US Army Corps of Engineers®
Buffalo District
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Sampling and Analysis Plan
Final

Balance of Plant Operable Unit
Investigation to Refine the Extent of Soil Contamination
Niagara Falls Storage Site
Lewiston, New York
Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. W912QR-12-D-0023
Delivery Order No. DN02

U.S. Army Corps of Engineers
Buffalo District
Buffalo, New York

Prepared by:
URS Group, Inc.

October 2013

INTRODUCTION

This Sampling and Analysis Plan (SAP) describes activities to be completed during the Balance of Plant (BOP) Operable Unit Investigation to Refine the Extent of Soil Contamination at the Niagara Falls Storage Site (NFSS), Lewiston, New York.

This document was prepared by URS Group, Inc. (URS) for the United States Army Corps of Engineers (USACE) under the Formerly Utilized Sites Remedial Action Program (FUSRAP) in partial fulfillment of the requirements of Contract W912QR-12-D-0023, Delivery Order DN02. Technical oversight responsibilities for the tasks described in this document will be provided by the U.S. Army Corps of Engineers (USACE), Buffalo District.

This SAP consists of two components: a Field Sampling Plan (FSP), which follows, and a Quality Assurance Project Plan (QAPP), included as a separate volume.

The FSP covers the overall objectives of the investigation, outlines the tasks to be completed, and provides guidance and procedures to be followed while completing the effort.

The QAPP describes data quality objectives to be applied, the analytical methods and measurements, quality assurance/quality control (QA/QC) protocols for the work efforts, and the data assessment procedures for the evaluation and identification of any data limitations.

US Army Corps of Engineers
Buffalo District
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Volume 1
Field Sampling Plan
Final

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COMPLETION OF INDEPENDENT TECHNICAL REVIEW

URS Group, Inc. (URS) has completed the *Field Sampling Plan* for the Niagara Falls Storage Site Balance of Plant Operable Unit Investigation to Refine the Extent of Soil Contamination, Lewiston, New York. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with existing USACE policy.

[redacted]

Signature/URS Plan Preparer – [redacted] — 17 October 2013 — Date

[redacted]

Signature/URS Independent Technical Reviewer [redacted] — 17 October 2013 — Date

[redacted]

Signature/URS Project Manager – [redacted] — 17 October 2013 — Date

CERTIFICATION OF INDEPENDENT TECHNICAL REVIEW

Significant concerns and the explanation of the resolution are as follows:

Item	Technical Concerns	Possible Impact	Resolutions
	None		

As noted above, all concerns resulting from independent technical review of the plan have been resolved.

[redacted]

Sign [redacted] — 17 October 2013 — Date

Balance of Plant Operable Unit
Investigation to Refine the Extent of Soil Contamination
Niagara Falls Storage Site
Lewiston, New York
Sampling and Analysis Plan
Volume 1 – Field Sampling Plan

FINAL

Authored By:	[redacted]	17 October 2013
	[redacted] Project Manager	Date
Authored By:	[redacted]	17 October 2013
	[redacted] Site Radiation Safety Officer	Date
Reviewed By:	[redacted]	17 October 2013
	[redacted] Certified Health Physicist	Date
Approved By:	[redacted]	17 October 2013
	[redacted] Project Manager	Date

[X] New Plan

[ ] Title Change

[ ] Plan Revision

[ ] Plan Rewrite

Effective Date 17 October 2013

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LIST OF ACRONYMS

AEC	Atomic Energy Commission
AGI	American Geosciences Institute
AOC	area of contamination
APP	Accident Prevention Plan
ASTM	American Society for Testing and Materials
BOP	Balance of Plant
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHHM	Certified Hazardous Materials Manager
CHP	Certified Health Physicist
COLIWASA	composite liquid waste samplers
COR	Contracting Officer's Representative
cpm	count per minute
cm	centimeter
cm/sec	centimeters per second
CWM	Chemical Waste Management
COC	chain-of-custody
CO	carbon monoxide or Contracting Officer
CQC	Contractor Quality Control
cu yd	cubic yard
DoD	Department of Defense
DOE	Department of Energy
DOL	United States Department of Labor
DOT	New York Department of Transportation
DQCR	Daily Quality Control Report
DQO	data quality objectives
DNAPL	dense non-aqueous phase liquid
EOD	explosive ordinance disposal
EM	electromagnetic or Engineering Manual
EPA	Environmental Protection Agency
EU	Exposure Unit
eV	electron volt
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet/foot
FUSRAP	Formerly Utilized Sites Remedial Action Program
GIS	Geographical Information System
GPS	Global Positioning System
HCL	hydrochloric acid
HDPE	High Density Polyethylene
Hg	Mercury
HSO	Health and Safety Officer
HTRW	Hazardous, Toxic and Radioactive Waste
H_2S	Hydrogen Sulfide
IATA	International Air Transportation Association
ID	identification

in	inch/inches
IWCS	Interim Waste Containment Structure
IDW	Investigation-Derived Waste
KCl	potassium chloride
LB	large bore
LEL	Lower Explosive Limit
LNAPL	light non-aqueous phase liquid
LOOW	Lake Ontario Ordnance Works
LWBZ	Lower Water-Bearing Zone
m	meter
MC	macro core
MED	Manhattan Engineer District
MGM	multi-gas meter
MGP	manufactured gas plant
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mm	millimeter
MS	matrix spike
mS/cm	millisiemens per centimeter
MSD	matrix spike duplicate
mV	millivolts
NAD	North American Datum
NaI	sodium iodide
NAPL	non-aqueous phase liquid
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NIST	National Institute of Standards and Technology
NFSS	Niagara Falls Storage Site
NRC	Nuclear Regulatory Commission
NRRPT	National Registry of Radiation Protection Technologists
NTU	nephelometric turbidity unit
ORP	oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
OSO	On-site Safety Officer
OU	Operable Unit
O_2	Oxygen
PAH	polycyclic aromatic hydrocarbons
pCi/g	picocuries per gram
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan
Ra	radium
Ra-226/228	radium-226/228
RCRA	Resource Conservation and Recovery Act

RFP	request for proposal
RI	Remedial Investigation
RPP	Radiation Protection Plan
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SDSFIE	Spatial Data Standard for Facilities, Infrastructure and Environment
SOP	standard operating procedure
SOW	scope of work
SRSO	Site Radiation Safety Officer
SSHO	Site Safety and Health Officer
TC	toxicity characteristics
Th	thorium
Th-230	thorium-230
TNT	trinitrotoluene
TSC	temporary storage container
TSDF	treatment, storage, and disposal facility
U	uranium
UEL	upper explosive limit
UFP	Uniform Federal Policy (p.1-5)
U-235	uranium-235
U-238	uranium-238
µm	micrometer
URS	URS Group, Inc.
U.S.	United States
USACE	United States Army Corps of Engineers
USCS	Unified Soils Classification System
USDOE	United States Department of Energy
USDOT	United States Department of Transportation
UWBZ	upper water-bearing zone
VOC	volatile organic compound

1.0 INTRODUCTION

This document was prepared by URS Group, Inc. (URS) for the United States Army Corps of Engineers (USACE) under the Formerly Utilized Sites Remedial Action Program (FUSRAP), in partial fulfillment of the requirements of Contract 912QR-12-D-0023, Delivery Order DN02. Technical oversight responsibilities for the tasks described in this document will be provided by the U.S. Army Corps of Engineers (USACE), Buffalo District.

URS will conduct a Balance of Plant Operable Unit Investigation to Refine the Extent of Soil Contamination at the Niagara Falls Storage Site (NFSS). This Field Sampling Plan (FSP) presents the overall objectives of the investigation, outlines the tasks to be completed, and provides guidance and procedures to be followed while completing the effort.

1.1 Site Description

The NFSS is located at 1397 Pletcher Road in the Town of Lewiston (Figure 1). The NFSS represents a portion of the Lake Ontario Ordnance Works (LOOW), a former trinitrotoluene (TNT) production plant which shut down in 1943. Portions of the LOOW site were used by the USACE Manhattan Engineer District (MED) and U.S. Atomic Energy Commission (AEC) to store radioactive residues and other materials beginning in 1944. Much of the radioactive residues sent to the NFSS originated from uranium processing activities conducted for MED and AEC at the Linde Air Products facility in Tonawanda, New York, the Mallinckrodt Chemical Works refinery in St. Louis, Missouri, and the Middlesex Sampling Plant in Middlesex, New Jersey.

Radiological constituents of concern at NFSS include isotopic uranium (U), isotopic thorium (Th), and radium (Ra)-226/228. Other constituents that occur on-site in lesser amounts include daughter products of the uranium series (Uranium-238 [U-238]) and, to some extent, the actinium (Ac) series (Uranium-235 [U-235]). Some volatile organic compound (VOC) contaminants are also present at the site.

Between 1982 and 1986, the US Department of Energy (USDOE) consolidated radioactive materials from a portion of the LOOW into a 10-acre Interim Waste Containment Structure (IWCS) on the NFSS (see Figure 2). The IWCS is an engineered landfill designed to retard radon emissions, infiltration from precipitation, and migration of contamination to groundwater.

During the development of the remedial investigation (RI), the NFSS was divided into 14 soil exposure units (EU) (Figure 2). An EU is defined as the geographic area in which a future receptor (for purposes of the baseline risk assessment) is assumed to work or live, and where a receptor may be exposed to site-related contaminants.

1.2 Site Geology

The geology of the NFSS is presented below, from shallowest to deepest:

- Surficial Soils and Fill - The surficial soil at the NFSS consists of a loose to medium dense, brown to yellowish silt with organic matter. Gravel and sands are generally encountered and are dispersed randomly throughout the unit. Thicknesses of surficial deposits vary from 0 to 1.5 meters (m) (0 to 5 feet [ft]), with an average range of 0.3 to 0.6 m (1 to 2 ft). The landscape in some areas of the NFSS is routinely maintained and contains several centimeters (cm) (inches [in]) of loamy topsoil and grass.

- Brown Clay Unit - The Brown Clay Unit, also known as the "Upper Clay Till" or the "Brown Clay Till," is a brownish or reddish, poorly sorted, brown silty clay till deposit indicative of a ground moraine. The thickness of the unit varies from 1.8 to 7 m (6 to 23 ft). The consistency of the upper clay till ranges from medium soft to hard with plasticity increasing with depth. Thin sand and silt seams, pockets, and lenses are more common in the basal portion of the unit.

  The sand and silt lenses in the basal portion of this unit range from thin partings (i.e., small joints in clay) up to 1.5 m (1 to 5 ft) in thickness. The lateral extent and thickness of these lenses varies abruptly. These intermittent sand lenses likely represent glaciofluvial deposits and are generally vertically and horizontally discontinuous. When saturated, these lenses, pockets and/or seams are most likely not hydraulically interconnected and do not represent a continuous water-bearing zone or aquifer. The sand and gravel in the lenses are usually moist to saturated and vary from loose to dense. Occasional extensive deposits of sand and gravel 5.3 to 6.1 m (17.5 to 20 ft) in thickness occur within the Brown Clay Unit.

- Gray Clay Unit - The Gray Clay Unit, also known as the "Glacio-Lacustrine Clay Unit," is of lacustrine origin. Coarse-grained sand and gravel lenses of the Brown Clay Unit are found intermittently along the top of the Gray Clay Unit and are not representative of a contiguous lithologic unit. The Gray Clay Unit occasionally grades vertically to a silt and sand mixture and lenses of fine to medium-grained sand are dispersed throughout the unit. A "Middle Silt Till Unit" is found occasionally off-site where the lower portion of the Gray Clay Unit is absent. The overall consistency of the unit ranges from soft to medium soft, with clay portions being slightly to highly plastic. The clay is generally wet and sand lenses are wet to saturated.

  The thickness of the Gray Clay Unit varies from less than 1.5 to 9.1 m (5 to 30 ft) and it is the thickest unconsolidated unit on-site.

- Sand and Gravel Unit - The Sand and Gravel Unit, also referred to as "Alluvial Sand and Gravel," consists of clean sand to mixtures of sand, gravel, and silt. The unit is glaciofluvial in origin, normally wet to saturated, and exhibits loose to medium relative density. In general, the thickest portions of the unit are present where depressions occur in the underlying bedrock.

  The Sand and Gravel Unit is approximately 0.9 to 2.1 m (3 to 7 ft) in thickness and occurs 4.6 to 8.5 m (15 to 28 ft) below ground surface (bgs).

- Red Silt Unit - The Red Silt Unit, referred to as the "Basal Red Till," consists of angular fragments of red shale bedrock in a sandy silt matrix that suggests that this is a lodgement till. The Red Silt Unit is composed of clayey, gravelly silt with lesser amounts of sand. Gravel is dispersed throughout the unit and consists of both rounded and angular fragments of bedrock. This unit is generally dry to moist, over-consolidated, and ranges from medium to very dense. The Red Silt Unit varies in thickness from 0 to 2.1 m (0 to 7 ft). The top of the Red Silt Unit varies across the NFSS from a minimum of 5.1 m (17 ft) bgs to a maximum of 13.7 m (45 ft) bgs. The base varies from 6.7 to 14.9 m (22 to 49 ft) bgs.

- Queenston Formation - The Queenston Formation is the uppermost bedrock unit beneath the NFSS and consists of brownish red shale, siltstone, and mudstone. The top 1.8 to 3.7 m (6 to 12 ft) of the Queenston Formation are moderately weathered, fractured and more permeable than lower portions of the formation. The Queenston Formation is typically encountered 9.75 to 14.9 m (32 to 49 ft) bgs.

1.3 Site Hydrogeology

There are two water-bearing zones identified at the NFSS: the upper water-bearing zone (UWBZ) and the lower water-bearing zone (LWBZ).

The UWBZ is typified by clayey silt and silty clay with occasional sand and gravel lenses. Coarse-grained, possibly channel fill deposits, are sporadically present in the basal portion of the zone on the undulating upper surface of the Gray Clay Unit. However, based on boring logs and recent statistical analysis, these sand seams, pockets, and lenses are intermittent and vertically and horizontally discontinuous. USACE performed a geostatistical analysis to assess the continuity of sand lenses in the UWBZ at the NFSS to evaluate whether the sand lenses act as preferential migration pathways for contamination. Lithologic information from boring logs was spatially analyzed using semivariogram calculations and models. The results suggest the sand lenses in the UWBZ are not horizontally continuous over distances greater than 4.5 to 6.1 m (15 to 20 ft).

Saturated conditions occur in the UWBZ in both the continuous, low permeability clays and in the discontinuous lenses of sand and gravel. Throughout the UWBZ, the coarse-grained lenses, pockets and seams vary considerably in thickness and extent and range from dry to saturated. As a result, the occurrence of groundwater varies across the NFSS.

The Gray Clay Unit (Unit 3) acts as an aquitard separating the UWBZ from the LWBZ. For purposes of classification, wells that terminate in the Gray Clay Unit are considered representative of the UWBZ.

The LWBZ extends from the bottom of the Gray Clay Unit to the bottom of the weathered zone of the Queenston Formation and consists of the stratified sands and gravels of the Sand and Gravel Unit, the dense silt and sands of the Red Silt Unit, and the weathered and fractured upper portions of the Queenston Formation. The thickness of the LWBZ varies from about 3.0 to 11.7 m (10 ft to about 38.5 ft). The LWBZ has significantly higher permeability and more lateral continuity than the UWBZ.

The general direction of groundwater flow in the LWBZ is to the northwest. The highest gradients occur south of the NFSS and the Modern Landfill property.

Reference Documents

This project will be performed in accordance with the Scope of Work (SOW) and the following documents:

- American Society for Testing and Materials (ASTM) D6914 – 04E1, Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
- “Report of the Results for the Remedial Investigation of Underground Utility Lines Formerly Used by the Department of Defense, Lake Ontario Ordnance Works (LOOW)”
- Uniform Federal Policy (UFP) QAPP
- USACE EM 385-1-1, 15 September 2008, Safety and Health Requirements Manual
- USACE ER 385-1-92 (1 May 2007) Safety and Occupational Health Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) Activities
- USACE ER 385-1-80 (30 June 2010) Ionizing Radiation Protection
- USACE EM 385-1-80 (30 May 1997) Radiation Protection Manual
- USACE EM 385-1-1 Section 25 Excavation and Trenching
- USACE EM-1110-35-1 Management Guidelines for Working with Radioactive and Mixed Waste
- USACE EM 1110-1-1804 Geotechnical Investigations
- USACE EM 1110-1-1003 (July 1, 2003) NAVSTAR Global Positioning System Surveying
- USACE EM 1110-1-1005 (January 1, 2007) Control and Topographic Surveying
- USACE EM 1110-1-1802 (August 31, 1995) Geophysical Exploration for Engineering and

Environmental Investigations

- USACE document Policies, Guidance and Requirements for Geospatial Data and Systems, ER-1110-1-8156 (September 1995)
- United States Department of Labor Occupational Safety and Health Administration (USDOL OSHA) 29 Code of Federal Regulations (CFR) 1926 Safety and Health Regulations for Construction
- USDOL OSHA 29 CFR 1910 Occupational Safety and Health Standards
- USDOL OSHA 29 CFR 1910.120 or 1926.65 HAZWOPER Standard
- UFGS-01 35 26 (February 2012) Governmental Safety Requirements
- UFGS-01 35 29.13 (January 2008) Health, Safety, and Emergency Response Procedures for Contaminated Sites
- U.S. Nuclear Regulatory Commission (NRC) 10 CFR Part 20 Standards of Protection Against Radiation
- USACE Engineering Form ENG 5056 - HTRW Drilling Log
- 29 CFR 1926 Subpart P, Safety and Health Regulations for Construction, Excavations
- Environmental Protection Agency (EPA) 540/G-91/009 Management of Investigation-Derived Wastes During Site Inspections
- EP-200-1-2 Process and Procedures for Resource Conservation and Recovery Act (RCRA) Manifesting
- Spatial Data Standard for Facilities, Infrastructure and Environment (SDSFIE) 3.0 Gold

2.0 PROJECT UNDERSTANDING

2.1 Project Objectives

The objectives of this field investigation in support of the BOP Operable Unit (OU) Feasibility Study (FS) are to:

- Delineate soil contamination at 378 locations across the NFSS,
- Expose and evaluate the former LOOW sanitary sewer in the EU11,
- Perform a geophysical survey in the area south of the IWCS to identify the presence of buried structures, and
- Manage/sample/dispose of existing Investigation-Derived Waste (IDW) and IDW that will be generated during the field investigation.

2.2 Primary Field Investigation Activities

2.2.1 Soil Borings

Borings will be advanced at 378 locations across the NFSS (see Figures 3 through 10 and Table 1). Each boring will be advanced to an approximate depth of 0.91 m (3 ft). Soil samples will be retained from the 0- to 15-cm (0- to 0.5-ft) interval, 15- to 61-cm (0.5- to 2-ft) interval, and 61- to 91-cm (2- to 3-ft) interval for laboratory analysis of select radionuclides. Some samples will be analyzed for PAHs.

2.2.2 Manhole MH06 Removal

Historically, manhole MH06, located in EU11 (see Figure 11), has contained uranium-impacted water. Although the manhole was plugged, water continues to accumulate in it. To ensure that the sewer associated with the manhole is properly plugged the manhole and underlying sewer will be removed and the resulting void space backfilled with concrete. Prior to initiating this task, URS will divert the water in South 31 Ditch to prevent the seepage of water from the ditch into the excavations. Details regarding the South Ditch diversion are described in Section 3.3.2, below.

2.2.3 Investigative Excavations in EU11

Recent groundwater analytical data for well OW11B and investigative excavations in the EU11 area have shown concentrations of uranium greater than the drinking water standard. Based on USACE's review of soil and groundwater data, the source for this uranium in groundwater is likely uranium in the soil that resulted from former activities in the area. However, the former LOOW sanitary sewer may also be a contributing factor, so investigative excavations will be conducted to inspect the sewer system and collect and analyze soil and groundwater samples (see Figure 11).

Four (4) soil samples will be collected from each excavation. One (1) sample will be collected from the top 0.15 meter (6 inches) of the highest radiological detector reading during the surface survey prior to excavation. One (1) sample will be collected from the bottom of the excavation and two (2) samples will be collected from the sidewalls of the excavation. These two samples will be collected from the locations with the highest radiological readings.

The soil samples will be collected using a hand auger or Macro core sampler attached to an extended handle.

If groundwater is encountered, one (1) filtered groundwater sample will be collected from each trench and analyzed in accordance with the analytical schedule provided herein.

The excavation area will be restored to its original grade and a confirmation gamma radiation survey will be conducted to document the final radiological condition of the area.

2.2.4 Geophysical Survey in Area South of IWCS

Several LOOW structures (building foundations, water and sewer lines, etc.) were located in the area south of the IWCS. A geophysical survey will be performed to delineate the presence and extent of these structures (see Figure 12).

2.3 Project Organization

The proposed project team, shown in the attached Project Organization Chart (see Figure 13), consists of staff from URS' Buffalo, New York, office with health physics support from our Salt Lake City, Utah, office. The project team is familiar with many of USACE's requirements and concerns, which will enable the work to be performed immediately, efficiently, safely and in accordance with USACE's policies and procedures.

