTION/ID OF MATERIAL	GRAPHIC LOG / WELL SCHEMATIC (not to scale)	COMMENTS
								0.5			
								1.0			
								1.5			
								2.0			
								2.5			
								3.0			
								3.5			
								4.0			
								4.5			
								5.0			
								5.5			
								6.0			
								6.5			
								7.0			
								7.5			
								8.0			
								8.5			
								9.0			
								9.5			
								10.0			
								10.5			
								11.0			
								11.5			
								12.0			
								12.5			
								13.0			
								13.5			
								14.0			
								14.5			
								15.0			
								15.5			
								16.0			
								16.5			
								17.0			
								17.5			
								18.0			
								18.5			
								19.0			
								19.5			
								20.0			
								20.5			
								21.0			
								21.5			

SAMPLE TYPE

HC = Hand Cleared (post hole or auger)

MC = Macro Core SC = Sonic Core

SS = Split Spoon ST = Shelby Tube

SPT = Standard Penetration Test

Enter number of blows to advance 6 inches (for SS sampling only)

COMMENTS:

ATTACHMENT 3 – MISSOURI WELL INSTALLATION FORM

MISSOURI DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY PROGRAM

MONITORING WELL CERTIFICATION REPORT

NOTE: This form is not to be used for nested wells

OFFICE USE ONLY		DATE RECEIVED	
REFERENCE NO.		CHECK NO.	
STATE WELL NO.		REVENUE NO.	
ENTERED	APPROVED	DATE	ROUTE / /

OWNER AND SITE INFORMATION

PROPERTY OWNER NAME WHERE WELL IS LOCATED	PRIMARY PHONE NUMBER WITH AREA CODE	WELL NUMBER	**WELL COMPLETION DATE**
PROPERTY OWNER MAILING ADDRESS	CITY	STATE	ZIP CODE
PHYSICAL ADDRESS OF PROPERTY WHERE WELL IS LOCATED	CITY	COUNTY	
NAME OF SITE, BUSINESS, OR CLEANUP PROJECT	DNR/EPA PROJECT NUMBER OR REGULATORY SITE ID NUMBER (IF APPLICABLE)	VARIANCE NUMBER (IF ISSUED)	
PRIMARY CONTRACTOR NAME (PLEASE PRINT)	PERMIT NUMBER	Section 256.607(3), RSMo, requires all primary contractors to comply with all rules and regulations promulgated pursuant to Sections 256.600 to 256.640 RSMo.	

SURFACE COMPLETION

TYPE	LENGTH AND DIAMETER OF SURFACE COMPLETION	DIAMETER AND DEPTH OF THE HOLE SURFACE COMPLETION WAS PLACED	SURFACE COMPLETION GROUT
☐ Above Ground	Length ______ FT.	Diameter ______ IN.	☐ Concrete
☐ Flush Mount	Diameter ______ IN.	Length ______ FT.	☐ Other ______

☐ Locking Cap
☐ Weep Hole

Elevation ______ FT.

ANNULAR SEAL

Length ______ FT.

☐ Slurry ☐ Chips
☐ Pellets ☐ Granular
☐ Cement/Slurry

IF CEMENT/BENTONITE MIX:

Bags of Cement Used ______
% of Bentonite Used ______
Water Used Per Bag ______ GAL.

SECONDARY FILTER PACK LENGTH

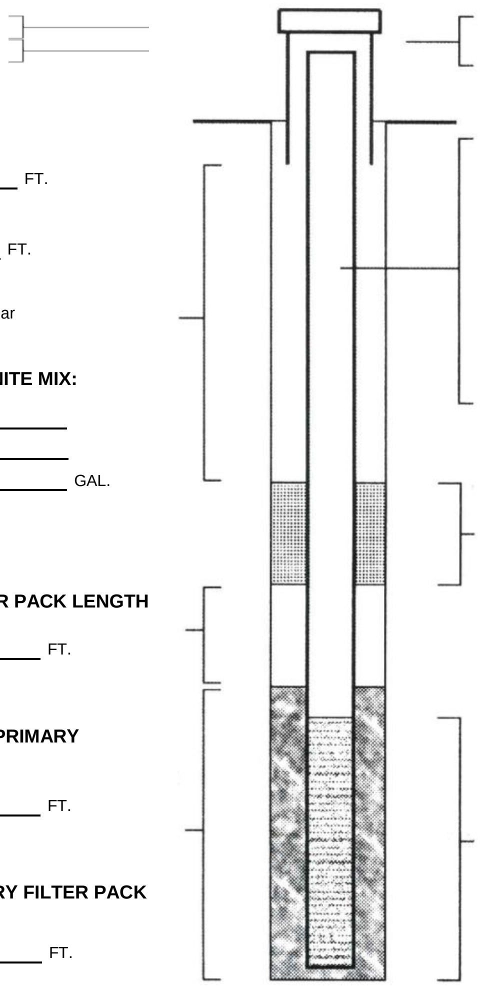
______ FT.

DEPTH TO TOP OF PRIMARY FILTER PACK

______ FT.

LENGTH OF PRIMARY FILTER PACK

______ FT.



SURFACE COMPLETION

☐ Steel ☐ Aluminum ☐ Plastic

RISER OR CASING (IF OPEN HOLE COMPLETION)

Riser/Casing Diameter ______ IN.
Riser/Casing Length ______ FT.
Diameter Of Drill Hole ______ IN.
Weight Or SDR# ______

MATERIAL

☐ Steel ☐ Thermoplastic (PVC)
☐ Other ______

BENTONITE SEAL

Length ______
☐ Chips ☐ Pellets ☐ Granular
☐ Saturated Zone ☐ Hydrated

SCREEN

Screen Diameter ______ IN.
Screen Length ______ FT.
Diameter Of Drill Hole ______ IN.
Depth To Top ______ FT.

SCREEN MATERIAL

☐ Steel ☐ Thermoplastic (PVC)
☐ Other ______

LOCATION OF WELL (D/M/S FORMAT ONLY)

Latitude ______ ° ______ ' ______ "
Longitude ______ ° ______ ' ______ "

SMALLEST LARGEST
______ ¼ ______ ¼ ______ ¼

Section ______ Township ______ North
Range ______ ☐ E ☐ W

TYPE OF WELL (CHECK ONE)

☐ Direct Push ☐ Extraction ☐ Inclinometer
☐ Gas Migration ☐ Injection ☐ Lysimeter
☐ Observation ☐ Open Hole ☐ Other (specify)
☐ Piezometer ☐ Standard ______

MONITORING FOR (CHECK ALL THAT APPLY)

☐ Explosives ☐ Metals
☐ Pesticides/Herbicides ☐ Petroleum
☐ Radionuclides ☐ SVOCS
☐ VOCS (non-petroleum) ☐ Geotechnical Data

DEPTH		FORMATION DESCRIPTION (OR ATTACH BORING LOG*)
FROM	TO	
TOTAL DEPTH: FT.		☐ *Boring Log Attached
STATIC WATER LEVEL FT.		**PUMP INSTALLED** ☐ Yes ☐ No

For cased wells, submit additional as-built diagrams showing well construction details including type and size of all casing, hole diameter and grout used.

I hereby certify that the monitoring well herein described was constructed in accordance with Missouri Department of Natural Resources requirements.

MONITORING WELL INSTALLATION CONTRACTOR	PERMIT NUMBER	DATE	MONITORING WELL INSTALLATION CONTRACTOR APPRENTICE (IF APPLICABLE)	PERMIT NUMBER

 SEND COMPLETED FORM ALONG WITH $100 CERTIFICATION FEE TO: MISSOURI DEPARTMENT OF NATURAL RESOURCES, MISSOURI GEOLOGICAL SURVEY, WELL INSTALLATION SECTION, PO BOX 250, ROLLA, MO 65402 PHONE: 573-368-2165 FAX: 573-368-2317 EMAIL: welldrillers@dnr.mo.gov
RECORD (AND FEE) MAY BE SUBMITTED ONLINE: dnr.mo.gov/mowells