The project will be managed out of our Buffalo office. The following table presents a list of key personnel that will work on the project:

Key Project Personnel

Title
Program Manager
Project Manager
URS Quality Assurance (QA)/Quality Control (QC) Officer
Certified Health Physicist (CHP)
Health Physics Support/ Site Radiation Safety Officer (SRSO)
Site Safety & Health Officer (SSHO)
Field Investigation Coordinator
Site Supervisor/Contractor Quality Control (CQC) System Manager (CQCM)
Site Supervisor/CQC System Manager (Alternate)
Project Chemist

The qualifications of key URS personnel and their organizational responsibilities are summarized below.

Program Manager. All correspondence with the USACE Contracting Officer (CO) will be transmitted through his office. The Program Manager will coordinate with the URS Project Manager to meet all base contract and project technical and administrative requirements. He also provides a critical outlet for USACE outside the project team and is in a position to coordinate with other senior URS executives to implement corrective actions.

Project Manager. The Project Manager will be the primary day-to-day contact with Buffalo USACE personnel and will be ultimately responsible for the technical and relational success of the effort. The Project Manager is a URS-certified Project Manager with over 29 years of experience performing and managing environmental investigations. The Project Manager also has more than eleven years of experience performing RI/FS activities at the LOOW for the USACE including functioning as URS' Project Manager for the recent BOP OU Field Investigation.

Project QA/QC Officer. In this role, the Project QA/AC Officer will function independently from the URS Project Manager to verify that URS QA/QC policy is implemented and to serve as the lead Independent Technical Reviewer. The Project QA/QC Officer is an engineer whose 37-year career includes project manager of three Dayton, Ohio, Formerly Utilized Sites Remedial Action Program (FUSRAP) projects for the Buffalo District (Dayton Unit 3 – Bonebreak Seminary; Dayton Unit 4 – Runnymede Playhouse; and Dayton Warehouse).

Senior Health Physicist. The Senior Health Physicist is a nuclear engineer with extensive experience working with radiological and mixed waste issues, including investigation and remediation of contaminated sites. The Senior Health Physicist's knowledge of USEPA, DOE, NRC, FUSRAP, and state regulations pertaining to the handling of such wastes has been applied in the investigation, remediation, and closure of thorium, radium, and uranium sites in eleven states. The Senior Health Physicist will provide senior level review of project deliverables and oversee project field health physics support personnel.

Field Investigation Coordinator. In this role, the Field Investigation Coordinator will aid the URS Project Manager in coordinating and monitoring the activities of the project team. The Field Investigation Coordinator is a senior geologist/project manager with 21 years of experience in environmental investigation and remediation. The Field Investigation Coordinator served as the Team Coordinator for the Linde 5-Year Review project completed for the USACE Buffalo District in 2010. The Field Investigation Coordinator will coordinate all field investigative activities including coordination of URS field resources as well as subcontractors. The Field Investigation Coordinator functioned as the Field Investigation Coordinator for the BOP Operational Unit (OU) Field Investigation.

Site Radiation Safety Officer. The Site Radiation Safety Officer has over 19 years of experience in radiological assessment and verification surveys; analyzing radiological and site data, and is the designated Radiation Safety Officer for URS's Utah Radioactive Materials License. The Site Radiation Safety Officer's areas of expertise include radiological assessments, radioactive material regulatory compliance, developing, reviewing and, implementing radiological work plans, radiation safety procedures, and radiological training programs to ensure safe handling of radioactive materials. The Site Radiation Safety Officer will conduct training and be on-site during the gamma walkover survey and coordinate the processing of the gamma walkover data to provide USACE with the required information to evaluate the need to adjust soil-boring locations. The Site Radiation Safety Officer will also oversee the initial soil scanning process and initial trench investigation activities by the Rad Technician to ensure compliance with project objectives and regulatory requirements (e.g., proper packing and labeling to conform with Federal and State Department of Transportation shipping requirements). The Site Radiation Safety Officer will be available via telephone to provide technical support during remaining portions of the project.

Site Safety and Health Officer. The Site Safety and Health Officer is a senior geologist with 22 years of experience in environmental investigation and remediation and is currently the URS Buffalo Office Safety Representative. The Site Safety and Health Officer has spent most of the past 10 years as the Team Coordinator for performance based remedial activities at the former Pease Air Force Base in Portsmouth, New Hampshire, the former Loring Air Force Base in Limestone, Maine, and the former Plattsburgh Air Force Base in Plattsburgh, New York. The Site Safety and Health Officer's responsibilities included supervising field staff, overseeing report preparation, interfacing with Air Force and regulatory agency personnel, implementing the health and safety program and ensuring health and safety compliance. The Site Safety and Health Officer functioned as a Field Geologist for the BOP OU Field Investigation. The Site Safety and Health Officer currently functions as the URS Buffalo office safety manager.

Site Supervisor/CQC System Manager. The Site Supervisor/CQC System Manager has over 9 years of experience in groundwater and soil investigation and remediation at various hazardous waste and radioactive/mixed waste sites. The Site Supervisor/CQC System Manager has been involved with investigation and remediation activities at the Hanford Site in Washington, West Valley Demonstration Project in New York, and various proposed low-level radioactive waste facilities in Utah. The Site Supervisor/CQC System Manager will also be responsible for overall management of CQC and have the authority to act in all CQC matters for URS.

Site Supervisor/CQC System Manager Alternate. Site Supervisor/CQC System Manager Alternate has over 12 years of experience in various geologic/hydrogeologic studies. Responsibilities have included drilling supervision during soil boring and monitoring well installation; collection of surface soil, subsurface soil, surface water, groundwater, soil vapor, indoor air, and Non-Aqueous Phase Liquid (NAPL) samples for analysis; preparation of boring logs; and assisting in the design of remediation systems. The Site Supervisor/CQC System Manager Alternate served as field geologist for investigation activities at the Shallow Land Disposal Area located in Parks Township, Pennsylvania under FUSRAP, as well as the Dayton Warehouse preliminary assessment/site inspection. The Site Supervisor/CQC System Manager Alternate functioned as the Field Geologist/CQC System Manager for the BOP OU Field Investigation.

Project Chemist. The Project Chemist is an Environmental Chemist with over 21 years of experience in data auditing/determining data usability, field/lab coordination, and preparing request for proposals (RFPs), subcontract agreements, and QAPPs. The Project Chemist will participate in preparation of project plans including the QAPP in accordance with the Uniform Federal Policy. The Project Chemist functioned as the Project Chemist for the BOP OU Field Investigation.

All field personnel will receive Radiological Worker/Authorized User training prior to commencement of field activities.

The following subcontractors will be involved in this project:

Soil Sampling and Excavation
Russo Development, Inc.
3710 Milestrip Road
Blasdell, New York 14129
Phone: 716-844-8745

Laboratory Analytical Services
TestAmerica-Saint Louis
13715 Rider Trail North
Earth City, Missouri 63045
Phone: 314-298-8566

Geophysical Survey
Hager-Richter Geoscience
8 Industrial Way, D-10
Salem, New Hampshire 03079
Phone: 603-893-9944

IDW – Solids Transportation & Disposal
Waste Technology Services, Inc.
435 North Second Street
Lewiston, New York 14092
Phone: 716-754-5400
EQ Wayne Disposal Facility
Belleville, Michigan

IDW – Liquids Transportation & Disposal
Perma-Fix Environmental Services, Inc.
2800 Solway Road
Knoxville, Tennessee 37931
Phone: 865-342-7609

2.4 Project Schedule

A detailed project schedule prepared using Microsoft Project is presented as Figure 14. The project schedule reflects the contract award date of August 28, 2013.

3.0 FIELD ACTIVITIES

The specific field investigative activities are described in this section. The investigation will focus on the primary contaminants of concern (i.e., select radionuclides and PAHs).

The investigative activities described herein will be performed in accordance with USACE-accepted technical work plans, quality assurance/control plans, and health and safety plans. Field activities will be performed in general accordance with URS' Standard Operating Procedures (SOPs) for select activities included in Appendix A unless otherwise stated in the following sections.

USACE will perform brush clearing as needed to allow easy access to investigation locations.

The fieldwork will include the following activities:

1. Conduct Global Positioning System (GPS) gamma radiation walkover surveys at each of the proposed soil boring locations, to locate the highest surface radiation level in the area.
2. Perform a geophysical survey to identify subsurface structures in the area south of the IWCS.
3. Advance 378 soil borings with the collection of three soil samples from each boring for laboratory analysis.
4. Excavation Activities:
    - Expose the sewer south of MH06.
    - Divert the water in South 31 Ditch
    - Remove manhole MH06.
    - Complete six investigative excavations to expose and inspect the former LOOW sanitary sewer in the EU11 area with the collection of soil and groundwater samples for laboratory analysis.
5. Survey the locations and elevations of investigation locations.
6. Restore areas disturbed during investigation activities.
7. Manage and dispose of IDW.

As one of the first field activities, URS and USACE will field locate the borings to be completed during the investigation. The borings will be located using GPS. The USACE will provide the GPS with boring location coordinates uploaded to the unit. Each location will be marked with a survey stake/flag. Because of the large number of borings and the possibility that some stakes could be damaged during normal NFSS maintenance activities, the markouts will be conducted in phases.

Intrusive field activities will begin with soil borings in the EU11 area. Once those borings have been completed, excavation activities will begin in that area, along with the geophysical survey in the area south of the IWCS. Excavation activities will be completed concurrent with the completion of the remaining soil borings.

Areas disturbed during NFSS activities will be restored to a condition equal to that which existed prior to the commencement of work.

All work will meet the substantive and/or administrative requirements of all environmental permits, licenses, and/or certificates required to complete the work. URS will provide the USACE with copies of all required permits, permit equivalencies, licenses and certificates.

URS will have Health Physics (HP)/radiation technician staff on-site during mobilization, fieldwork, and demobilization activities in accordance with the Work Plans. HP/radiation technician staff will provide continuous coverage during invasive activities to scan soils and equipment, and identify any areas of highly contaminated soil requiring notification of the USACE. URS envisions using the following radiation detection equipment or equivalent during the project:

Radiation Field Instrumentation			
Instrument	**Detector**	**Radiation Detected**	**Function**
Ludlum Model 2221 scaler/ratemeter	Ludlum Model 44-10 NaI scintillator (2”x2”)	Gamma	Walk Over Survey Paired with a Trimble Geo6000 survey grade GPS, soil scanning
Ludlum Model 2221 scaler/ratemeter	Ludlum Model 44-9 Geiger-Mueller (pancake)	Alpha-beta-gamma	Soil screening timed counts & direct contamination
Ludlum Model 2360 dual channel scaler	Ludlum Model 43-93 scintillator	Alpha-beta	Soil sample timed counts
Ludlum Model 2221 scaler/ratemeter	Ludlum Model 2 NaI scintillator (2”x2”) w/Lead Shield	Gamma	Excavation timed counts
Ludlum Model 12 ratemeter	Ludlum Model 44-9 Geiger-Mueller (pancake)	Alpha-beta-gamma	Frisking - personnel, equipment
Ludlum Model 12s	Integrated NaI detector	Gamma	Radiation exposure rates
Ludlum Model 2929 dual channel scaler	Ludlum Model 43-10-1 scintillator	Alpha-beta	Smear counting

3.1 Radiation Survey

URS will initially gather background gamma radiation data from the area off-site toward Pletcher Road. Approximately 5,000 background measurements will be collected with a focus on areas with surface material (i.e., grass, gravel, bare dirt) similar to the on-site areas to be investigated. Background measurements will not be collected from areas covered by asphalt or concrete. The background data will be field processed and summary statistics generated using standard statistical formulas in Excel to provide field values for evaluation of the data gathered at the proposed sample locations.

A 9 square meter (3 m x 3 m) (100 square foot grid (10 ft x10 ft)) will be overlaid with the proposed boring survey flag/stake as the center point. In areas of greater borehole density, and in the area of proposed excavations, a survey grid will be established over the entire area, extending approximately 3 m (10 ft) beyond the perimeter boring/excavation locations.

A detailed gamma survey will be conducted to pinpoint the high gamma radiation measurement associated with each boring location. The high gamma radiation location will be marked with a pin flag. Field posting plot figures will be generated using Surfer®, a contouring and surface modeling software package which will allow for the data to be reviewed at the NFSS and to have the USACE consulted regarding adjustments to the sample locations. Locations that exhibit significantly high gamma radiation levels will be marked to identify areas where ambient radiation levels may interfere with the collection of radiation data from the soil samples.

The gamma survey data will be field processed as described in RP-8.0 GPS "Gamma Radiation Surveys". Surfer posting plots will be generated which will show measurements above the NFSS background levels, the USACE's proposed sample location, and the highest gamma pin flag location. This data will be provided to the USACE field staff, and sampling locations may be adjusted based on review of the data.

3.2 <u>Soil Borings</u>

An estimated 378 soil borings will be completed. Each boring will be advanced to a depth of 0.9 m (3 ft). URS will be prepared to drill to a depth of 1.5 m (5 ft) if required by the USACE. Three soil samples are to be collected from each boring, with each soil sample representing the following intervals:

- 0- to 15-cm (0- to 0.5-ft) below grade,
- 15- to 61-cm (0.5- to 2-ft) below grade, and
- 61- to 91-cm (2- to 3-ft) below grade.

The surface sample (i.e., 0- to 15-cm (0- to 0.5-ft)) will be collected using a decontaminated shovel and/or trowel. If present, any non-soil material (e.g., grass, vegetation, asphalt, gravel, concrete) will be removed and either reused or properly discarded. The surface soil sample will then be collected from the underlying soil to a maximum depth of 15 cm (0.5 ft). The sampling area will be expanded as needed to ensure the collection of a sufficient volume of soil for the required analyses. The surface soil will be logged by URS's geologist and scanned for alpha, beta and gamma radioactivity (e.g., Ludlum Model 44-9 & Ludlum Model 43-93) and VOCs using a photoionization detector (PID). Prior to conducting the radioactivity scans the surface soils will be placed on plastic or in a container, and spread out into a consistent thickness, and then placed in appropriate sample containers.

The remaining portion of each boring will be advanced using an acetate-lined, 7.6 cm- (3-in) diameter Macro core sampler using direct-push drilling. Following sampling, each borehole will be backfilled with bentonite chips. Once the borehole has been backfilled, the area will be restored to a condition equal to that which existed prior to sampling. The boring location will be re-staked for subsequent surveying.

Soil Sampling/Screening

URS will establish a centralized sample preparation station in each general sampling area. For example, there are five locations to be delineated in EU1. URS will set up one sample preparation station in EU1. As the borings in EU1 are completed, the Macro core soil samples will be transferred to the sample preparation station where they will be placed on a plastic-lined work surface. The samples will be visually inspected, scanned for alpha, beta and gamma radioactivity (e.g., Ludlum Model 44-9 & Ludlum Model 43-93) and VOCs using a PID, and placed in appropriate sample containers.

Prior to sampling, a timed radiological measurement (Ludlum Model 44-10) will be collected on the soil surface. The initial 15 cm (0.5 ft) of soil will be removed and placed on plastic. Once sufficient material has been collected, radiological measurements will be collected from the sample material.

Using a direct-push drill rig, the core sampler will be driven to a depth of 0.9 m (3 ft). PID and radiological data will be gathered from the soil core from the 15 to 61-cm (0.5- to 2-ft) and 61- to 91-cm (2- to 3-ft) intervals.

URS will notify the USACE on-site representative if the field data indicates the need to advance the sampler to a greater depth. If needed, the boring will be advanced to the required depth. Each additional 31-cm (1-ft) interval will be scanned for PID and radiological measurements and additional samples collected for laboratory analyses as needed. If additional volume is needed, an additional boring will be advanced adjacent to the original boring. Soils from the same horizon will be composited to provide the needed sample volume.

URS will prepare a boring log for each boring using Engineering Form 5056 – HTRW Drilling Log. At a minimum, the following information will be provided on each log:

- Boring identification,
- Start and end dates,
- Geologist and driller names,
- Drilling company and equipment used,
- Hole diameter,
- Sample collection intervals and recoveries,
- Boring location (northing and easting) and elevation,
- Soil, rock, and/or fill material descriptions in accordance with ASTM D2488-06,
- Material boundaries or transitions,
- Depth to the water table,
- Radiological measurements will include; Surface gamma exposure rate
  For each subsequent interval the total pancake cpm, and the alpha cpm and beta cpm values from the 43-93 instrument, and
- PID scan measurements.

Decontamination

A radiological survey of the drill rig and drilling equipment will be completed prior to drilling activities and a free release survey will be conducted at the end of the work prior to the equipment leaving the NFSS.

Decontamination of sampling equipment will be performed between each boring location. Decontamination will consist of dry removal of soil followed by a wash with Alconox and water and a fresh water rinse. IDW suspected of containing elevated radiation or organic contaminant levels will be segregated from the remaining IDW.

Waste generated during decontamination will be containerized at the point of generation and transported to the IDW storage location. Radiological screening instrumentation will be available at all locations to confirm the adequacy of the dry decontamination effort. Wet equipment shall be dried before radiological screening.

Weekly waste surveys will be conducted to document the radiation levels in the waste storage area. Surveys of the waste packages will be conducted on the generator waste packages as soon as practical.

Decontamination fluids and solids (i.e., IDW) will be containerized as described in Section 3.7 below.

Soil Boring Sample Analysis

The soil samples collected from the soil borings will be submitted for laboratory analysis in accordance with the following schedule:

Soil Sample Analysis Schedule

PARAMETER	METHODS
Isotopic U-238 and Th-230	DOE EML HASL-300m, Alpha Spectroscopy
Ra-226	EPA 901.1, Gamma Spectrscopy
PAHs (select samples)	EPA SW846 8270D-Selected Ion Monitoring (SIM)

In order to comply with USACE sampling protocols, the collection frequency of field duplicates and matrix spike (MS)/matrix spike duplicate (MSD) samples will be 10% and 5%, respectively, of the total number of soil samples collected. Note: MS/MSD samples are not required for the Ra-226 analyses.

Analytical results for samples collected from the field investigative activities will be received within standard turnaround time (not to exceed 28 days). URS's subcontract laboratory, TestAmerica, will provide the appropriate number of sample containers and coolers for all samples. Sample coolers will be scanned upon receipt for surface contamination. Samples from locations with high radiation levels will be specially labeled, as required by the laboratory, and segregated to ensure the total package does not exceed the 49 CFR 173.421 limited quantity requirements. The packaged shipments will undergo a radiological survey to document they are in compliance with Department of Transportation (DOT) surface contamination and dose rate guidelines, and properly labeled as UN2910 radioactive material, excepted package-limited quantity.

URS will ship the samples, following proper handling, preservation, and COC protocols, to the laboratory under the supervision of the USACE Health Physicist or other designated USACE personnel. TestAmerica will provide courier service to deliver the sample containers to the NFSS and pick up the samples.

3.3 Excavations

3.3.1 General Excavation Requirements

Prior to commencing excavation activities, as mentioned in Section 3.2 above, URS will perform a gamma walkover survey of the proposed excavation areas. URS will then repeat the survey following completion of excavation activities.

Per EM 385-1-1 Section 25, an Excavation/Trenching Plan will be submitted and accepted by the USACE prior to beginning excavation operations. The Excavation/Trenching Plan is included as Attachment 12 of the Accident Prevention Plan (APP).

Excavation walls will be braced, sloped and/or benched in accordance with applicable Federal, state, and local regulations and requirements to maintain stable sidewalls for personnel to safely enter the trenches (as needed), perform radiological scans, record visual observations, and collect samples. Stable sides and slopes and/or benches will be maintained until excavated soils are returned to the field investigative trench. An OSHA-compliant scaffold stage and guardrail system will be used to allow personnel to safely scan/inspect the excavation walls when standing at grade. The excavation subcontractor, Russo, will provide a competent person to inspect and confirm safety aspects of the excavation.

Soils will be stockpiled next to the trench locations on plastic sheeting, laid out in the order of removal, and placed back into the trench once soil classification, radiological scanning, and sampling are completed. Gamma radiation measurements will be collected on the stockpiled soils during excavation. Soils will be returned to the trench in the reverse order of removal, the soils removed from the bottom of the excavation will be returned to the excavation first, followed by the next deepest soils and ending with the first soils removed from the excavation being returned last to the excavation. Each excavation location will be restored by compacting and re-grading to match adjacent grade followed by seeding and mulching.

Trenches may require dewatering. The dewatering plan is described in Attachment 12 of the APP. All excavation water generated during dewatering activities will be containerized in drums or in a poly tank and transported to the IDW storage area. Should a small volume of water seep into a trench, a sump will be created at the end or side of the trench into which the water will be directed. As needed, a submersible or trash pump will be used to transfer the water from the trench into a temporary storage tank at ground level. The water will be transferred to the IDW storage area for subsequent waste characterization and disposal.

While excavating, URS' field geologist will prepare a detailed excavation log including a description of soil types (using ASTM Method D2488-06 soil classification system) and location of radiological or soil anomalies. Excavation materials will be visually observed and described with respect to depth and location. Photographs of the excavations will be taken and referenced by location and direction for future use. Field activities and observations will also be logged in a bound field logbook and on a field investigative excavation log form. The excavation log will include, but not be limited to, the following:

- A plan view of the excavation;
- Survey coordinates of the excavation;
- Cross-sections of the excavation's walls;
- Project information including project number, location, owner, and client;
- Field information including date and time arrived and personnel responsible for logging the excavation;
- Description of soils, color, moisture content, consistency, gradation, and other pertinent data including each sequential boundary between soil types and individual lithologies;
- Depth of first-encountered free water along with the method of determination and any subsequent distinct water levels encountered thereafter;
- Excavation information including the excavation dimensions, excavation method, sampling method(s), and the start and end time of the excavation for the trench;
- Radiological count measurements from the trenches' sidewalls and bottom including the instrument used and calibration information;
- The static count measurement obtained at each sample location;
- The number of samples taken with location and sample number;
- Sample collection and preparation method;
- Backfill type and quantity (if necessary); and,
- Field observations.