ATTACHMENT 4 – WELL DEVELOPMENT LOG

WELL DEVELOPMENT LOG

Well ID:

Date ______ Field Personnel ______ Weather ______

Site Name ______ Contractor ______ Project No. ______

Site Location ______ Evacuation Method ______ ______

Well information:

Depth to Bottom (Initial) * ______ ft. Date(s) Installed ______ Date(s) Developed ______

Depth to Bottom (Final)* ______ ft. Driller ______ Development Time Start: ______

Depth to Water (Initial)* ______ ft. Well Diameter ______ in. Stop: ______

Depth to Water (Final)* ______ ft. Casing Volume ______ gal. Total: ______

* Measuring point ______ Pump setting* (intake) ______

Well Volumes	Volume of Water Removed (Gallons)	Temperature ^{o}C	pH s.u	Conductivity mS/cm	Turbidity (NTU)	Approximate Flow Rate (gal/min)	Depth to Water (ft.)	Appearance of Water
Start								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Development Water Characteristics:

Total volume of Development water removed: ______

Physical appearance at start

Color ______

Odor ______

Sheen/Free Product ______

Physical appearance at end

Color ______

Odor ______

Sheen/Free Product ______

NOTES: ______

Geologist Signature: ______

ATTACHMENT 5 – WELL DECOMMISSIONING RECORD

FIGURE 3

WELL DECOMMISSIONING RECORD

Site Name:	Well I.D.:
Site Location:	Driller:
Drilling Co.:	Inspector:
	Date:

DECOMMISSIONING DATA
(Fill in all that apply)

<u>OVERDRILLING</u>

Interval Drilled	
Drilling Method(s)	
Borehole Dia. (in.)	
Temporary Casing Installed? (y/n)	
Depth temporary casing installed	
Casing type/dia. (in.)	
Method of installing	

<u>CASING PULLING</u>

Method employed	
Casing retrieved (feet)	
Casing type/dia. (in)	

<u>CASING PERFORATING</u>

Equipment used	
Number of perforations/foot	
Size of perforations	
Interval perforated	

<u>GROUTING</u>

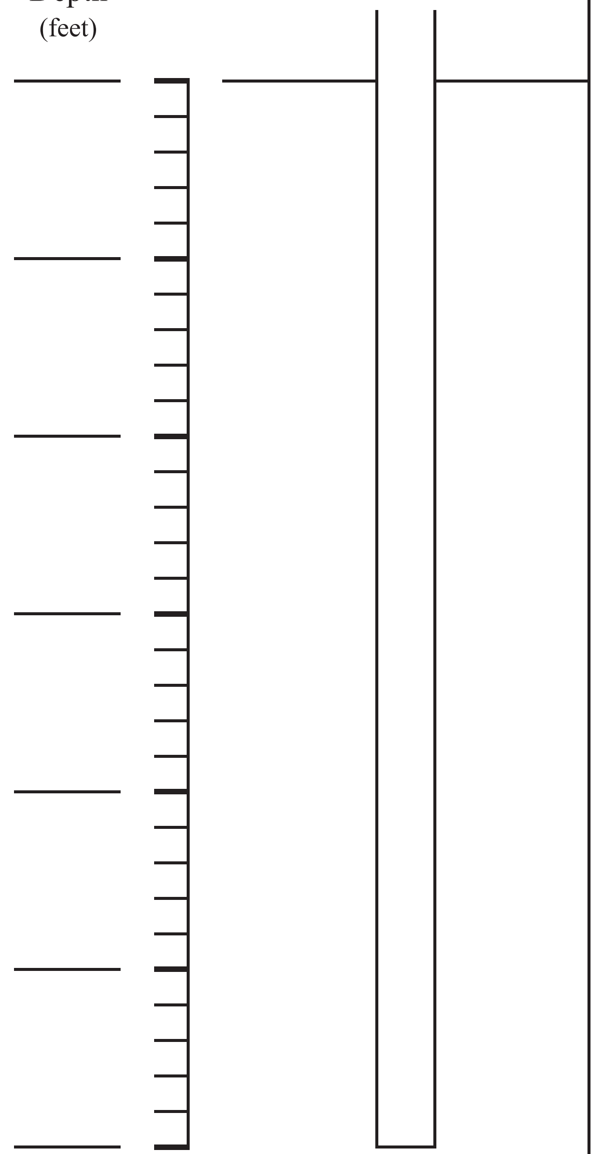
Interval grouted (FBLS)	
# of batches prepared	

<u>For each batch record:</u>

Quantity of water used (gal.)	
Quantity of cement used (lbs.)	
Cement type	
Quantity of bentonite used (lbs.)	
Quantity of calcium chloride used (lbs.)	
Volume of grout prepared (gal.)	
Volume of grout used (gal.)	

WELL SCHEMATIC*

Depth
(feet)



COMMENTS:

* Sketch in all relevant decommissioning data, including: interval overdrilled, interval grouted, casing left in hole, well stickup, etc.

Drilling Contractor

Department Representative

ATTACHMENT 6 – MISSOURI WELL ABANDONMENT FORM

MISSOURI DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY PROGRAM

MONITORING WELL/TEST HOLE/SOIL AND GEOTECHNICAL BORING PLUGGING REGISTRATION REPORT

FOR OFFICE USE ONLY	
REF NO.	DATE RECEIVED
CR NO.	CHECK NO.

ROUTE	APPROVED	DATE	ENTERED	STATE CERT NO.	REVENUE NO.
/ /					

OWNER AND SITE INFORMATION

PROPERTY OWNER NAME WHERE WELL IS LOCATED | PRIMARY PHONE NUMBER WITH AREA CODE

PROPERTY OWNER MAILING ADDRESS | CITY | STATE | ZIP CODE

PHYSICAL ADDRESS OF PROPERTY WHERE WELL IS LOCATED | CITY

NAME OF SITE, BUSINESS, OR CLEANUP PROJECT | DNR/EPA PROJECT NUMBER OR REGULATORY SITE ID NUMBER (IF APPLICABLE) | VARIANCE NUMBER (IF ISSUED)

PRIMARY CONTRACTOR NAME (PLEASE PRINT) | PERMIT NUMBER

Section 256.607(3), RSMo, requires all primary contractors to comply with all rules and regulations promulgated pursuant to Sections 256.600 to 256.640 RSMo.

LOCATION INFORMATION

Latitude ______° ______' ______"

Longitude ______° ______' ______"

COUNTY

______ ¼ ______ ¼ ______ ¼

Section ______ Township ______N Range ______ ☐ E ☐ W

MONITORING WELL INFORMATION

DATE WELL PLUGGED | ORIGINAL DRILLER (IF KNOWN) | DATE ORIGINALLY DRILLED (IF KNOWN) | REFERENCE NUMBER (IF KNOWN) | WELL NUMBER

DEPTH OF WELL ft. | STATIC WATER LEVEL ft. | LENGTH OF RISER AND SCREEN ft. | DIAMETER OF RISER AND SCREEN in. | RISER AND SCREEN PLUGGED IN PLACE ☐ Yes ☐ No (Removed) | PUMP OR SAMPLING EQUIPMENT REMOVED ☐ Yes ☐ No ☐ N/A | CASING REMOVED ☐ Yes ☐ No ☐ N/A

TEMPORARY MONITORING WELL/SOIL BORING/GEOTECHNICAL BORING INFORMATION

Quantity	Depth of Well or Boring (ft.)	Diameter (in.)	Total Depth (Linear Feet) of All Wells or Borings