A copy of the excavation log sheet will be submitted to the USACE Contracting Officer's Representative (COR) upon completion of the field investigation. The original excavation log will be maintained with the project file.

Radiological measurements will be collected from the sidewalls, and bottom of the trenches using a calibrated shielded sodium iodide (NaI) detector. The detector will be positioned to ensure the open face is positioned toward the location being measured and a timed count will be collected while the detector is slowly moved across an area of approximately of 0.46 square meters (5 square feet) [0.3 m (1ft) vertical, 1.5m (5 ft) horizontal]. Approximately 130 measurements will be collected per trench.

Four (4) soil samples will be collected from each excavation. One (1) sample will be collected from the top 0.15 meter (6 inches) of the highest radiological detector reading during the surface survey prior to excavation. One (1) sample will be collected from the bottom of the excavation and two (2) samples will be collected from the sidewalls of the excavation. These two samples will be collected from the locations with the highest radiological readings.

The soil samples will be collected using a hand auger or Macro core sampler attached to an extended handle.

If groundwater is encountered, one (1) filtered groundwater sample will be collected from each trench and analyzed in accordance with the analytical schedule provided herein.

The excavation area will be restored to its original grade and a confirmation gamma radiation survey will be conducted to document the final radiological condition of the area.

Each excavation will be surveyed for location, boundaries, dimensions, and elevations by a URS surveyor. Because the surveying will not be performed at the actual time of excavation, the depth of the excavation below ground surface will be measured with a tape measure at the time of excavation. The ground surface elevation will subsequently be surveyed by the surveyor.

3.3.2 Remove Manhole MH06

URS will remove the brick and mortar-constructed manhole MH06. Prior to initiating this task, URS will divert the water in South 31 Ditch to prevent the seepage of water from the ditch into the excavations. Details are provided below.

South 31 Ditch Diversion

Manhole MH06 is in very close proximity to South 31 Ditch. Excavation of manhole MH06 will involve diverting the flow of water in South 31 Ditch. To accomplish this, the two sets of culverts (four total) upstream and downstream of the portion of South 31 Ditch in the area of MH06 (this section of the ditch will herein be referred to as the “MH06 portion of South 31 Ditch”) will be blocked. Specifically, sand bags will be used to block the upstream side of the culverts leading into the MH06 area and the downstream side of the culverts leading to the Central Drainage Ditch. URS will measure the water level in MH07 prior to performing the work at MH06 to assess the potential hydraulic head that could flow from the trunk line connecting to MH06. Once the culverts are blocked, the water present within the MH06 portion of South 31 Ditch will be removed using a trash pump and discharged into the downstream section of the ditch. A pump and hose will then be used to divert the flow of water from the upstream portion of South 31 Ditch to the downstream portion of the ditch (see Figure 11).

In advance of this effort, USACE will contact the adjacent property owner, Modern Disposal, to inform them of the proposed ditch diversion work and to coordinate with Modern Disposal so that effluent discharges from the disposal facility do not occur during the ditch diversion.

Expose Sewer South of MH06

Following diversion of South 31 Ditch, the area south of MH06 will be excavated to expose the concrete encased sewer. The excavation will extend from the southern side of South 31 Ditch to MH06 (see Figure 11). The purpose of the excavation is to evaluate the sewer in this area. Based on the evaluation, any additional work needed will be discussed with USACE.

The soils removed from the excavation will be placed on plastic and scanned for radioactivity. No soil or groundwater samples will be collected from this excavation. Because of possible instability of the ditch sidewalls following dewatering, no personnel will enter the ditch/excavation; all inspections will be performed from grade. The excavation sidewalls and bottom will be scanned, where possible without entering the excavation, with a shielded NaI detector for radiologic impacts.

Following completion of the excavation, the soils will be returned to the excavation in the reverse order of removal and the ditch and side-slopes graded to match pre-existing conditions. The ditch will not require any further restoration. However, any portions of the excavation that extend beyond the sidewalls of the ditch will require restoration following procedures discussed in Section 3.6 below.

MH06 Removal

To minimize water entering the excavation during manhole removal, the sewer trunk line will be plugged at locations up-gradient and down-gradient of the manhole. Plugging the sewer trunk line will be accomplished by using a 10 cm (4-in) diameter core drill to penetrate the trunk line at a location approximately 3 m (10 ft) up-gradient and down-gradient of the manhole. If the water in the pipe is under gravity pressure, a 10 cm (4-in) PVC pipe will be inserted into the cored hole to prevent water from discharging into the excavation. Once a section has been cored, the sewer pipe will be plugged by adding concrete slurry through the cored hole.

After the sewer has been plugged, the water present in manhole MH06 will be removed and containerized for subsequent disposal. The manhole and underlying section of sewer will then be removed and placed in a plastic-lined roll-off(s).

Once the manhole has been removed, the sidewalls and bottom of the excavation will be scanned for radioactivity and soil and groundwater samples collected as discussed below in Section 3.3.3.

After scanning and sampling has been completed, the excavation will be backfilled with concrete to approximately 0.6 m (2 ft) above the concrete-encased sewer line. The remaining portion of the excavation will be backfilled with clean soil. Final NFSS restoration will be performed as described in Section 6 below.

3.3.3 Investigative Excavations

The SOW requires excavations to be performed to expose the former LOOW sanitary sewer to enable the collection of soil and groundwater samples for laboratory analyses. Following removal of MH06 and backfilling, URS will complete excavations to investigate approximately 27 m (90 ft) of the concrete-encased sewer line between the north side of manhole MH06 to the road north of former excavation IE7. The purpose of the excavations is to inspect the concrete-encased sewer for evidence of damage which may contribute to the flow of uranium-impacted groundwater in the area; to scan the excavation bottom and sidewalls for radioactivity; and to collect soil and groundwater samples.

Six excavations, each approximately 4.5 m long by 2 m wide by 2.6 to 4 m deep (15 ft long by 6 ft wide by 8 to 12 ft deep), will be completed along the approximately 49 m (160 ft) length from MH06 to the road north of former excavation IE7. To minimize the generation of groundwater, each excavation will be separated by approximately 3 m (10 ft) of unexcavated area. However, an excavation may be extended if warranted by the observation of damaged sewer or as requested by USACE. The excavations will be advanced to depths sufficient to visually inspect the top and sides of the concrete-encased sewer.

The approximate locations of the excavations are shown in Figure 11. The actual locations may be adjusted in the field to avoid subsurface utilities (e.g., buried electrical lines) and/or to avoid excavating previously investigated areas (e.g., IE7 and IE8).

Excavation Soil and Groundwater Sample Analysis

The soil and groundwater samples collected from the excavations will be submitted for laboratory analysis in accordance with the following schedule:

Excavation Soil and Groundwater Sample Analysis Schedule

PARAMETER	METHODS
Mass Uranium (Total-U) (water only)	ASTM D5174-02, Trace Uranium by Pulsed-Laser Phosphorimetry
Isotopic Uranium-234, 235 and 238	DOE EML HASL-300m, Alpha Spectroscopy
Radium- 226	EPA 903.1, Radon Emanation (water)/EPA 901.1, Gamma Spectroscopy (soil)
Isotopic Thorium-228, 230 and 232	DOE EML HASL-300m, Alpha Spectroscopy
Anions (unfiltered only)(water only)	EPA 300.0 or SW846 9056 Ion Chromatography
Total Dissolved Solids (unfiltered only) (water only)	Standard Methods 2540C or EPA 160.1
Alkalinity (unfiltered) (water only)	Standard Methods 2320B or EPA 310.1

(1) Groundwater samples for radiological parameters will be filtered via disposable 0.45 micron in-line field filters.
(2) This schedule does not include QA/QC samples, which will be in addition to those listed above

Four (4) soil samples will be collected from each excavation. One (1) sample will be collected from the top 0.15 meter (6 inches) of the highest radiological detector reading during the surface survey prior to excavation. One (1) sample will be collected from the bottom of the excavation and two (2) samples will be collected from the sidewalls of the excavation. These two samples will be collected from the locations with the highest radiological readings.

The soil samples will be collected using a hand auger or Macro core sampler attached to an extended handle.

If groundwater is encountered, one (1) filtered groundwater sample will be collected from each trench and analyzed in accordance with the analytical schedule provided herein.

The excavation area will be restored to its original grade and a confirmation gamma radiation survey will be conducted to document the final radiological condition of the area.

In order to comply with USACE sampling protocols, the collection frequency of field duplicates and MS/MSD samples will be 10% and 5%, respectively, of the total number of soil samples collected. Note: MS/MSD samples are not required for the Ra-226 analyses by gamma spectroscopy.

Analytical results for samples collected from the field investigative activities will be received within standard turnaround time (not to exceed 28 days). URS's subcontract laboratory, TestAmerica, will provide the appropriate number of sample containers and coolers for all samples. Sample coolers will be scanned upon receipt for surface contamination. Samples from locations with high radiation levels will be specially labeled, as required by the laboratory, and segregated to ensure the total package does not exceed the 49 CFR 173.421 limited quantity requirements. The packaged shipments will undergo a radiological survey to document they are in compliance with Department of Transportation surface contamination and dose rate guidelines, and properly labeled as UN2910 radioactive material, excepted package-limited quantity.

URS will ship the samples, following proper handling, preservation, and COC protocols, to the laboratory under the supervision of the USACE Health Physicist or other designated USACE personnel. TestAmerica will provide courier service to deliver the sample containers to the NFSS and pick up the samples.

3.4 Geophysical Survey

URS's geophysical subcontractor, Hager-Richter Geoscience, will perform a geophysical survey to identify the presence of utilities and other subsurface features in the area south of the IWCS and described as follows (see Figure 12): bound to the north by the toe of the slope of the IWCS, to the west by an imaginary line extending south from the western edge of the IWCS, to the east by the Central Drainage Ditch, and to the south by an imaginary line running east-west approximately through MH08.

Following completion of the work, GPS-configured maps will be provided to the USACE showing utility and subsurface appurtenances. Survey methods for utility locations will include electromagnetic (EM) and magnetometer. URS will comply with the following guidance as well as standard industry practice to plan and perform geophysical surveys:

- USACE EM 1110-1-1003 (July 1, 2003) NAVSTAR Global Positioning System Surveying;
- USACE EM 1110-1-1005 (January 1, 2007) Control and Topographic Surveying; and,
- USACE EM 1110-1-1802 (August 31, 1995) Geophysical Exploration for Engineering and

Environmental Investigations.

QA/QC of the geophysical survey data will be in accordance with the manufacturer's recommendations and URS' accepted work plans. QA/QC procedures will be performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis. URS will provide the QA/QC results to the USACE.

The geophysical survey will be conducted concurrently with other NFSS investigation activities.

Electromagnetic (EM-31)

The Geonics Ltd. EM-31 MK2 will be used during the survey. The EM-31 survey will be interfaced directly with a GPS, eliminating the need for a survey grid. The GPS coordinates will be electronically recorded simultaneously with the EM-31 measurements using a data logger. Data will be geo-referenced to North American Datum (NAD) 1983 New York State Plane Coordinates and NGVD 88 Datum. Graphical presentation of the EM-31 survey results will be provided including a site plan showing the area of investigation and data collection points. In addition, EM-31 modeling techniques will be employed to estimate depths to buried objects and probable subsurface layering.

Electromagnetic (EM-61)

The Geonics Ltd. EM-61 MK2 will be used during the survey. The EM-61 will be interfaced directly with a GPS, eliminating the need for a survey grid. The GPS coordinates will be electronically recorded simultaneously with the EM-61 measurements using a data logger. Data will be geo-referenced to NAD 1983 New York State Plane Coordinates and National Geodetic Vertical Datum (NGVD) 88 Datum. Graphical presentation of the EM-61 survey results will be provided including a site plan showing the area of investigation and data collection points. In addition, EM-61 modeling techniques will be employed to estimate depths to buried objects and probable subsurface layering.

Magnetometer

A Geometrics G858-G cesium vapor magnetometer will be used in the survey. The G858-G will be interfaced directly with a GPS. The GPS coordinates will be electronically recorded simultaneously with the magnetic measurements using a data logger. Data will be geo-referenced to NAD 1983 New York State Plane Coordinates and NGVD 88 Datum. Graphical presentation of the survey results will be provided including a site plan showing the area of investigation and data collection points. In addition, modeling techniques will be employed to estimate depths to buried objects and determine the subsurface layering.

3.5 Surveying

Each boring and excavation will be surveyed for location and elevation (and boundaries and dimensions for excavations), by a URS surveyor. The survey coordinates will be geo-referenced to NAD 1983 New York State Plane Coordinates and NGVD 88 Datum. Because the surveying will not be performed at the actual time of excavation, the depth of the excavation below ground surface will be measured with a tape measure at the time of excavation. The ground surface elevation will subsequently be surveyed by the surveyor.

3.6 Site Restoration

Following completion of excavation activities, URS will restore the NFSS to a condition equal to pre-investigation conditions. . Each excavation will be finished to grade, include a layer of clean topsoil, and properly seeded and mulched. URS will provide the USACE with certification of clean imported material prior to bringing the material on-site.

3.7 IDW Management and Disposal

IDW includes, but is not limited to, soil, liquid, and sludge generated during sampling activities, decontamination liquids, and waste personal protective equipment (PPE), and debris generated from MH06 removal. URS will take necessary handling and packaging procedures to avoid cross contamination.

URS will use waste minimization methods when dealing with IDW to the extent possible and comply with EPA 540/G-91/009, *Management of Investigation-Derived Wastes During Site Inspections* and applicable New York State and local regulations.

URS has identified the following waste streams that will be managed as part of this investigation:

1. Liquid wastes generated during decontamination.
2. Soils generated during sampling.
3. Contaminated (based on gamma scans and/or presence of visible contamination) soil, PPE, plastic, and other disposable materials used during sampling and waste management activities.

4. Non-contaminated PPE, plastic, and other disposable materials used during sampling and waste management activities.
5. Existing 5-gallon container of suspected chlorinated solvents.

3.7.1 IDW Management and Storage Requirements

URS will provide plastic-lined, tarp-covered 30 cubic yard (cu yd) roll-off containers for the storage of solid IDW generated during investigative activities. The roll-off containers will be stored at a centralized location approved by the USACE pending sampling, analysis, and disposal. The roll-offs will be labeled as "Waste Material" with appropriate labels, which will include the matrix, sampling locations, sampling depths, date, point of contact and telephone number.

URS has been informed that USACE will provide storage tanks (i.e., existing on-site poly tanks) to allow for temporary storage of liquid IDW and the efficient separation of liquids requiring different treatment/disposal options.

Materials displaying the presence of radiological contamination will be consolidated separately with any visibly contaminated material as 'radiological waste'.

PPE, High Density Polyethylene (HDPE) sheeting, disposable materials, and non-indigenous waste will be placed in trash bags at the point of generation. These bags of non-contaminated PPE, HDPE sheeting, disposable materials, and non-indigenous waste will be placed in the roll-offs. The PPE will be cut or torn to render it unusable prior to placement in the trash bags or containers.

URS will catalog and track all IDW generated during field investigative activities. Waste manifests and logs will be developed documenting all generated IDW. A logbook will be maintained that documents drum (or waste container) identification numbers, the type of waste, the generation start date, the storage time requirements, and personnel performing the waste containerization. The logbook will include a description of the drums contents (e.g., soil, water, etc.), and the total volume of IDW placed in the temporary on-site storage location.

3.7.2 IDW Sample Analysis and Disposal Requirements

Laboratory data will be used to classify the IDW as hazardous, non-hazardous, or radiological waste. IDW will be segregated and assembled by waste type and/or location of origin. URS will be responsible for supplying the data necessary to support transportation and off-site disposal of the IDW. Procedures for sample handling, preservation, containerization, shipping, holding times, and sample custody will be provided in the QAPP.

URS will sample the existing IDW (5 gallons of suspected chlorinated solvents) for waste characterization analysis for the purpose of off-site disposal.

Waste characterization parameters will be based on the acceptance criteria of the USACE-accepted disposal facility. Off-site disposal options will be determined based on the results of the waste characterization analysis. URS assumes that the IDW will be considered radioactive and therefore the waste will be analyzed for disposal at facilities permitted to accept such waste.

URS will comply with EM-1110-35-1, "Management Guidelines for Working with Radioactive and Mixed Waste and EP-200-1-2, "Process and Procedures for RCRA Manifesting". URS will submit the waste manifests to the USACE for review and signature. URS will not ship any contaminated material for disposal until the off-site sampling results have been provided to and approved by the USACE COR, and the USACE COR signs all shipping papers per Department of Defense (DOD) Regulation 4500.9-R.

URS will meet and submit all disposal facility requirements, including but not limited to, the disposal facility's waste acceptance criteria and prepare the waste profile sheets for shipping and disposal of the IDW. Radiological surveys to document compliance with DOT regulations will be conducted on individual waste packages or conveyances as appropriate. URS will be responsible for the rejection of any package or contaminated materials by the disposal facility for non-compliance with the requirements of the acceptance criteria at no additional costs to the Government. URS will not redirect a shipment without first obtaining USACE approval.

Work required to complete transportation to the disposal facility (loading, marking, labeling, manifesting, etc.), which is not otherwise specified, is considered incidental to and included in the costs required to complete this work.

URS will submit the Certification of Disposal and any shipment records to USACE within 10 days of receipt of contaminated material by the disposal facility.

URS assumes that the solid IDW will meet the requirements for disposal at the EQ Wayne facility in Belleville, Michigan (i.e., radium-226 less than 50 picocuries per gram [pCi/g] averaged over the load and combined total thorium and uranium less than 500 micrograms per kilogram [mg/kg]). The liquid IDW generated during the 2012 BOP Field Investigation was disposed of at a permitted and licensed facility.

4.0 FIELD OPERATIONS DOCUMENTATION

4.1 Daily Quality Control Report (DQCR)

A Daily Quality Control Report (DQCR) will be prepared documenting each day of project field operations. The DQCR will be signed by the Site Supervisor/CQC Manager and submitted electronically to the USACE Buffalo District Project Manager (PM) on a weekly basis. The DQCR will include, at a minimum, the following information:

- A daily summary of NFSS activities;
- Weather information;
- Field instrument measurements;
- Identification of all field and control samples collected;
- QA sample tables that match up primary, replicate QA/QC, and other field control samples (e.g., blanks);
- Copies of COC forms, field-generated analytical results, and any other project forms that are generated;
- Results of quality control activities performed including field instrument calibrations;
- List of Contractor/Subcontractors and area of responsibility for work performed;
- List of NFSS visitors;
- List of on-site equipment;
- Any deviations from the FSP including the justification for the deviation;
- Any problems encountered during daily field activities; and,
- A summary of any instructions received from USACE or government personnel.

A copy of the DQCR is included in Appendix B.

4.2 Field Logbook and Logsheet Requirements

All information pertinent to the field investigative activities, including field instrumentation calibration data, will be recorded in field logbooks. Each logbook will have the NFSS name and project name and number on the inside front cover. Sufficient information will be recorded in the logbooks to permit reconstruction of all conducted field investigative activities. The logbooks will be bound and the pages will be consecutively numbered and water resistant. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all accomplished activities, names of individuals involved in field investigative activities, date and time of drilling, excavation, and/or sampling at each location, weather conditions, a description of any problems encountered, and all field measurements. Lot numbers, manufacturer names, and expiration dates of standard solutions used for field instrument calibration will be recorded in the field logbooks. A summary of each day’s activities will also be recorded in the logbooks. If any recorded information is noticed to be in error, the original entry will be crossed out so that the original entry is still legible and will be replaced with the new entry. All such changes will be initialed by the Site Supervisor. At the conclusion of each workday, the person responsible for maintaining the logbook will sign and date the day's documentation entries.

Information recorded on other project documents will not be repeated in the logbooks (e.g., boring logs, drum logs, etc.), although a summary of other project related field documentation will be included where deemed necessary. All field logbooks will be kept in the possession of the Site Supervisor or the recording author, or in a secure place when not being utilized for fieldwork. Upon completion of the field activities, all logbooks will become part of the final project evidence file. The title page of each logbook will be labeled as follows:

- Logbook title: NFSS BOP Field Investigation (2013);
- Project name: NFSS BOP Field Investigation (2013);
- USACE contract number and project delivery order number;
- Start date for field investigative activities recorded in the logbook; and,
- End date for field investigative activities recorded in the logbook.