TOTAL NUMBER OF WELLS/BORINGS

AVERAGE DEPTH OF ALL WELLS/BORINGS

DATE FIRST WELL/BORING WAS PLUGGED | DATE LAST WELL/BORING WAS PLUGGED

TEST HOLE INFORMATION

DATE TEST HOLE PLUGGED | DEPTH OF WELL ft. | LENGTH OF GROUT PLUG Bottom ______ ft. Top ______ ft. | DAVIS FORMATION REACHED ☐ Yes ☐ No | MECHANICAL PACKER (IF USED) ☐ Yes, Depth ______ft. ☐ No | AMOUNT OF CLEAN FILL (IF USED) ______ Tons or ______ Cubic Yards | CASING REMOVED (CHOOSE ONE) ☐ Yes, Diameter of Remaining Borehole ______ in. ☐ No, Diameter of Casing ______ in.

PLUGGING INFORMATION (This section is required in addition to one of the well, soil boring or test hole sections above.)

WELL REMOVED BY EXCAVATION ☐ Yes ☐ No

GROUT INSTALLATION METHOD ☐ Gravity ☐ Tremie ☐ Pressure

GROUT MATERIAL USED
CEMENT ☐ Type I ☐ Type III
BENTONITE ☐ Chips ☐ Pellets ☐ Other ☐ Granular ☐ Slurry

NUMBER OF SACKS OF GROUT USED ______
LBS PER SACK ______

NUMBER OF GALLONS OF WATER USED PER SACK ______

GROUT HYDRATED TO SATURATION ☐ Yes ☐ No

FINISHED SURFACE MATERIAL ☐ Asphalt ☐ Concrete ☐ Soil ☐ Other

SURFACE MATERIAL DEPTH ______ ft. ______ in.

DRILLER NOTES

I hereby certify that the monitoring well herein described was plugged in accordance with the Department of Natural Resources requirements.

MONITORING WELL INSTALLATION CONTRACTOR | PERMIT NUMBER | DATE

MONITORING WELL INSTALLATION CONTRACTOR APPRENTICE (IF APPLICABLE) | PERMIT NUMBER | DATE

SEND COMPLETED FORM ALONG WITH $50 REGISTRATION FEE TO: MISSOURI DEPARTMENT OF NATURAL RESOURCES, MISSOURI GEOLOGICAL SURVEY, WELL INSTALLATION SECTION, PO BOX 250, ROLLA, MO 65402 PHONE: 573-368-2165 FAX: 573-368-2317 EMAIL: welldrillers@dnr.mo.gov
SUBMIT RECORD AND FEE WITHIN 60 DAYS AFTER WELL PLUGGING OR WITHIN 180 DAYS AFTER THE PLUGGING OF TEMPORARY WELLS
RECORD (AND FEE) MAY BE SUBMITTED ONLINE: dnr.mo.gov/mowells

ATTACHMENT 7 – STANDARD GROUNDWATER/ LEACHATE SAMPLING LOG

Standard Ground Water Sampling Log

Date ____________
Site Name ____________ Weather ____________
Location ____________ Well # ____________
Project No. ____________ Evacuation Method ____________
Personnel ____________ Sampling Method ____________

Well Information:

Depth of Well * ____________ ft.
Depth to Water * ____________ ft.
Length of Water Column ____________ ft.
Volume of Water in Well ____________ gal.(s)
3X Volume of Water in Well ____________ gal.(s)

Water Volume /ft. for:
____ 2" Diameter Well = 0.163 X LWC
____ 4" Diameter Well = 0.653 X LWC
6" Diameter Well = 1.469 X LWC

Volume removed before sampling ________ gal.(s)
Did well go dry? ________

* Measurements taken from [ ] Well Casing [ ] Protective Casing [ ] (Other, Specify) ____________

Instrument Calibration:

pH Buffer Readings
4.0 Standard ________
7.0 Standard ________
10.0 Standard ________

Conductivity Standard Readings
84 S Standard ________
1413 S Standard ________

Water parameters:

Gallons Removed	Temperature Readings	pH Readings	Conductivity Readings uS/cm	Turbidity Readings Ntu
initial	initial	initial	initial	initial

Water Sample:
Time Collected ________

Physical Appearance at Start
Color ____________
Odor ____________
Turbidity (> 100 NTU) ____________
Sheen/Free Product ____________