Logbook entries will include, but not be limited, to the following information:

- Name and title of author and Site Supervisor;
- Date and times of arrival and departure from NFSS;
- Description of the sampling and/or monitoring activity;
- Name and address of the field contact(s);
- Names and responsibilities of field crew members;
- Names, affiliations, and purpose of any NFSS visitors;
- Level of PPE worn at the NFSS and/or specific sampling locations;
- Weather conditions on the day of sampling and any additional environmental conditions or observations relevant to the field activities;
- Field instrumentation or equipment used, and purpose of use (e.g., health and safety screening or sample selection for laboratory analysis);
- Sample collection method and sample handling procedures including the distinction between composite and grab samples;
- Number and volume of sample(s) collected with each sample given a unique sampling identification;
- Document the sample locations on a site plan. The exact locations of sampling points will be documented for purposes of generating an accurate representation of the NFSS conditions using the field investigative data and defining data gaps that could impact the project objectives specified in this SOW;
- Location, description and log of sampling point photographs;
- Identification of sample numbers, volumes, and containers (number, size, type) used for each sample collected. Note the day and time of each sample, identify any associated QC samples or any factors that may affect quality. Also, identify the name of the sample collector;

- Record of any field measurements, field screening/analytical results generated, calibration methods used, field results, and QC information;
- Identify decontamination procedures employed for sampling equipment;
- Document appropriate references to maps and photographic logs of the NFSS;
- Record information on scheduling modifications, change orders, sampling or drilling decisions, changes, and/or modifications accepted by the USACE;
- Information regarding access agreements, if applicable;
- Describe the number of shipping coolers packed, note COC numbers or attach a copy of the COC, and record the mode of transportation, and applicable tracking numbers;
- Decontamination procedures;
- IDW documentation including types and numbers of containers (or drums), contents, type, and approximate volume of waste, and waste classification (hazardous or non- hazardous);
- Record name and address of all receiving laboratories and couriers;
- Information on sample preservation methods;
- Maintain appropriate documentation for IDW. Note contents and volumes of waste generated, storage, and disposal methods used. In addition, record all analytical methods and sampling results for the IDW in order to generate waste disposal characterization as necessary;
- Name and address of QA laboratory for the project; and,
- Type, matrix, and characterization method for generated IDW.

Field data collected during invasive soil sampling will be recorded on boring logs formatted specifically for the field investigative activities at the NFSS.

4.3 Photographic Records

Photographs will be taken to document visual information such as sample locations, field conditions, indications of visual contamination, or additional items as determined by the USACE. In some cases, a photograph of the actual sample collected may be required from two or more reference points to facilitate relocating the sampling point at a later date or at locations as specified by the USACE. All photographs will be digitized images with descriptive captions and unique identifiers. Coordinates of each photograph will be recorded using GPS and tabulated in Excel format. A NFSS photo map will also be included with the NFSS photographs and clearly indicate the location and direction of each photograph.

For each photograph taken during the field investigative activities, field logbook entries will include the following items:

- Date and time;
- Photographer (name and signature);
- Site name;
- General direction faced and description;
- Unique identifier in sequential order for each photograph; and,

- Site photo map.

In addition to the information recorded in the field logbook, one or more photograph reference maps will be prepared. Photographs taken to document sampling points will include two or more permanent reference points within the photograph to facilitate relocating the point at a later date.

4.4 Sample Documentation

4.4.1 Sample Nomenclature

The sample identification system will follow the structure presented below:

Sample ID Structure

Sampling Location Identification: XXXXNNxx-xx-####	
XXXX = Sample Location Code	Examples 1000 - Location 1000 1001 - Location 1001
NN = Sample Type	Examples SS = Surface Soil SB = Subsurface Soil GW = Groundwater from Investigative Trench
xx-xx = Sample Depth	Examples 0.0-0.5 = Surface Soil Sample Depth 2.0-3.0 = Subsurface Soil Sample Depth
#### = Sequential Sample Number [unique for entire investigation]	Examples 0001 – Unique identifier nonspecific to media 9003 – QA/QC sample for the project
Examples of Sample IDs for this Investigation 1001SS0.0-0.5-0001 – Surface Soil Sample collected from 0.0 to 0.5 ft bgs from location 1001 1001SB0.5-1.0-0002 – Subsurface Soil Sample collected from 0.5 - 1.0 ft bgs from location 1001 1001SS0.0-0.5D-9002– Duplicate surface soil sample collected from 0.0-0.5 ft bgs from location 1001 IE9TB12.5-3.0—0161 - Trench Boring Soil Sample collected from 2.5-3.0 ft bgs from investigative excavation trench 9 IE10GW4.5-5.0-0162 – Groundwater collected from investigative excavation trench 10 unfiltered IE10GW4.5-5.0F-0162 – Groundwater collected from investigative excavation trench 10 filtered	

4.4.2 Sample Labels

Sample labels will be affixed to all containers during sampling activities at the time of sample collection and securely affixed to the container prior to shipment. Sample label information will include, but not be limited to, the following:

- Sampling contractor identification;
- Sample identification number;
- Site name;

- Sample station number;
- Requested analysis;
- Type of sample (discreet, grab, or composite);
- Type of chemical preservative present in container;
- Date and time of sample collection; and,
- Sampler's name and signature or initials.

4.4.3 Chain-of-Custody Records

COC forms will be completed and will accompany each sample at all times. Data on the forms will include the sample identification (ID), tracking number, depth interval, date sampled, time sampled, project name, project number, and signatures of those in possession of the sample. Forms will accompany those samples shipped to the designated laboratory so that sample possession information can be maintained. The field team will retain a separate copy of the COC reports at the field office. Additionally, the sample ID; date and time collected; collection location; tracking number; and analysis will be documented in the field logbook.

The individual responsible for shipping the samples from the field to the laboratory will be responsible for completing the COC form. This individual will also inspect the form for completeness and accuracy. In addition, this individual will be responsible for determining the shipping classification for samples under United States Department of Transportation (USDOT) Regulatory Requirements. After the form has been inspected and determined to be satisfactorily completed, the responsible individual will sign, date, and note the time of transfer on the form. For commercial carriers, the COC form will be placed in a sealable plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. For laboratory couriers, the COC form will be placed in a sealable plastic bag on the top of the cooler for the courier to accept custody. The field copy of the form will be appropriately filed and kept at the NFSS for the duration of the field investigative activities.

Shipping containers will be secured using nylon strapping tape and COC seals. COC seals will be placed on each cooler used for sample transport. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the coolers in such a manner that if the cooler is opened, the seals will be broken. COC seals placed in this manner will ensure that no sample tampering occurs between the time of sample placement in the coolers to the time the coolers are opened for analysis at the laboratory. Cooler custody seals will be signed and dated by the individual responsible for completing the COC form contained within the cooler.

Contracted Laboratory Custody Responsibilities

TestAmerica will document the receipt of analytical samples by accepting custody of the samples from the accepted shipping company. In addition, TestAmerica will check the condition of the shipping coolers and received samples upon receipt and will immediately inform URS if any sample containers are broken or if any tampering occurred with the seals on the cooler(s). URS will, in turn, notify the USACE Buffalo District PM, COR, and/or Project Chemist of such concerns and will recommend corrective actions. This documentation will be accomplished by completing the cooler receipt checklist as provided in the QAPP.

An example cooler receipt checklist will be provided to the laboratory at the start of the project. Copies of the completed checklists will be e-mailed to both the USACE Buffalo District PM and the Project Chemist immediately after they have been completed at the laboratory. The original completed checklists will be transmitted with the final analytical results from the laboratory

4.5 Field Analytical Records

As discussed in previous sections, documentation of all field activities will be maintained using field logbooks and applicable field forms (i.e., field sample sheets, instrument calibration logs, etc.).

Field instrumentation will be used to scan soil for radiological materials using an accepted radiological detector. As described in the Radiation Protection Plan (RPP), instruments for radiation surveys will be calibrated annually. Operational checks will be performed and documented per RP-3.0 “Portable Survey Instruments” (contained in Appendix A of the RPP).

Each field instrument used for measurement or analysis will be calibrated in accordance with the manufacturer’s recommendations with the calibration procedures. Calibration checks will also be performed as recommended by the manufacturer during the course of field investigative activities. Calibration records will be maintained in a field logbook. Additionally, all field personnel will be properly trained in the operation and calibration of the field instrumentation. Any field instrument out of calibration will be immediately re-calibrated. When field instrumentation is out of calibration or damaged, an evaluation will be made to ascertain the validity of previous results since the last acceptable (or valid) calibration check. If it is necessary to ensure the acceptability of suspect data, the originally required tests will be repeated if possible. Data or measurements since the last acceptable (or valid) calibration will be noted as suspect in the field logbook and further evaluated to determine the suitability of the data for its intended use.

Malfunctioning equipment will be replaced and any questionable measurements will be documented in the field logbook. The Site Supervisor will be responsible for ensuring that the field instrumentation is of the proper range, type, and accuracy for the measurements being performed and all field instrumentation are properly calibrated. Field instrumentation will undergo response verification checks as recommended by the manufacturer to detect anomalies in the data being generated. If an unacceptable response is obtained, the data will be labeled suspect, the problem documented in the field logbook, and appropriate corrective actions immediately implemented. Corrective actions will be approved by the USACE prior to implementation.

Field analytical and monitoring data not collected via instrumentation or on logs will be recorded in the field logbooks on a daily basis. At the end of each week, this data will be extracted from the logbooks and incorporated into the project analytical database. All field analytical and monitoring data will be used together with laboratory analytical data to evaluate the nature and extent of soil contamination.

4.6 Documentation Procedures

The documentation procedures for sample collection will include the following steps:

- Collection and placement of samples into laboratory sample containers;
- Completion of sample container label information;
- Completion of sample documentation information in the field logbook;
- Completion of project and sampling information sections of the COC form(s);
- Performing a completeness and accuracy check of the COC form(s);
- Completion of the sample relinquishment section of the COC form(s);
- Placing COC seals on the exterior of the cooler;
- Packaging and shipping the cooler to the nearest laboratory service center;
- Receive cooler at the laboratory, inspect the contents, and fax a copy of the contained COC form(s) and cooler receipt form(s); and,
- Transmittal of original COC form(s) with the final analytical results from laboratory.

Original COC record, shipping documents, and sample cooler receipt forms will be attached to each data package.

5.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

URS will use a TestAmerica lab courier to deliver samples to the TestAmerica laboratory in Amherst, New York. TestAmerica will then coordinate shipment of the samples to their St. Louis, Missouri, facility for analyses. However, in the event that URS must ship samples during the course of the investigation, URS will adhere to the following procedures.

5.1 Sample Packaging

Sample containers will be packaged in thermally insulated rigid-body coolers. Sample packaging and shipping will be conducted in accordance with applicable DOT regulatory requirements. Prior to sample shipment, each container will be prepared as follows:

- Contents of sample containers will be identified with definitive labels placed onto each container.
- The cap tightness will be checked and clear tape placed over the label completely encircling the container.
- Each sample container will be wrapped in bubble wrap or closed cell foam sheets.
- Each sample container will be enclosed in a clear zip-lock plastic bag. As much air as possible will be forced from the sample container bags before sealing.

Once the above procedures have been completed for each sample container, the following procedures will be performed for each sample cooler:

- Several layers of bubble wrap (inert packing material) will be placed on the bottom of the cooler and inside the cooler to prevent shifting during transport. The cooler will be lined with an open garbage bag, all samples will be placed upright inside the garbage bag, and the bag will be tied.
- Ice is not required for shipping most radiological solid samples. Ice is required for shipment of VOC and metals soil and water samples. Before initial placement of samples into a rigid-body cooler, the cooler drain plug will be taped shut both inside and outside the container.
- All required laboratory paperwork, including the COC form(s), will be placed inside the cooler if being transported by a shipping courier, or attached to the outside of the cooler if transported by a lab courier, to facilitate exchange of sample custody. If more than one cooler is being used, each cooler will have its own documentation.
- Upon completion of the packing process, the cooler lid will be closed and two signed/dated custody seals will be placed on the cooler, one across the front and one across the side of the cooler, such that opening the cooler will result in breaking the custody seals.
- Rigid-body coolers will be sealed by applying strapping tape directly to the cooler body.
- Arrows indicating "This Way Up" will be placed on each cooler.
- The cooler will then be delivered by commercial courier to the laboratory.

5.2 Requirements for Samples Classified as Radioactive Materials

Samples generated during project activities will be transported in accordance with procedures that ensure compliance with regulatory requirements for shipping radioactive samples. Radiological samples will follow the Sample Packaging procedures presented above for container preparation prior to sample shipment including a radiological survey on the outside of the container for radioactivity. In addition, each cooler will also undergo the following:

- Upon arrival at the NFSS, all coolers for sample shipment will undergo a radiation screening to ensure they are not radioactively contaminated.
- After the samples are properly packaged and before the cooler is sealed, it will undergo a DOT dose rate and contamination survey as detailed in RP-6.0 “Sample Handling and Chain-of-Custody” (contained in Appendix A of the RPP) to ensure the package meets the requirements as found in 49 CFR Part 173.
- A notice will be placed on the outside of each cooler that includes the name of the cosigner and the statement: “This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910”. The outside of the inner packaging or, if there is no inner packaging, the outside of the package itself, will be labeled “Radioactive” if fully applicable.

5.3 Sample Shipping

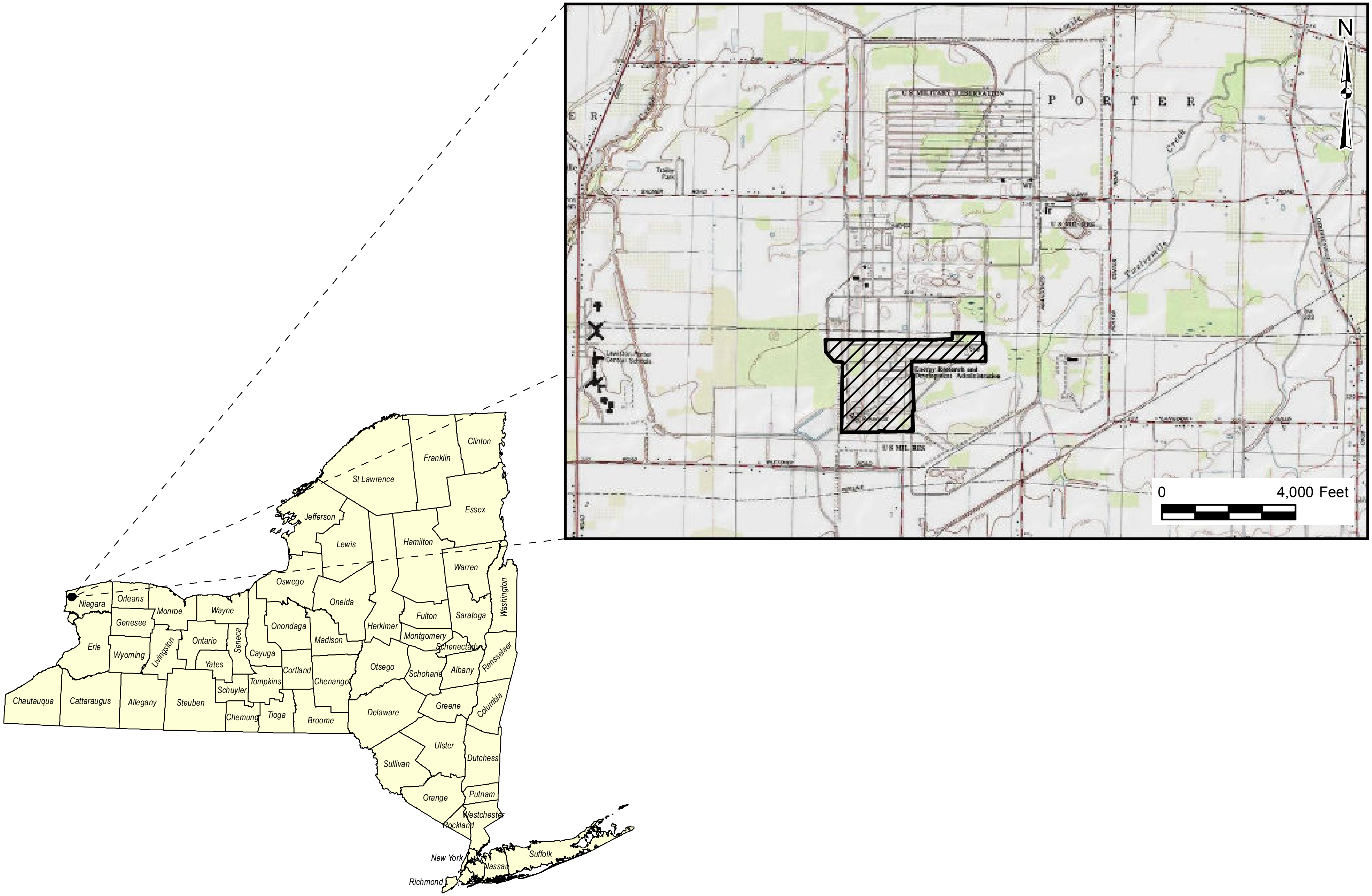
All environmental samples collected during the project will be shipped no later than 12 to 72 hours after time of collection. The latter time of 72 hours may be necessary if the samples are collected on a Friday and have to be shipped Monday. During the time between collection and shipment, all samples will be stored in a secure area to maintain custody. URS’s subcontracted laboratory, TestAmerica will provide pickup and delivery courier service.

6.0 REFERENCES

- ASTM D6914 – 04E1, Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
- "Report of the Results for the Remedial Investigation of Underground Utility Lines Formerly Used by the Department of Defense, Lake Ontario Ordnance Works (LOOW)"
- Uniform Federal Policy Quality Assurance Project Plans (UFP-QAPP): Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Final, Version 1, March 2005, (including March 2012 Part 2A Optimized Worksheets, Rev. 1)
- UFP QAPP
- USACE EM 385-1-1, 15 September 2008, Safety and Health Requirements Manual
- USACE ER 385-1-92 (1 May 2007) Safety and Occupational Health Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) Activities
- USACE ER 385-1-80 (30 June 2010) Ionizing Radiation Protection
- USACE EM 385-1-80 (30 May 1997) Radiation Protection Manual
- USACE EM 385-1-1 Section 25 Excavation and Trenching
- USACE EM-1110-35-1 Management Guidelines for Working with Radioactive and Mixed Waste
- USACE EM 1110-1-1804 Geotechnical Investigations
- USACE EM 1110-1-1003 (July 1, 2003) NAVSTAR Global Positioning System Surveying
- USACE EM 1110-1-1005 (January 1, 2007) Control and Topographic Surveying
- USACE EM 1110-1-1802 (August 31, 1995) Geophysical Exploration for Engineering and Environmental Investigations
- USACE document Policies, Guidance and Requirements for Geospatial Data and Systems, ER-1110-1-8156 (September 1995)
- USDOL OSHA 29 CFR 1926 Safety and Health Regulations for Construction
- USDOL OSHA 29 CFR 1910 Occupational Safety and Health Standards
- USDOL OSHA 29 CFR 1910.120 or 1926.65 HAZWOPER Standard
- UFGS-01 35 26 (February 2012) Governmental Safety Requirements
- UFGS-01 35 29.13 (January 2008) Health, Safety, and Emergency Response Procedures for Contaminated Sites
- USNRC 10 CFR Part 20 Standards of Protection Against Radiation
- USACE Engineering Form ENG 5056 - HTRW Drilling Log
- 29 CFR 1926 Subpart P, Safety and Health Regulations for Construction, Excavations
- EPA 540/G-91/009 Management of Investigation-Derived Wastes During Site Inspections
- EP-200-1-2 Process and Procedures for RCRA Manifesting
- Spatial Data Standard for Facilities, Infrastructure and Environment (SDSFIE) 3.0 Gold

FIGURES

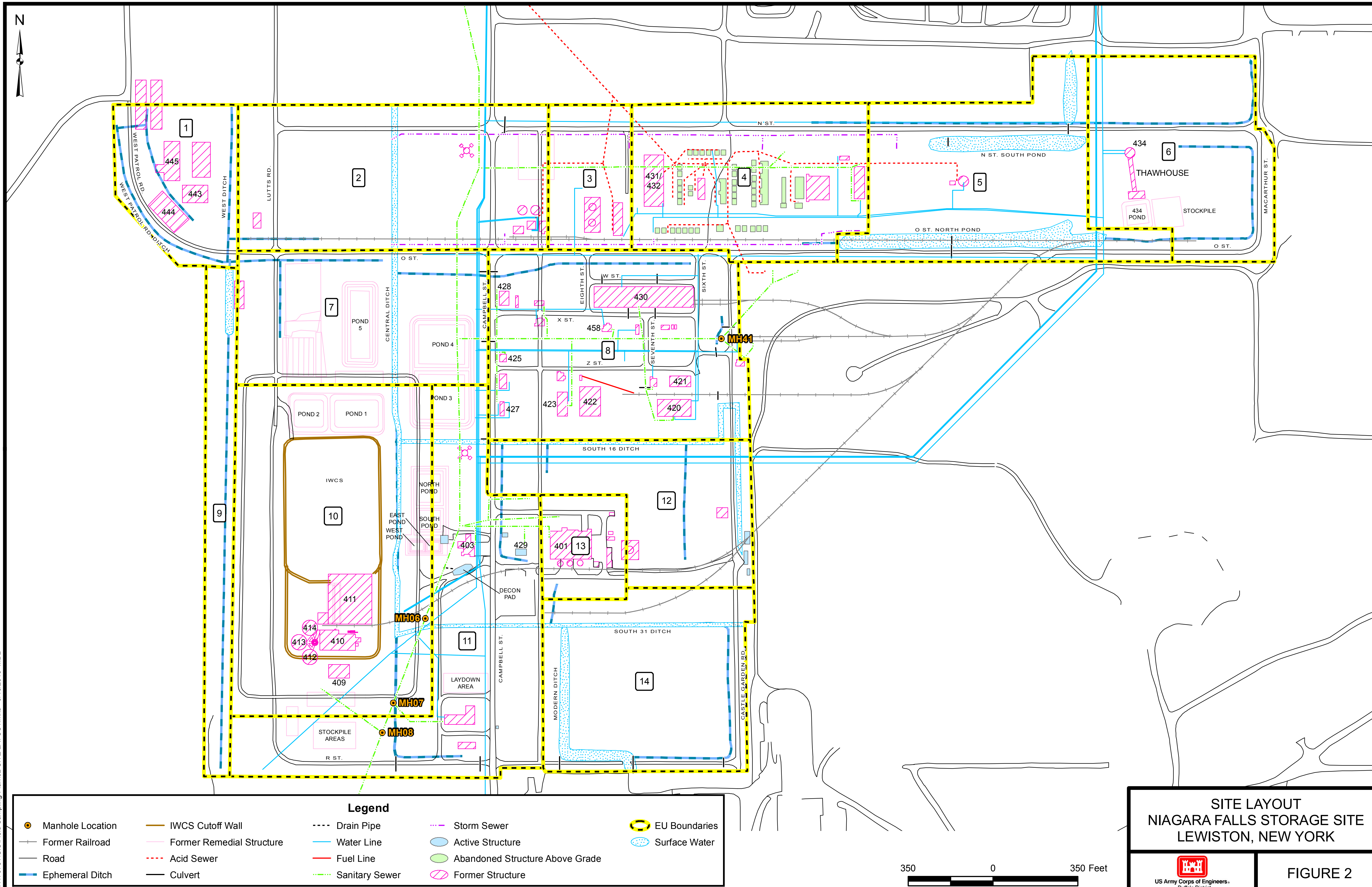
I:\11176781\GIS\Field Sampling Plan\01 SITE LOCATION.mxd 8/20/2013 MDL



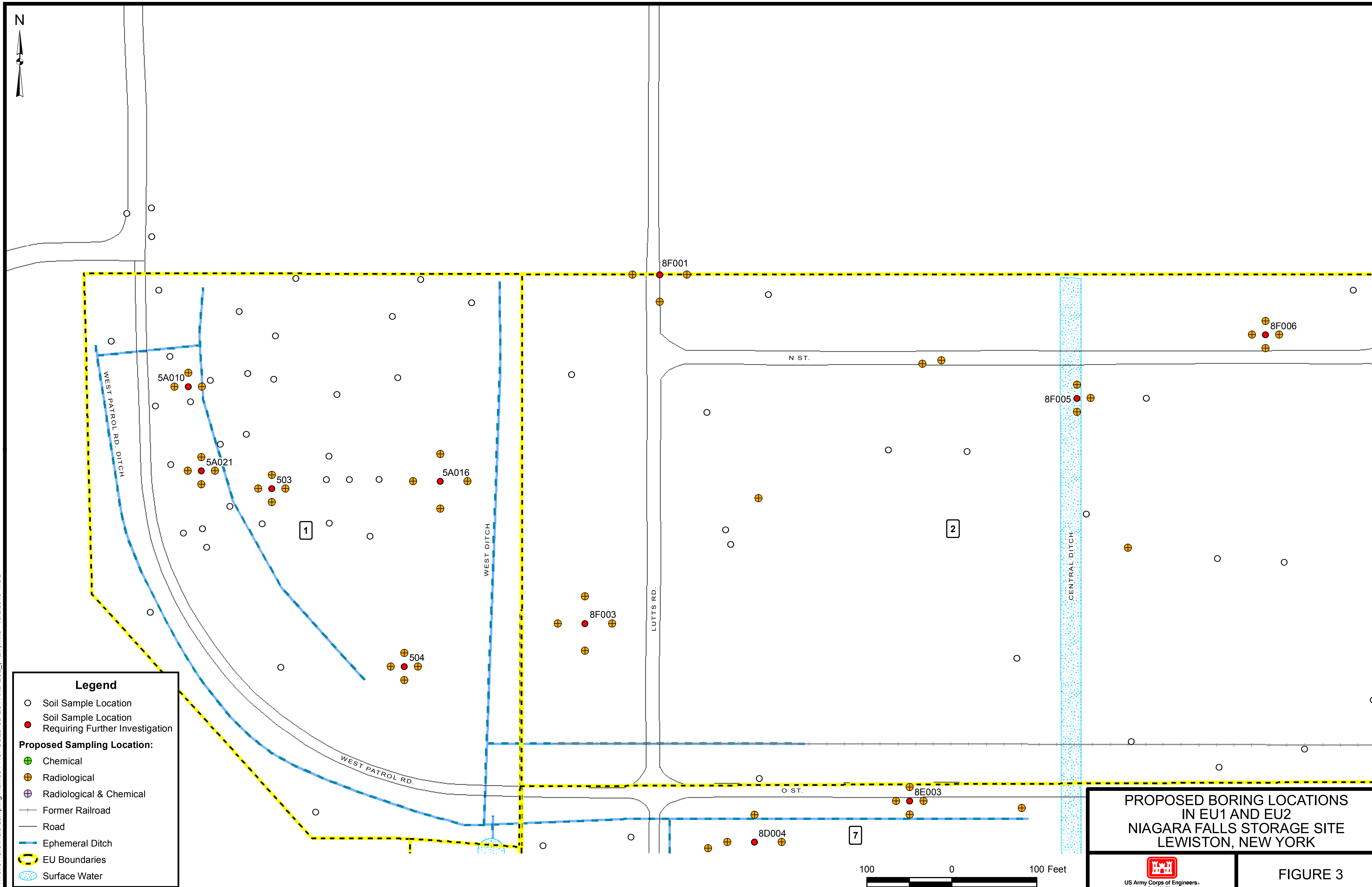
US Army Corps of Engineers
Buffalo District

SITE LOCATION
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 1



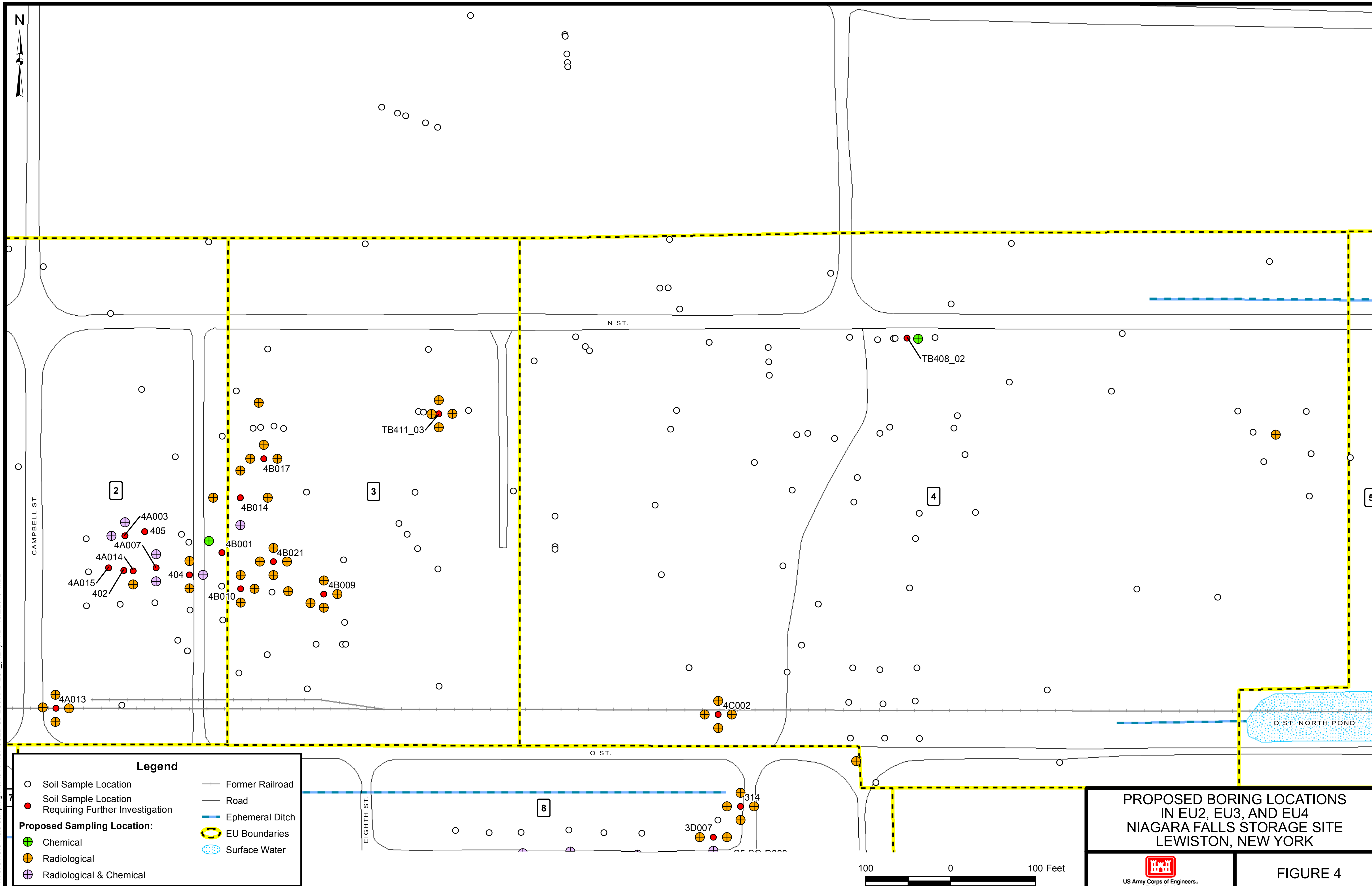
I:\11176781\GIS\Field Sampling Plan\02 SITE LAYOUT.mxd 9/10/2013 MDL



PROPOSED BORING LOCATIONS
IN EU1 AND EU2
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 3

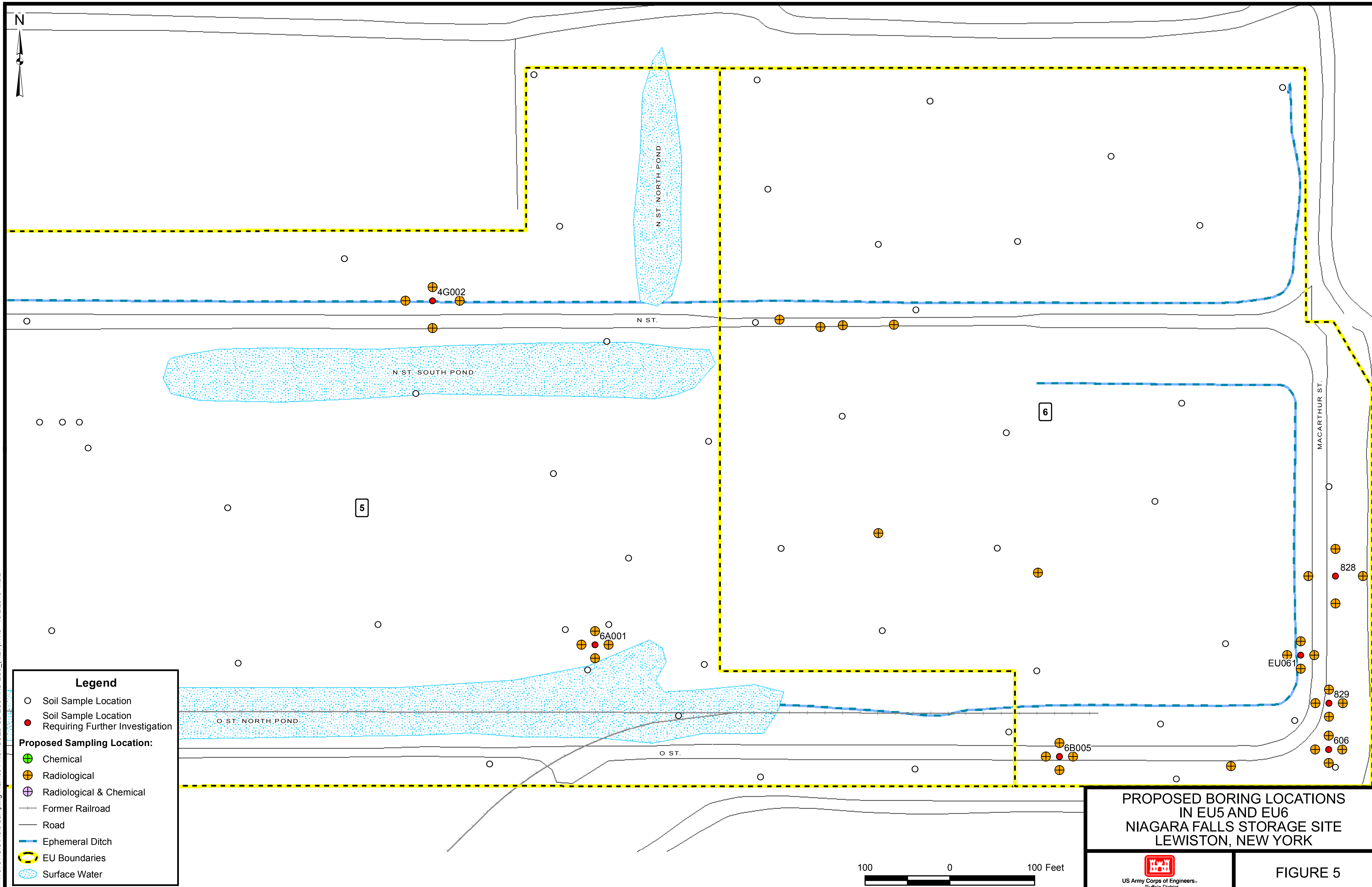
I:\11176781\GIS\Field Sampling Plan\03 PROPOSED SB EU1 AND EU2_(REV).mxd 10/2/2013 MDL



PROPOSED BORING LOCATIONS
IN EU2, EU3, AND EU4
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

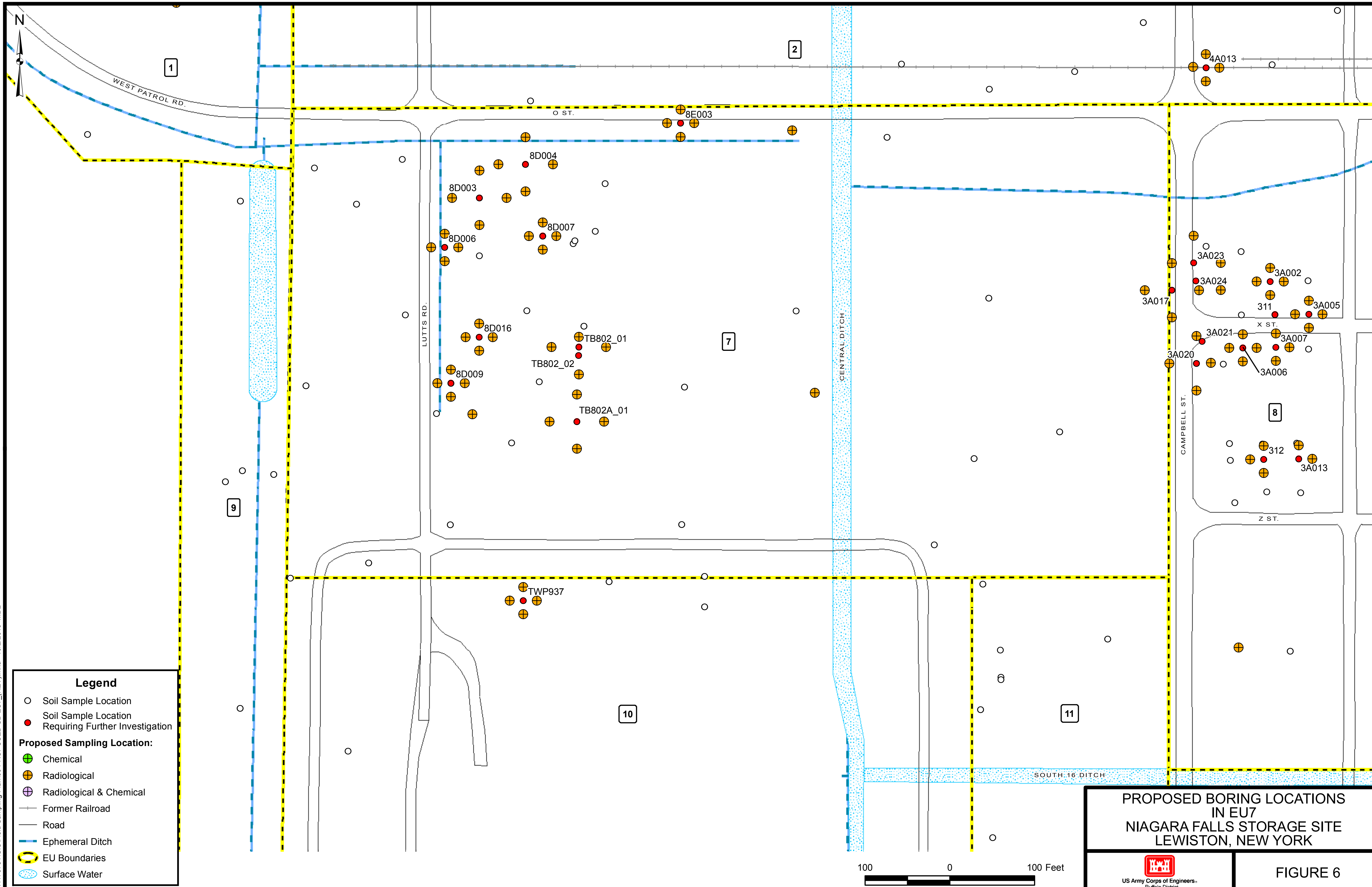
FIGURE 4

I:\11176781\GIS\Field Sampling Plan\04 PROPOSED SB EU3 AND EU4_(REV).mxd 10/2/2013 MDL



PROPOSED BORING LOCATIONS
IN EU5 AND EU6
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 5