Physical Appearance at Sampling
Color ____________
Odor ____________
Turbidity (> 100 NTU) ____________
Sheen/Free Product ____________

Samples collected:

Container Size	Container Type	# Collected	Field Filtered	Preservative	Container pH

Notes:

ATTACHMENT 8 – LOW-FLOWS GROUNDWATER/ LEACHATE SAMPLING LOG

Low Flow Ground Water Sampling Log

Date ______________ Personnel ______________ Weather ______________

Site Name ______________ Evacuation Method ______________ Well # ______________

Site Location ______________ Sampling Method ______________ Project # ______________

Well information:

Depth of Well * ______________ ft.

Depth to Water * ______________ ft.

Length of Water Column ______________ ft.

Depth to Intake * ______________ ft.

* Measurements taken from

- [ ] Top of Well Casing
- [ ] Top of Protective Casing
- [ ] (Other, Specify)

Start Purge Time: ______________

		10.0%	0.1	3%	10 mV	10%	10%	100-500 ml/min
Elapsed Time (min)	**Depth To Water (ft)**	**Temperature (celsius)**	**pH**	**Conductivity (ms/cm)**	**Oxidation Reduction Potential**	**Dissolved Oxygen (mg/l)**	**Turbidity (NTU)**	**Flow Rate (ml/min).**

End Purge Time: ______________

Water sample:

Time collected: __________ Total volume of purged water removed: ______________

Physical appearance at start

Color ______________

Odor ______________

Sheen/Free Product ______________

Physical appearance at sampling

Color ______________

Odor ______________

Sheen/Free Product ______________

Field Test Results:

Dissolved ferrous iron: __________

Dissolved total iron: __________

Dissolved total manganese: __________

Analytical Parameters:

Sample	Container Type	# Collected	Field Filtered	Preservative	Container pH

Manually conducted K-Test:

Falling Test				Rising Test			
Date/Time	ET	Depth (ft)	Drawdown	Date/Time	ET	Depth (ft)	Drawdown

ATTACHMENT 9 – K-TEST LOG

	K-TEST LOG	WELL ID

Site:	**Project #**	**Personnel:**	**Page 1 of**
Client:			
Project Loc.:	**File #**		**Start date**
Test Objective:		**Weather:**	**End date**

Well information		**K-Test Information**		**Minitroll/Transducer Info**	
DTW (static head)		Screen:		Type	
Well depth		Interval (ft)		SN #	
LWC		Length (ft)		Model #	
Measurements:		Fully submerged		PSI	
TOC Casing Other		Partially submerged*			
Slug type:		Lithology:		Pocket PC: SN #	
Solid PVC		Test Method:		Laptop: SN #	
Length (ft)		Falling head			
		Rising head		Depth reading (ft)	
Water		Head change during test (ft):		Depth minitroll (ft)	
Length (ft)		Falling head		Time start	
		Rising head		Time end	
Well condition:		Recovery %: (95% optimal)		Time interval (sec/min)	
Obstructions		Falling test			
Siltation		Rising test		* If partially submerged only rising test recommended.	

Manually conducted K-Test:

Falling Test				Rising Test			
Date/Time	ET	Depth (ft)	Drawdown	Date/Time	ET	Depth (ft)	Drawdown