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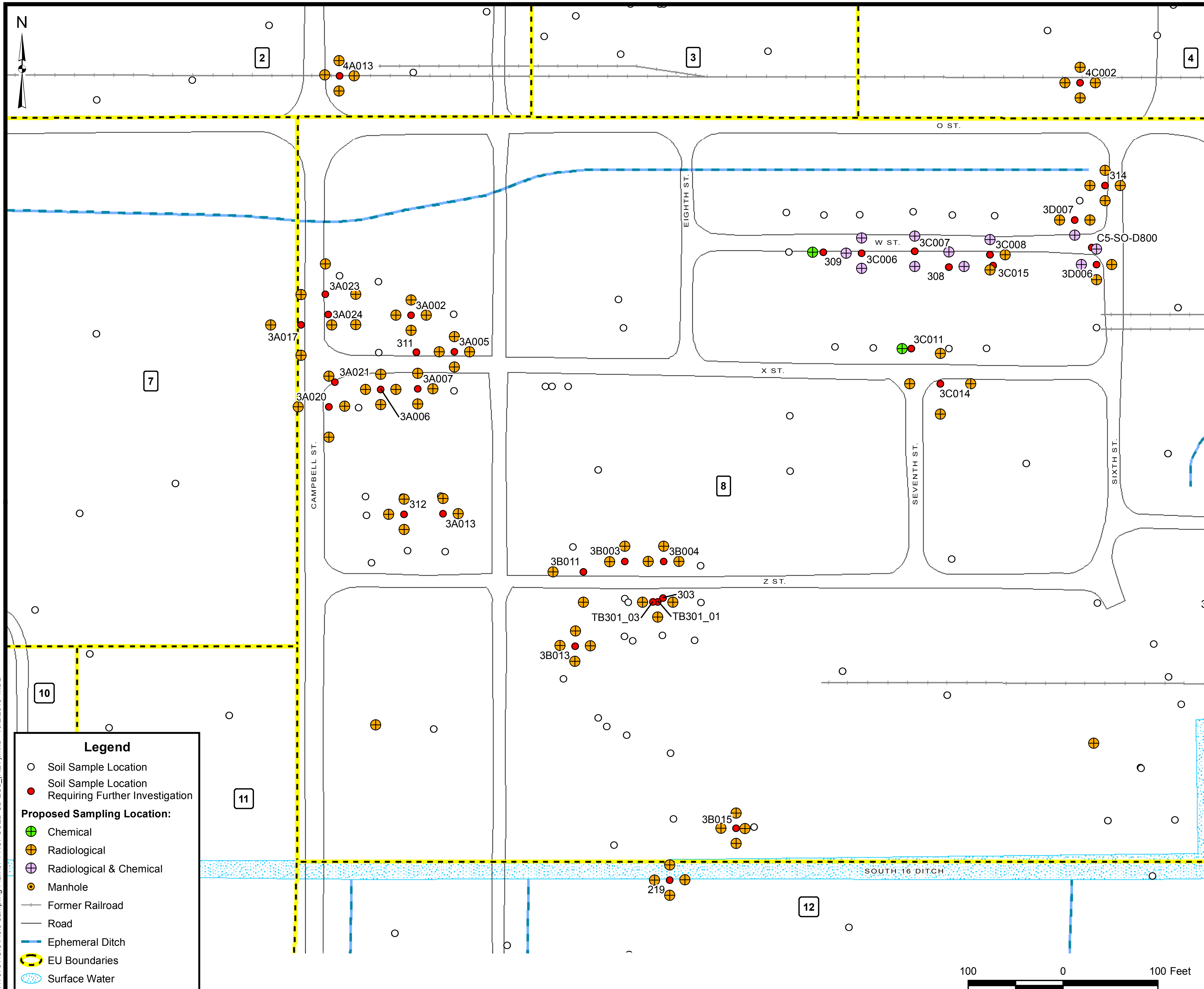
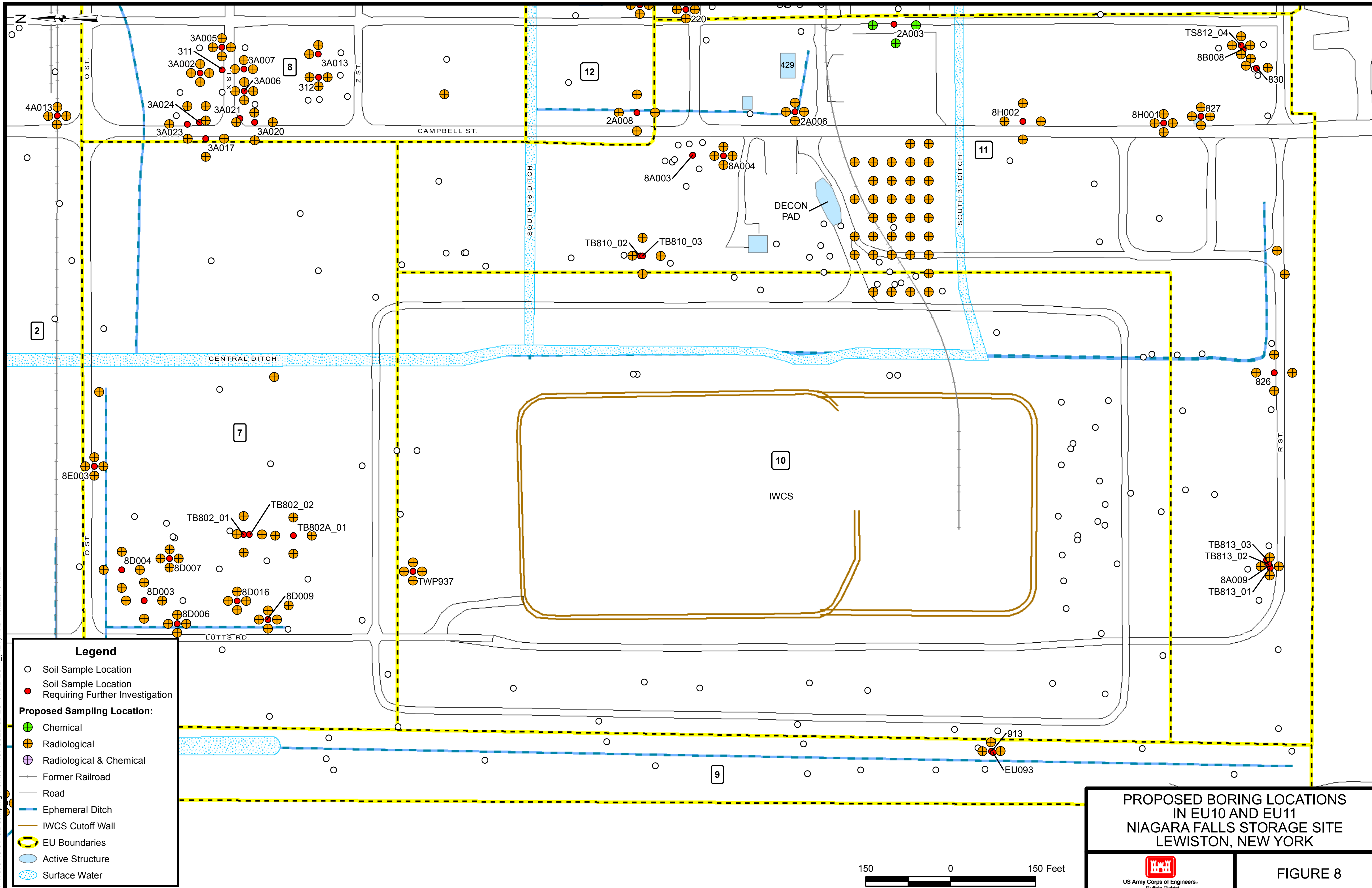


PROPOSED BORING LOCATIONS IN EU8
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

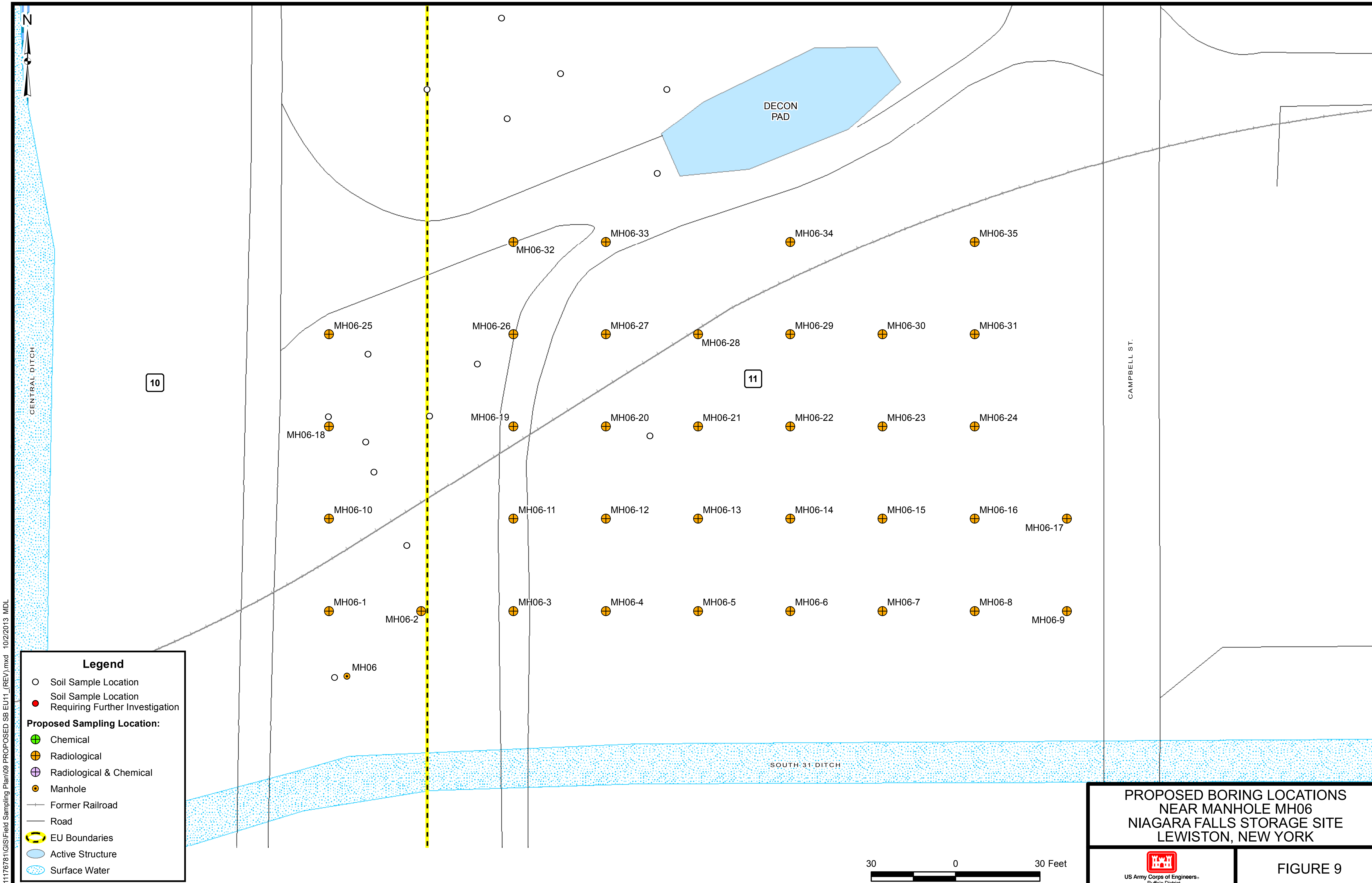
US Army Corps of Engineers
Buffalo District

FIGURE 7

I:\11176781\GIS\Field Sampling Plan\07 PROPOSED SB EU8_(REV).mxd 10/2/2013 MDL

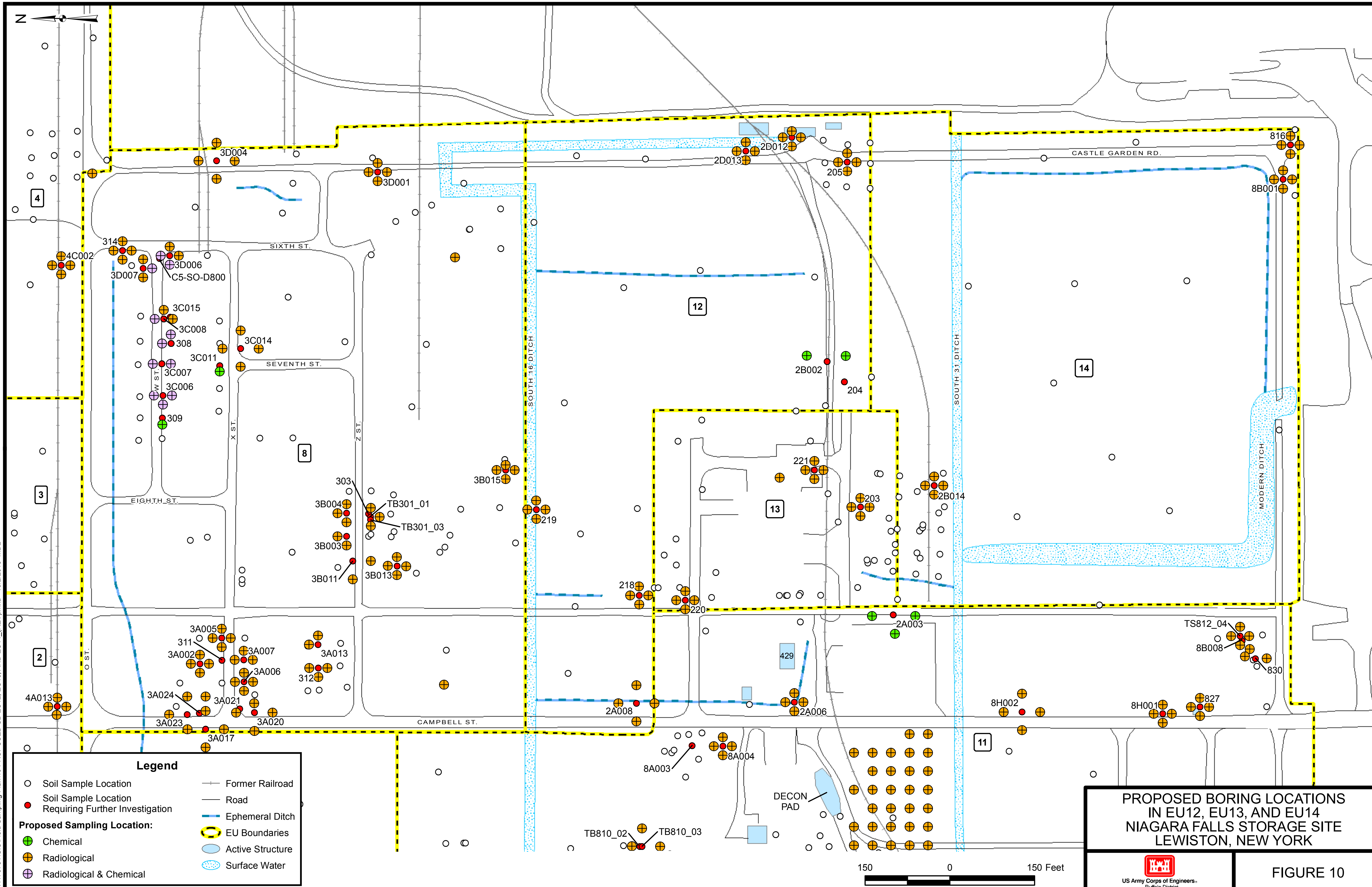


I:\11176781\GIS\Field Sampling Plan\08 PROPOSED SB EU10 AND EU11_(REV).mxd 10/2/2013 MDL

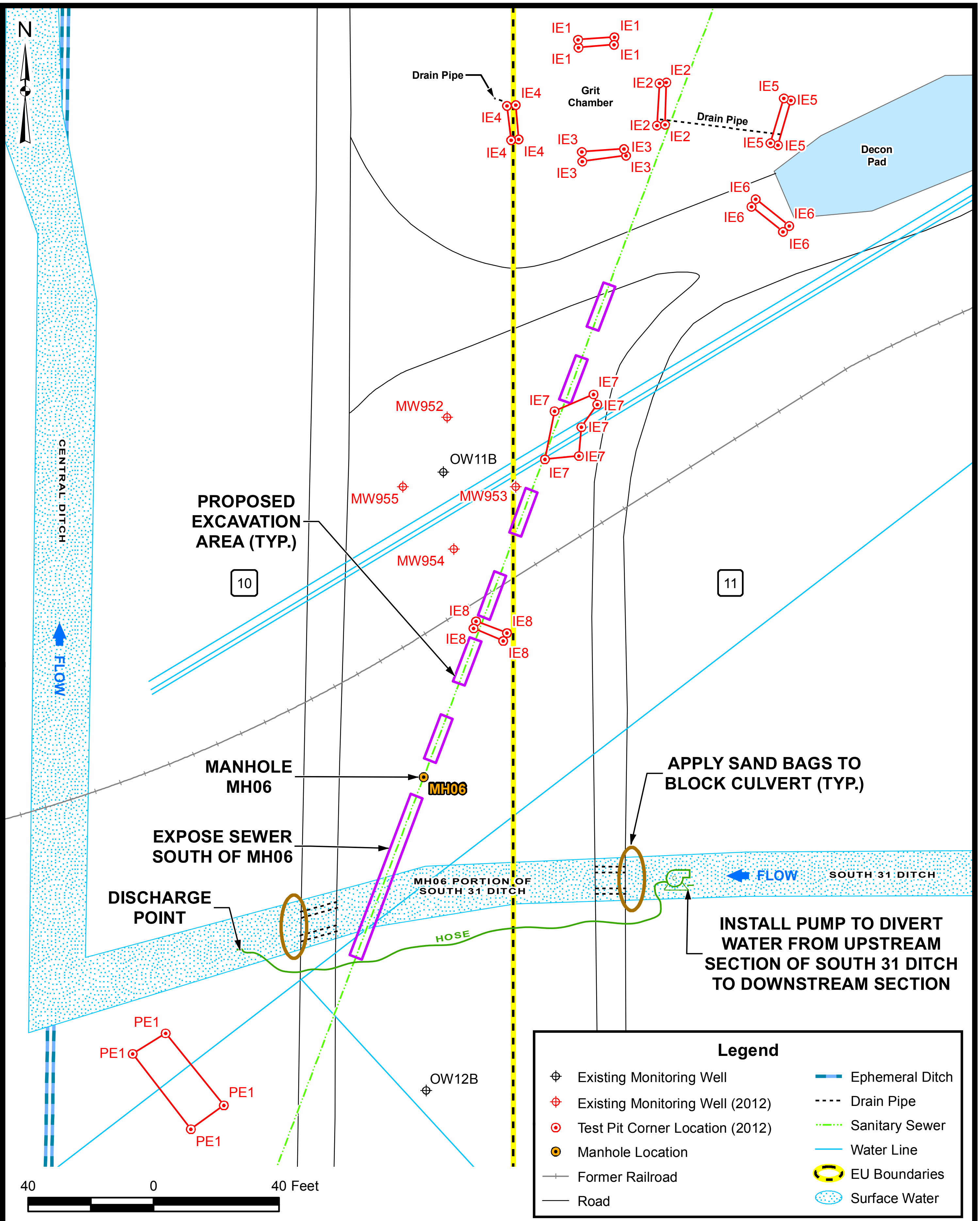


PROPOSED BORING LOCATIONS
NEAR MANHOLE MH06
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 9



I:\11176781\GIS\Field Sampling Plan\10 PROPOSED SB EU12, EU13, AND EU14_(REV).mxd 10/2/2013 MDL

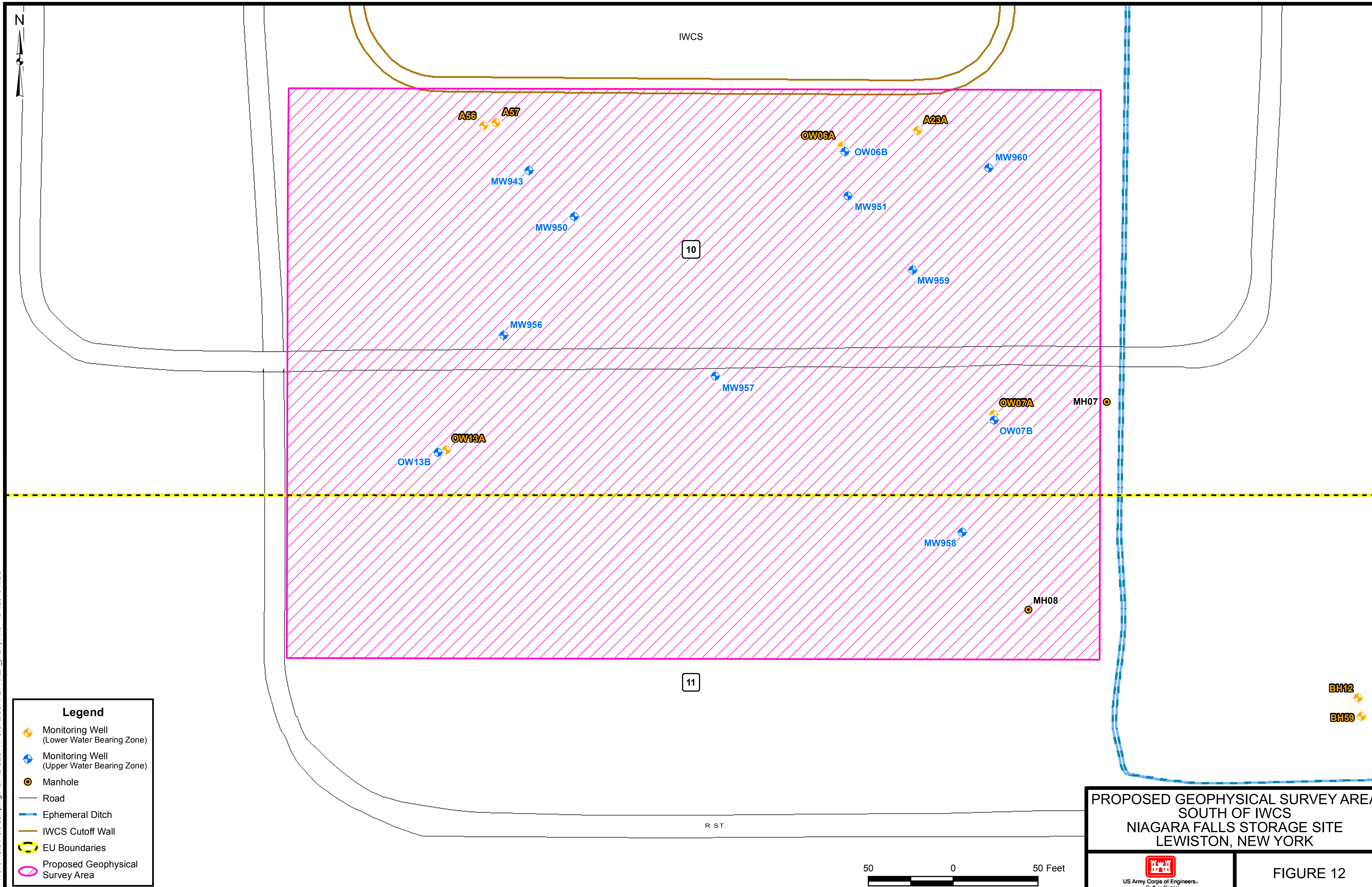


US Army Corps of Engineers
Buffalo District

MANHOLE MH06 AREA
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 11

I:\11176781\GIS\Field Sampling Plan\11 MANHOLE MH06 AREA.mxd 9/10/2013 MDL



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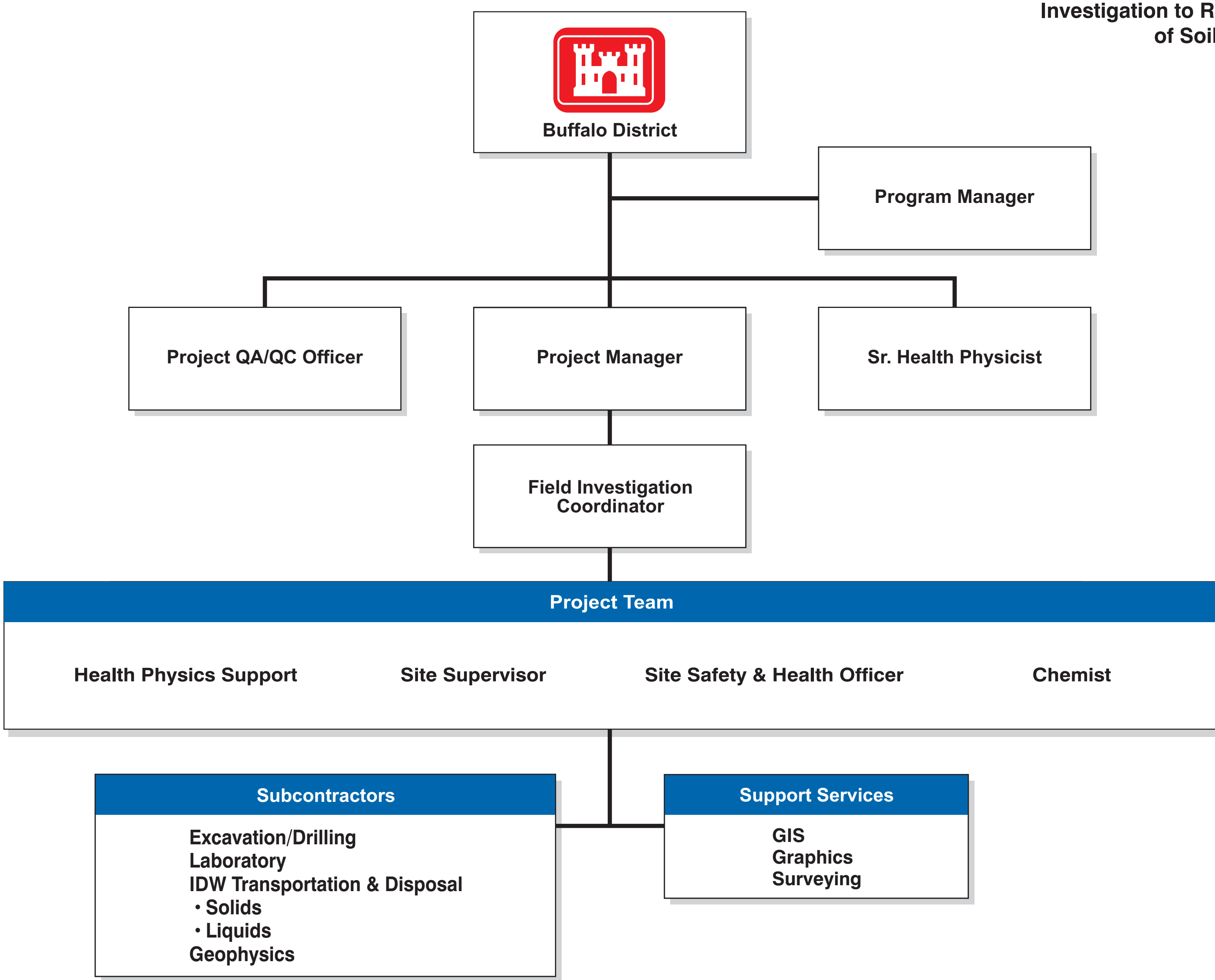
PROJECT ORGANIZATION CHART

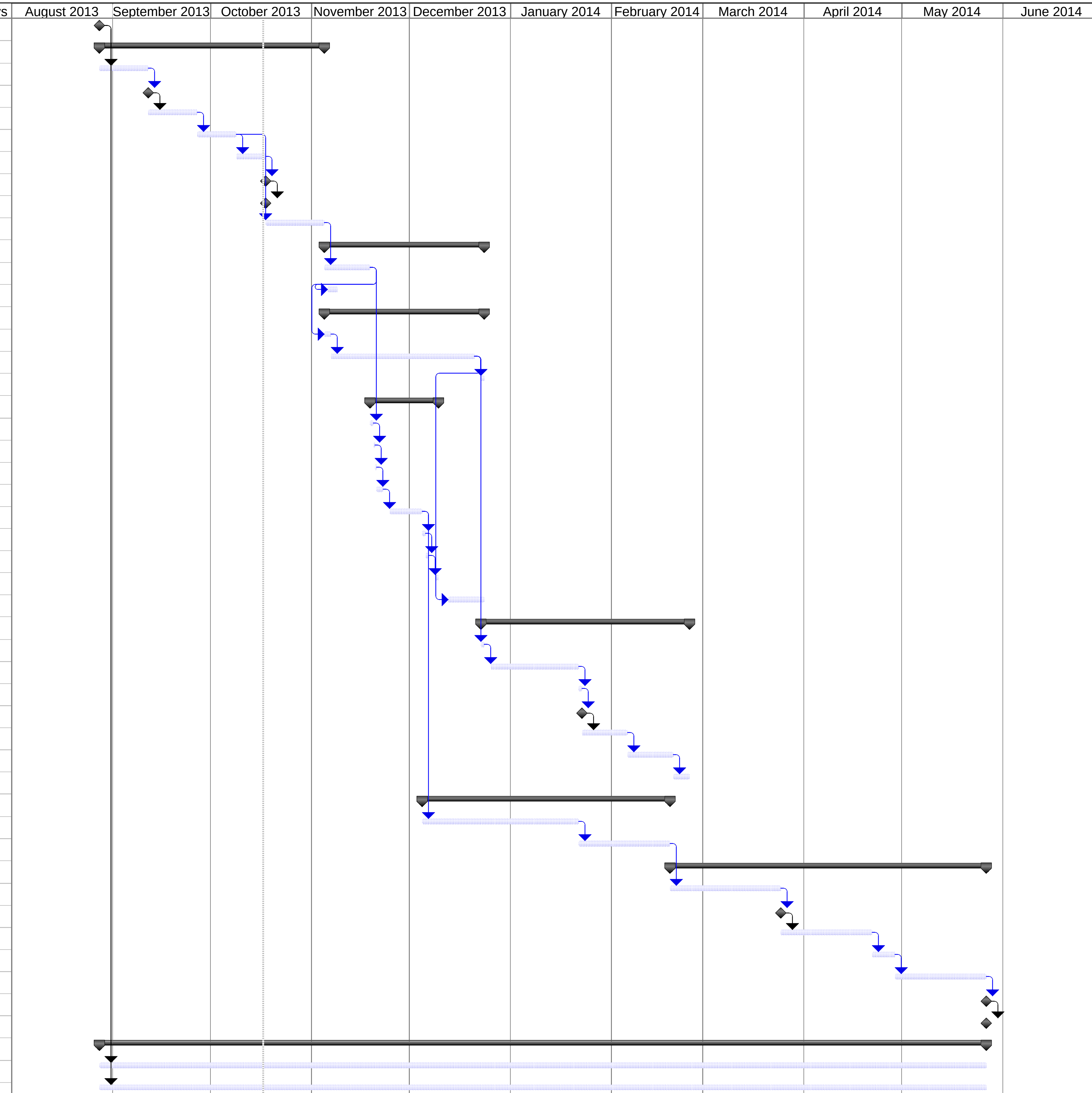
USACE Buffalo District
NFSS Balance of Plant Operable Unit
Investigation to Refine the Extent
of Soil Contamination



URS

Figure 13

ID	Task Name	Start	Finish	Business Days
1	**Project Award**	**Wed 8/28/13**	**Wed 8/28/13**	**0 days**
2	**Planning Documents**	**Wed 8/28/13**	**Mon 11/4/13**	**48 days**
3	Prepare Draft Planning Documents	Wed 8/28/13	Wed 9/11/13	10 days
4	Submit Draft to USACE	Wed 9/11/13	Wed 9/11/13	0 days
5	USACE Review	Thu 9/12/13	Thu 9/26/13	11 days
6	Response to USACE Comments	Fri 9/27/13	Tue 10/8/13	8 days
7	Revise Documents	Wed 10/9/13	Thu 10/17/13	7 days
8	Submit Final Documents to USACE	Thu 10/17/13	Thu 10/17/13	0 days
9	USACE Approval	Thu 10/17/13	Thu 10/17/13	0 days
10	NYSDEC and Community Review	Fri 10/18/13	Mon 11/4/13	12 days
11	**Site Investigation**	**Tue 11/5/13**	**Mon 12/23/13**	**33 days**
12	Radiation Survey	Tue 11/5/13	Mon 11/18/13	10 days
13	Geophysical Survey	Wed 11/6/13	Fri 11/8/13	3 days
14	**Drilling and Soil Sampling**	**Tue 11/5/13**	**Mon 12/23/13**	**33 days**
15	Mobilize Drilling Equipment	Tue 11/5/13	Wed 11/6/13	2 days
16	Soil Borings	Thu 11/7/13	Fri 12/20/13	30 days
17	Demob Drilling Equipment	Mon 12/23/13	Mon 12/23/13	1 day
18	**Excavation Investigation**	**Tue 11/19/13**	**Mon 12/9/13**	**13 days**
19	Mobilize Excavation Equipment	Tue 11/19/13	Tue 11/19/13	1 day
20	Block and Divert South 31 Ditch	Wed 11/20/13	Wed 11/20/13	0.5 days
21	Excavate and Expose Sewer in South 31 Ditch	Wed 11/20/13	Wed 11/20/13	0.5 days
22	Excavate and Backfill MH06	Thu 11/21/13	Fri 11/22/13	2 days
23	Excavate Six Trenches	Mon 11/25/13	Wed 12/4/13	6 days
24	Post Excavation Gamma Walkover Survey	Thu 12/5/13	Thu 12/5/13	1 day
25	Site Restoration	Fri 12/6/13	Fri 12/6/13	1 day
26	Demob Excavation Equipment	Mon 12/9/13	Mon 12/9/13	1 day
27	Surveying	Fri 12/13/13	Mon 12/23/13	7 days
28	**IDW Management**	**Mon 12/23/13**	**Mon 2/24/14**	**42 days**
29	Sample Collection	Mon 12/23/13	Mon 12/23/13	1 day
30	Sample Analyses	Thu 12/26/13	Tue 1/21/14	17 days
31	Prepare Waste Profiles	Wed 1/22/14	Wed 1/22/14	1 day
32	Submit Draft IDW Manifests/Acceptance Letters to USACE	Wed 1/22/14	Wed 1/22/14	0 days
33	USACE Review and Comment	Thu 1/23/14	Wed 2/5/14	10 days
34	Final Waste Manifests for USACE Signature	Thu 2/6/14	Wed 2/19/14	10 days
35	Waste T&D	Thu 2/20/14	Mon 2/24/14	3 days
36	**Environmental Sample Analyses**	**Thu 12/5/13**	**Tue 2/18/14**	**50 days**
37	Soil Analyses	Thu 12/5/13	Tue 1/21/14	30 days
38	USACE Data Validation	Wed 1/22/14	Tue 2/18/14	20 days
39	**Project Report**	**Wed 2/19/14**	**Mon 5/26/14**	**69 days**
40	Prepare Draft Report	Wed 2/19/14	Mon 3/24/14	24 days
41	Submit Draft Report to USACE	Mon 3/24/14	Mon 3/24/14	0 days
42	USACE Review	Tue 3/25/14	Mon 4/21/14	20 days
43	Address USACE Comments	Tue 4/22/14	Mon 4/28/14	5 days
44	Revise Draft Report	Tue 4/29/14	Mon 5/26/14	20 days
45	Submit Final Report to USACE	Mon 5/26/14	Mon 5/26/14	0 days
46	USACE Approval	Mon 5/26/14	Mon 5/26/14	0 days
47	**Project Management and Meetings**	**Wed 8/28/13**	**Mon 5/26/14**	**187 days**
48	Project Management	Wed 8/28/13	Mon 5/26/14	187 days
49	Bi-weekly Project Meetings	Wed 8/28/13	Mon 5/26/14	187 days