over →

ATTACHMENT 10 –SURFACE WATER/SEEP SAMPLING RECORD

PARSONS
SURFACE WATER/SEEP SAMPLING RECORD

SITE NAME: ______________________

PROJECT NUMBER: ______________________

SAMPLING DATE / TIME: ______________________

WEATHER: ______________________

SAMPLERS: __________ of __________

__________ of __________

SAMPLE ID: ______________________

SAMPLING METHOD: ______________________

DEPTH OF SAMPLE: ______________________

DESCRIPTION OF SAMPLING POINT

LOCATION: ______________________

PHYSICAL APPEARANCE: ______________________

DEPTH TO BOTTOM: ______________________

DRAINAGE DIRECTION: ______________________

UPSTREAM FROM: ______________________

DOWNSTREAM FROM: ______________________

SAMPLE DESCRIPTION

COLOR: ______________________

ODOR: ______________________

SUSPENDED MATTER: ______________________

OTHER: ______________________

FIELD TESTS

TEMPERATURE:	deg C	REDOX:	mV
pH:		DISSOLVED O2:	mg/L
CONDUCTIVITY:	ms/cm	TURBIDITY:	NTUs

SAMPLE ANALYSIS / QA/QC / CHAIN OF CUSTODY

ANALYZE FOR: ______________________

QA/QC SAMPLE ID: ______________________

ANALYZE QA/QC SAMPLES FOR: ______________________

DATE/TIME REFRIGERATED: ______________________

CHAIN OF CUSTODY NUMBER: ______________________

SHIPPED VIA: ______________________

LABORATORY: ______________________

COMMENTS / MISCELLANEOUS

____

____

____

ATTACHMENT 11 – SEDIMENT SAMPLING RECORD

PARSONS
SEDIMENT SAMPLING RECORD

SITE NAME: ____________________

PROJECT NUMBER: ____________________

SAMPLING DATE / TIME: ____________________

WEATHER: ____________________

SAMPLERS: __________ of __________

__________ of __________

SAMPLE ID: ____________________

SAMPLING METHOD: ____________________

DEPTH OF SAMPLE: ____________________

DESCRIPTION OF SAMPLING POINT

LOCATION: ____________________

PHYSICAL APPEARANCE: ____________________

DEPTH OF WATER: ____________________

DRAINAGE DIRECTION: ____________________

UPSTREAM FROM: ____________________

DOWNSTREAM FROM: ____________________

SAMPLE DESCRIPTION

TEXTURE: ____________________

COLOR: ____________________

ODOR: ____________________

OTHER: ____________________

FIELD TESTS

TEMPERATURE: __________ REDOX: __________

pH: __________ DISSOLVED O2: __________

CONDUCTIVITY: __________ OTHER: __________

SAMPLE ANALYSIS / QA/QC / CHAIN OF CUSTODY

ANALYZE FOR: ____________________

QA/QC SAMPLE ID: ____________________

ANALYZE QA/QC SAMPLES FOR: ____________________

DATE/TIME REFRIGERATED: ____________________

CHAIN OF CUSTODY NUMBER: ____________________

SHIPPED VIA: ____________________

LABORATORY: ____________________

COMMENTS / MISCELLANEOUS ____________________

ATTACHMENT 12 – SURFACE SOIL SAMPLING RECORD

PARSONS
SURFACE SOIL SAMPLING RECORD

SITE NAME: ______________________
PROJECT NUMBER: ______________________
SAMPLING DATE / TIME: ______________________
WEATHER: ______________________
SAMPLERS: ____________ of ____________
____________ of ____________

SAMPLE ID: ______________________
SAMPLING METHOD: ______________________
DEPTH OF SAMPLE: ______________________

DESCRIPTION OF SAMPLING POINT

LOCATION: ______________________
PHYSICAL APPEARANCE: ______________________
VEGETATION: ______________________
DRAINAGE DIRECTION: ______________________

SAMPLE DESCRIPTION

TEXTURE: ______________________
COLOR: ______________________
ODOR: ______________________
OTHER: ______________________

FIELD TESTS

VOCs: ____________ ppm
ALPHA: ____________ cpm
BETA: ____________ cpm
GAMMA: ____________ cpm

SAMPLE ANALYSIS / QA/QC / CHAIN OF CUSTODY

ANALYZE FOR: ______________________
QA/QC SAMPLE ID: ______________________
ANALYZE QA/QC SAMPLES FOR: ______________________
DATE/TIME REFRIGERATED: ______________________
CHAIN OF CUSTODY NUMBER: ______________________
SHIPPED VIA: ______________________
LABORATORY: ______________________

COMMENTS / MISCELLANEOUS ______________________