NFSS Schedule for Delin Invest Rev4

PROJECT SCHEDULE
BALANCE OF PLANT INVESTIGATION TO REFINE THE EXTENT OF SOIL CONTAMINATION
FIGURE 14

TABLES

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS (1)(2)	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU1	503	503-1	Radiological	1040163.37	1172989.16	Located in open area (no known sources)
EU1		503-2	Radiological	1040179.41	1173005.20	
EU1		503-3	Radiological	1040195.45	1172989.16	
EU1		503-4	Radiological	1040179.41	1172973.12	
EU1	504	504-1	Radiological	1040319.51	1172779.59	Located in open area (no known sources)
EU1		504-2	Radiological	1040335.55	1172795.63	
EU1		504-3	Radiological	1040351.59	1172779.59	
EU1		504-4	Radiological	1040335.55	1172763.55	
EU1	5A016	5A016-1	Radiological	1040345.78	1172997.74	Located in former pipe shop area where L-30s and KAPL were stored
EU1		5A016-2	Radiological	1040377.86	1173029.82	
EU1		5A016-3	Radiological	1040409.94	1172997.74	
EU1		5A016-4	Radiological	1040377.86	1172965.66	
EU1	5A021	5A021-1	Radiological	1040080.36	1173010.16	Located in former pipe shop area where L-30s and KAPL were stored
EU1		5A021-2	Radiological	1040096.40	1173026.20	
EU1		5A021-3	Radiological	1040112.44	1173010.16	
EU1		5A021-4	Radiological	1040096.40	1172994.12	
EU1	5A010	5A010-1	Radiological	1040064.97	1173109.38	Located in former pipe shop area where L-30s and KAPL were stored
EU1		5A010-2	Radiological	1040081.01	1173125.42	
EU1		5A010-3	Radiological	1040097.05	1173109.38	
EU2	8F003	8F003-1	Radiological	1040516.10	1172830.18	Located near former Baker-Smith Office Building
EU2		8F003-2	Radiological	1040548.18	1172862.26	
EU2		8F003-3	Radiological	1040580.26	1172830.18	
EU2		8F003-4	Radiological	1040548.18	1172798.10	
EU2	8F001	8F001-1	Radiological	1040604.15	1173241.17	Located near northern boundary of site and Lutts Road
EU2		8F001-2	Radiological	1040668.31	1173241.17	
EU2		8F001-3	Radiological	1040636.23	1173209.09	
EU2	8F005	8F005-1	Radiological	1041127.52	1173111.60	Located near CDD and Streetorm Sewer Outfall
EU2		8F005-2	Radiological	1041143.56	1173095.91	
EU2		8F005-3	Radiological	1041127.52	1173079.52	
EU2	8F006	8F006-1	Radiological	1041333.39	1173170.49	Located north of N Street
EU2		8F006-2	Radiological	1041349.43	1173186.53	
EU2		8F006-3	Radiological	1041365.47	1173170.49	
EU2		8F006-4	Radiological	1041349.43	1173154.45	
EU2	4A003	4A003-1	Rad/Chemical	1041616.35	1172890.14	Located in former radium storage vault area (Building 433)
EU2		4A003-2	Rad/Chemical	1041632.39	1172906.18	
EU2	4A014	4A014-1	Radiological	1041642.00	1172832.74	Located in former radium storage vault area (Building 433)
EU2	4A007	4A007-1	Rad/Chemical	1041669.10	1172868.43	Located in former radium storage vault area (Building 433)
EU2		4A007-2	Rad/Chemical	1041669.10	1172836.35	
EU2	404	404-1	Radiological	1041708.37	1172860.36	Located in former radium storage vault area (Building 433)
EU2		404-2	Rad/Chemical	1041724.41	1172844.32	
EU2		404-3	Radiological	1041708.37	1172828.28	
EU2	4B001	4B001-1	Chemical	1041731.29	1172884.32	Located in former radium storage vault area (Building 433)
EU2	4A013	4A013-1	Radiological	1041535.48	1172687.76	Located near railroad bed and O Street
EU2		4A013-2	Radiological	1041550.28	1172702.92	
EU2		4A013-3	Radiological	1041566.32	1172686.88	
EU2		4A013-4	Radiological	1041550.28	1172670.84	
EU3	4B009	4B009-1	Radiological	1041850.87	1172810.92	Located in former radium storage vault area (Building 433)
EU3		4B009-2	Radiological	1041866.71	1172837.54	
EU3		4B009-3	Radiological	1041882.75	1172821.50	
EU3		4B009-4	Radiological	1041866.71	1172805.46	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS (1)(2)	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU3	4B021	4B021-1	Radiological	1041791.42	1172859.79	Located in former radium storage vault area (Building 433)
EU3		4B021-2	Radiological	1041807.46	1172875.83	
EU3		4B021-3	Radiological	1041823.50	1172859.79	
EU3		4B021-4	Radiological	1041807.46	1172843.75	
EU3	4B010	4B010-1	Radiological	1041768.82	1172843.74	Located in former radium storage vault area (Building 433)
EU3		4B010-2	Radiological	1041784.86	1172827.70	
EU3		4B010-3	Radiological	1041768.82	1172811.66	
EU3	4B014	4B014-1	Radiological	1041736.41	1172935.05	Located in former radium storage vault area (Building 433)
EU3		4B014-2	Radiological	1041768.49	1172967.13	
EU3		4B014-3	Radiological	1041800.57	1172935.05	
EU3		4B014-4	Rad/Chemical	1041768.49	1172902.97	
EU3	4B017	4B017-1	Radiological	1041779.87	1172981.35	Located in former radium storage vault area (Building 433)
EU3		4B017-2	Radiological	1041795.91	1172997.39	
EU3		4B017-3	Radiological	1041811.95	1172981.35	
EU3	TB411_03	TB411_03-1	Radiological	1041993.84	1173033.84	Located north of former radium storage vault area (Building 433)
EU3		TB411_03-2	Radiological	1042002.28	1173050.26	
EU3		TB411_03-3	Radiological	1042018.32	1173034.22	
EU3		TB411_03-4	Radiological	1042002.28	1173018.18	
EU4	4C002	4C002-1	Radiological	1042315.57	1172679.63	Located near railroad bed and O Street
EU4		4C002-2	Radiological	1042331.61	1172695.67	
EU4		4C002-3	Radiological	1042347.65	1172679.63	
EU4		4C002-4	Radiological	1042331.61	1172663.59	
EU4	TB408_02	TB408_02-1	Chemical	1042567.48	1173122.49	Located along N Street in Acid Area
EU5	4G002	4G002-1	Radiological	1043609.45	1173167.11	Located near ephemeral ditch; gamma survey indicates hot spots along road
EU5		4G002-2	Radiological	1043641.53	1173183.24	
EU5		4G002-3	Radiological	1043673.61	1173167.11	
EU5		4G002-4	Radiological	1043641.53	1173135.03	
EU5	6A001	6A001-1	Radiological	1043817.07	1172761.13	Location of elevated gamma survey data (may be in ponded area)
EU5		6A001-2	Radiological	1043833.11	1172777.17	
EU5		6A001-3	Radiological	1043849.15	1172761.13	
EU5		6A001-4	Radiological	1043833.11	1172745.09	
EU6	6B005	6B005-1	Radiological	1044365.07	1172629.11	Location of elevated gamma survey data; near O Street
EU6		6B005-2	Radiological	1044381.11	1172645.15	
EU6		6B005-3	Radiological	1044397.15	1172629.11	
EU6		6B005-4	Radiological	1044381.11	1172613.07	
EU6	828	828-1	Radiological	1044674.95	1172842.06	Location of elevated gamma survey data; near MacArthur Street
EU6		828-2	Radiological	1044707.03	1172874.14	
EU6		828-3	Radiological	1044739.11	1172842.06	
EU6		828-4	Radiological	1044707.03	1172809.98	
EU6	829	829-1	Radiological	1044683.36	1172692.15	Location of elevated gamma survey data; near MacArthur Street
EU6		829-2	Radiological	1044699.40	1172708.19	
EU6		829-3	Radiological	1044715.44	1172692.15	
EU6		829-4	Radiological	1044699.40	1172676.11	
EU6	606	606-1	Radiological	1044682.97	1172637.65	Location of elevated gamma survey data; near MacArthur Street
EU6		606-2	Radiological	1044699.01	1172653.69	
EU6		606-3	Radiological	1044715.05	1172637.65	
EU6		606-4	Radiological	1044699.01	1172621.61	
EU6	EU061	EU061-1	Radiological	1044649.96	1172749.00	Location of elevated gamma survey data; near MacArthur Street
EU6		EU061-2	Radiological	1044666.00	1172765.04	
EU6		EU061-3	Radiological	1044682.04	1172749.00	
EU6		EU061-4	Radiological	1044666.00	1172732.96	
EU7	8E003	8E003-1	Radiological	1040914.62	1172621.34	Just south of O Street and west of CDD Also, located in the vicinity of Organic Burial Area and IWCS treatment pond 5
EU7		8E003-2	Radiological	1040930.66	1172637.38	
EU7		8E003-3	Radiological	1040946.70	1172621.34	
EU7		8E003-4	Radiological	1040930.66	1172605.30	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS (1)(2)	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU7	8D004	8D004-1	Radiological	1040715.77	1172572.74	Located in vicinity of Organic Burial Area
EU7		8D004-2	Radiological	1040747.85	1172604.82	
EU7		8D004-3	Radiological	1040779.93	1172572.74	
EU7		8D004-4	Radiological	1040747.85	1172540.66	
EU7	8D003	8D003-1	Radiological	1040661.15	1172533.32	Located in vicinity of Organic Burial Area
EU7		8D003-2	Radiological	1040693.23	1172565.40	
EU7		8D003-3	Radiological	1040725.31	1172533.32	
EU7		8D003-4	Radiological	1040693.23	1172501.24	
EU7	8D006	8D006-1	Radiological	1040636.38	1172474.68	Located in vicinity of Organic Burial Area
EU7		8D006-2	Radiological	1040652.42	1172490.72	
EU7		8D006-3	Radiological	1040668.46	1172474.68	
EU7		8D006-4	Radiological	1040652.42	1172458.64	
EU7	8D007	8D007-1	Radiological	1040751.88	1172488.28	Located in vicinity of Organic Burial Area
EU7		8D007-2	Radiological	1040767.92	1172504.32	
EU7		8D007-3	Radiological	1040783.96	1172488.28	
EU7		8D007-4	Radiological	1040767.92	1172472.24	
EU7	8D009	8D009-1	Radiological	1040643.82	1172314.44	Located in vicinity of Organic Burial Area
EU7		8D009-2	Radiological	1040659.86	1172330.48	
EU7		8D009-3	Radiological	1040675.90	1172314.44	
EU7		8D009-4	Radiological	1040659.86	1172298.40	
EU7	8D016	8D016-1	Radiological	1040677.07	1172368.79	Located in vicinity of Organic Burial Area
EU7		8D016-2	Radiological	1040693.11	1172384.83	
EU7		8D016-3	Radiological	1040709.15	1172368.79	
EU7		8D016-4	Radiological	1040693.11	1172352.75	
EU7	TB802A_01	TB802A_01-1	Radiological	1040776.16	1172269.07	Located in vicinity of Organic Burial Area and IWCS treatment Pond 5
EU7		TB802A_01-2	Radiological	1040808.24	1172301.15	
EU7		TB802A_01-3	Radiological	1040840.32	1172269.07	
EU7		TB802A_01-4	Radiological	1040808.24	1172236.99	
EU7	TB802_01	TB802_01-1	Radiological	1040778.51	1172357.04	Located in vicinity of Organic Burial Area and IWCS treatment Pond 5
EU7		TB802_01-2	Radiological	1040810.79	1172369.21	
EU7		TB802_01-3	Radiological	1040842.67	1172357.04	
EU7		TB802_01-4	Radiological	1040810.59	1172324.96	
EU8	3B015	3B015-1	Radiological	1041953.05	1171893.35	Near (south of) former Building 422 that stored uranium rods
EU8		3B015-2	Radiological	1041969.09	1171909.39	
EU8		3B015-3	Radiological	1041978.25	1171893.08	
EU8		3B015-4	Radiological	1041969.09	1171877.31	
EU8	3B013	3B013-1	Radiological	1041783.21	1172085.99	Located near former Building 422 that stored uranium rods
EU8		3B013-2	Radiological	1041799.51	1172101.51	
EU8		3B013-3	Radiological	1041815.29	1172085.75	
EU8		3B013-4	Radiological	1041798.96	1172069.43	
EU8	TB301_03 (and TB301_01)	TB301_01-1	Radiological	1041870.26	1172131.78	Located near former Building 422 that stored uranium rods
EU8		TB301_01-2	Radiological	1041902.34	1172131.78	
EU8		TB301_01-3	Radiological	1041886.30	1172116.17	
EU8	312	312-1	Radiological	1041602.79	1172224.60	Located in area of elevated gamma readings
EU8		312-2	Radiological	1041618.83	1172240.64	
EU8		312-3	Radiological	1041618.83	1172208.56	
EU8	3A013	3A013-1	Radiological	1041660.12	1172241.07	Located in area of elevated gamma readings
EU8		3A013-2	Radiological	1041676.16	1172225.03	
EU8	3B003	3B003-1	Radiological	1041851.72	1172190.69	Located near former Building 422 that stored uranium rods
EU8		3B003-2	Radiological	1041835.68	1172174.62	
EU8	3B004	3B004-1	Radiological	1041876.50	1172174.87	Located near former Building 422 that stored uranium rods
EU8		3B004-2	Radiological	1041892.54	1172190.91	
EU8		3B004-3	Radiological	1041908.58	1172174.87	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS [(1)(2)]	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU8	3B011	3B011-1	Radiological	1041775.94	1172163.72	Located near former Building 422 that stored uranium rods
EU8		3B011-2	Radiological	1041808.02	1172131.64	
EU8	3A002	3A002-1	Radiological	1041610.29	1172434.40	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A002-2	Radiological	1041626.33	1172450.44	
EU8		3A002-3	Radiological	1041642.37	1172434.40	
EU8		3A002-4	Radiological	1041626.33	1172418.36	
EU8	3A005	3A005-1	Radiological	1041655.91	1172395.79	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A005-2	Radiological	1041671.95	1172411.83	
EU8		3A005-3	Radiological	1041687.99	1172395.79	
EU8		3A005-4	Radiological	1041671.95	1172379.75	
EU8	3A007	3A007-1	Radiological	1041633.22	1172372.99	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A007-2	Radiological	1041649.26	1172356.95	
EU8		3A007-3	Radiological	1041633.22	1172340.91	
EU8	309	309-1	Chemical	1042049.65	1172500.92	Located in vicinity of Building 430
EU8	3A006	3A006-1	Radiological	1041578.23	1172356.25	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A006-2	Radiological	1041594.27	1172372.29	
EU8		3A006-3	Radiological	1041610.31	1172356.25	
EU8		3A006-4	Radiological	1041594.27	1172340.21	
EU8	3A017	3A017-1	Radiological	1041478.38	1172424.10	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A017-2	Radiological	1041510.46	1172456.18	
EU8		3A017-3	Radiological	1041542.54	1172424.10	
EU8		3A017-4	Radiological	1041510.46	1172392.02	
EU8	3A020	3A020-1	Radiological	1041507.45	1172337.98	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A020-2	Radiological	1041539.53	1172370.06	
EU8		3A020-3	Radiological	1041556.31	1172338.49	
EU8		3A020-4	Radiological	1041539.53	1172305.90	
EU8	3A023	3A023-1	Radiological	1041536.01	1172488.63	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3A023-2	Radiological	1041568.09	1172456.55	
EU8		3A023-3	Radiological	1041568.09	1172424.47	
EU8	3C014	3C014-1	Radiological	1042152.17	1172362.23	Located in "Shops Area." Radioactive residues were stored in several of the former Buildings and corroded uranium billets were cut into smaller sections in the riggers shop.
EU8		3C014-2	Radiological	1042184.25	1172394.31	
EU8		3C014-3	Radiological	1042216.33	1172362.23	
EU8		3C014-4	Radiological	1042184.25	1172330.15	
EU8	3D001	3D001-1	Radiological	1042480.58	1172119.52	Located near area where empty K-65 drums were cleaned and filled drums were shipped to Fernald
EU8		3D001-2	Radiological	1042496.62	1172135.56	
EU8		3D001-3	Radiological	1042512.66	1172119.52	
EU8		3D001-4	Radiological	1042496.62	1172103.48	
EU8	3D004	3D004-1	Radiological	1042484.80	1172404.79	Located near former railroad line
EU8		3D004-2	Radiological	1042516.88	1172436.87	
EU8		3D004-3	Radiological	1042548.96	1172404.79	
EU8		3D004-4	Radiological	1042516.88	1172372.71	
EU8	308	308-1	Rad/Chemical	1042193.27	1172501.19	Located in the vicinity of Building 430 where soil excavated from off-site remediated areas was stored in 1988
EU8		308-2	Rad/Chemical	1042209.31	1172485.776	
EU8	3C008	3C008-1	Rad/Chemical	1042236.65	1172514.16	Located near northern edge of former Building 430 where uranium billets were stored
EU8		3C008-2	Radiological	1042252.69	1172498.12	
EU8		3C008-3	Radiological	1042236.65	1172482.08	
EU8	314	314-1	Radiological	1042341.95	1172571.16	Located in the vicinity of Building 430 where soil excavated from off-site remediated areas was stored in 1988
EU8		314-2	Radiological	1042357.99	1172587.20	
EU8		314-3	Radiological	1042374.03	1172571.16	
EU8		314-4	Radiological	1042357.99	1172555.12	
EU8	3C006	3C006-1	Rad/Chemical	1042085.17	1172499.95	Located in the vicinity of Building 430 where soil excavated from off-site remediated areas was stored in 1988
EU8		3C006-2	Rad/Chemical	1042101.21	1172515.99	
EU8		3C006-3	Rad/Chemical	1042101.21	1172483.91	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS [(1)(2)]	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU8	3C007	3C007-1	Rad/Chemical	1042157.21	1172517.76	Located in the vicinity of Building 430 where soil excavated from off-site remediated areas was stored in 1988
EU8		3C007-2	Rad/Chemical	1042157.21	1172485.68	
EU8	3D006	3D006-1	Rad/Chemical	1042332.89	1172487.98	Located in the vicinity of Building 430 where soil excavated from off-site remediated areas was stored in 1988
EU8		3D006-2	Rad/Chemical	1042348.93	1172504.02	
EU8		3D006-3	Radiological	1042364.97	1172487.98	
EU8		3D006-4	Radiological	1042348.93	1172471.94	
EU8	3D007	3D007-1	Radiological	1042310.06	1172534.85	Located in the vicinity of Building 430 where soil excavated from off-site remediated areas was stored in 1988
EU8		3D007-2	Radiological	1042342.14	1172534.85	
EU8		3D007-3	Rad/Chemical	1042326.10	1172518.81	
EU8	3C011	3C011-1	Chemical	1042143.90	1172399.09	Located in vicinity of Building 430
EU9	913	913-1	Radiological	1040426.88	1171050.82	Located in area of elevated gamma activity, west of IWCS and bordering on Niagara Mohawk property
EU9		913-2	Radiological	1040442.92	1171035.56	
EU9		913-3	Radiological	1040427.27	1171018.74	
EU10	TWP937	TWP937-1	Radiological	1040728.96	1172057.90	Located in vicinity of IWCS treatment Ponds 1 and 2
EU10		TWP937-2	Radiological	1040745.00	1172073.94	
EU10		TWP937-3	Radiological	1040761.04	1172057.90	
EU10		TWP937-4	Radiological	1040745.00	1172041.86	
EU10	MH06/0W11B	MH06-1	Radiological	1041239.17	1171145.49	Located in the vicinity of well OW11B, MH06, and the former decontamination pad to further investigate the source of uranium in the groundwater
EU10		MH06-2	Radiological	1041271.98	1171145.49	
EU11		MH06-3	Radiological	1041304.79	1171145.49	
EU11		MH06-4	Radiological	1041337.60	1171145.49	
EU11		MH06-5	Radiological	1041370.41	1171145.49	
EU11		MH06-6	Radiological	1041403.21	1171145.49	
EU11		MH06-7	Radiological	1041436.02	1171145.49	
EU11		MH06-8	Radiological	1041468.83	1171145.49	
EU11		MH06-9	Radiological	1041501.64	1171145.49	
EU10		MH06-10	Radiological	1041239.17	1171178.30	
EU11		MH06-11	Radiological	1041304.79	1171178.30	
EU11		MH06-12	Radiological	1041337.60	1171178.30	
EU11		MH06-13	Radiological	1041370.41	1171178.30	
EU11		MH06-14	Radiological	1041403.21	1171178.30	
EU11		MH06-15	Radiological	1041436.02	1171178.30	
EU11		MH06-16	Radiological	1041468.83	1171178.30	
EU11		MH06-17	Radiological	1041501.64	1171178.30	
EU10		MH06-18	Radiological	1041239.17	1171211.11	
EU11		MH06-19	Radiological	1041304.79	1171211.11	
EU11		MH06-20	Radiological	1041337.60	1171211.11	
EU11		MH06-21	Radiological	1041370.41	1171211.11	
EU11		MH06-22	Radiological	1041403.21	1171211.11	
EU11		MH06-23	Radiological	1041436.02	1171211.11	
EU11		MH06-24	Radiological	1041468.83	1171211.11	
EU10		MH06-25	Radiological	1041239.17	1171243.92	
EU11		MH06-26	Radiological	1041304.79	1171243.92	
EU11		MH06-27	Radiological	1041337.60	1171243.92	
EU11		MH06-28	Radiological	1041370.41	1171243.92	
EU11		MH06-29	Radiological	1041403.21	1171243.92	
EU11		MH06-30	Radiological	1041436.02	1171243.92	
EU11		MH06-31	Radiological	1041468.83	1171243.92	
EU11		MH06-32	Radiological	1041304.79	1171276.73	
EU11		MH06-33	Radiological	1041337.60	1171276.73	
EU11		MH06-34	Radiological	1041403.21	1171276.73	
EU11		MH06-35	Radiological	1041468.83	1171276.73	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS (1)(2)	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU11	8A009	8A009-1	Radiological	1040737.83	1170542.78	Located in area of elevated gamma activity, south of IWCS
EU11		8A009-2	Radiological	1040753.87	1170558.82	
EU11		8A009-3	Radiological	1040769.91	1170542.78	
EU11		8A009-4	Radiological	1040753.87	1170526.74	
EU11	826	826-1	Radiological	1041064.38	1170534.62	Located in area of elevated gamma activity, south of IWCS
EU11		826-2	Radiological	1041096.46	1170566.70	
EU11		826-3	Radiological	1041128.54	1170534.62	
EU11		826-4	Radiological	1041096.46	1170502.54	
EU11	830	830-1	Radiological	1041635.96	1170545.96	Former parking area. This location may have been a staging area for inbound trucks during the operation of the NFSS and sloughing of loads while the trucks were in the parking area may account for the sporadic and shallow nature of the elevated radiological SRCs found here.
EU11		830-2	Radiological	1041652.05	1170575.94	
EU11	TS812_04	TS812_04-1	Radiological	1041659.40	1170593.10	Former parking area. This location may have been a staging area for inbound trucks during the operation of the NFSS and sloughing of loads while the trucks were in the parking area may account for the sporadic and shallow nature of the elevated radiological SRCs found here.
EU11		TS812_04-2	Radiological	1041675.44	1170609.14	
EU11		TS812_04-3	Radiological	1041691.48	1170593.10	
EU11		TS812_04-4	Radiological	1041675.44	1170577.06	
EU11	827	827-1	Radiological	1041533.86	1170664.31	Located along Campbell Street, near area of elevated gamma activity (source unknown)
EU11		827-2	Radiological	1041549.90	1170680.35	
EU11		827-3	Radiological	1041565.94	1170664.31	
EU11		827-4	Radiological	1041549.90	1170648.27	
EU11	8H001	8H001-1	Radiological	1041521.72	1170730.25	Located along Campbell Street, near area of elevated gamma activity (source unknown)
EU11		8H001-2	Radiological	1041537.76	1170746.29	
EU11		8H001-3	Radiological	1041553.80	1170730.25	
EU11		8H001-4	Radiological	1041537.76	1170714.21	
EU11	8H002	8H002-1	Radiological	1041508.87	1170979.40	Located along Campbell Street, near area of elevated gamma activity (source unknown)
EU11		8H002-2	Radiological	1041540.95	1171011.48	
EU11		8H002-3	Radiological	1041573.03	1170979.40	
EU11		8H002-4	Radiological	1041540.95	1170947.32	
EU11	2A006	2A006-1	Radiological	1041542.06	1171382.12	Located along Campbell Street, near area of elevated gamma activity (source unknown)
EU11		2A006-2	Radiological	1041558.10	1171398.16	
EU11		2A006-3	Radiological	1041574.14	1171382.12	
EU11		2A006-4	Radiological	1041558.10	1171366.08	
EU11	8A004	8A004-1	Radiological	1041464.02	1171508.91	Located along Campbell Street, near area of elevated gamma activity
EU11		8A004-2	Radiological	1041480.06	1171524.95	
EU11		8A004-3	Radiological	1041496.10	1171508.91	
EU11		8A004-4	Radiological	1041480.06	1171492.87	
EU11	2A003	2A003-1	Chemical	1041710.88	1171167.99	Located near former slurry pond area, south of Building 401, that was filled with presumably clean fill (but which may have contained coal tar)
EU11		2A003-2	Chemical	1041710.88	1171244.66	
EU11		2A003-3	Chemical	1041678.989	1171204.268	
EU11	TB810_02	TB810_03-1	Radiological	1041270.68	1171651.88	Located near North Pond
EU11		TB810_03-2	Radiological	1041303.28	1171669.97	
EU11		TB810_03-3	Radiological	1041334.84	1171651.88	
EU11		TB810_03-4	Radiological	1041302.76	1171619.80	
EU12	218	218-1	Radiological	1041731.12	1171656.81	Located in an area of elevated gamma readings (source unknown)
EU12		218-2	Radiological	1041747.16	1171672.85	
EU12		218-3	Radiological	1041763.20	1171657.07	
EU12		218-4	Radiological	1041747.16	1171640.77	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS (1)(2)	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU12	2A008	2A008-1	Radiological	1041524.14	1171661.72	Located near an area of elevated gamma readings (source unknown)
EU12		2A008-2	Radiological	1041556.22	1171693.80	
EU12		2A008-3	Radiological	1041588.30	1171661.72	
EU12		2A008-4	Radiological	1041556.22	1171629.64	
EU12	2B002	2B002-1	Chemical	1042171.84	1171360.38	Located near former railroad line
EU12		2B002-2	Chemical	1042171.43	1171291.21	
EU12	219	219-1	Radiological	1041882.98	1171838.76	Located south of South 16 ditch; also, south of 3B015
EU12		219-2	Radiological	1041899.02	1171854.80	
EU12		219-3	Radiological	1041915.06	1171839.02	
EU12		219-4	Radiological	1041899.02	1171822.72	
EU13	221	221-1	Radiological	1041953.01	1171346.9	Located in unpaved area approximately 35 feet SE of former Building 401; elevated gamma activity
EU13		221-2	Radiological	1041969.05	1171362.94	
EU13		221-3	Radiological	1041985.09	1171346.9	
EU13		221-4	Radiological	1041969.05	1171330.86	
EU13	203	203-1	Radiological	1041887.49	1171265.24	Located 80 feet south of former Building 401; location of 'nugget' that exhibited a gamma count rate of 200,000 cpm; nugget was removed and count rates normal. The radium-226 concentration in sample SS203-003, collected approximately 80 feet south of Building 401 in EU 13, was 1,140 pCi/g – the highest radium-226 concentration measured at the NFSS. The gamma radiation at this location measured 200,000 cpm. This sample consisted of a single 'nugget', which accounted for almost the entirety of the gamma radiation measured at this location. When the site-wide gamma walkover survey was performed (2001) after the 'nugget' was removed, elevated gamma radiation was no longer present at this location.
EU13		203-2	Radiological	1041903.53	1171281.28	
EU13		203-3	Radiological	1041919.57	1171265.24	
EU13		203-4	Radiological	1041903.53	1171249.20	
EU13	220	220-1	Radiological	1041722.85	1171575.27	Located northwest of former Building 401; source of elevated radionuclides unknown
EU13		220-2	Radiological	1041738.89	1171591.31	
EU13		220-3	Radiological	1041754.93	1171575.27	
EU13		220-4	Radiological	1041738.89	1171559.23	
EU14	2B014	2B014-1	Radiological	1041925.73	1171134.61	Elevated concentrations of radiolonuclides were found in surface and subsurface soil samples collected in the northwest portion of EU 14, north of the South 31 Ditch in an area formerly used by the AEC as a sludge pit. The purpose of the sludge pit is not known, though apparently it was constructed contemporaneously with the production of boron-10 in Building 401. Source of contamination may also be related to contaminated fill material.
EU14		2B014-2	Radiological	1041941.77	1171150.65	
EU14		2B014-3	Radiological	1041957.81	1171134.61	
EU14		2B014-4	Radiological	1041941.77	1171118.57	
EU14	8B001	8B001-1	Radiological	1042467.50	1170517.17	Located in the southeast corner of the site, along the perimeter road (Castle Garden); location of elevated gamma readings
EU14		8B001-2	Radiological	1042483.54	1170533.21	
EU14		8B001-3	Radiological	1042499.58	1170517.17	
EU14		8B001-4	Radiological	1042483.54	1170501.13	
EU14	816	816-1	Radiological	1042528.73	1170504.15	Located in the southeast corner of the site, along the perimeter road (Castle Garden); location of elevated gamma readings
EU14		816-2	Radiological	1042544.77	1170520.19	
EU14		816-3	Radiological	1042560.81	1170504.15	
EU14		816-4	Radiological	1042544.77	1170488.11	
EU12	205	205-1	Radiological	1042498.33	1171288.50	Located along Castle Garden Road; likely area of elevated gamma readings
EU12		205-2	Radiological	1042514.37	1171304.54	
EU12		205-3	Radiological	1042530.41	1171288.50	
EU12		205-4	Radiological	1042514.37	1171272.46	

TABLE 1

COORDINATES AND ANALYTICAL REQUIREMENTS FOR BORINGS

EU	EXISTING BORING	NEW BORING	LABORATORY ANALYSIS (1)(2)	EASTING	NORTHING	LOCATION and/or FORMER USE OF AREA
EU12	2D012	2D012-1	Radiological	1042542.41	1171386.68	Located in the eastern boundary of the site, along the perimeter road (Castle Garden); location of elevated gamma readings
EU12		2D012-2	Radiological	1042558.45	1171402.72	
EU12		2D012-3	Radiological	1042569.17	1171386.68	
EU12		2D012-4	Radiological	1042558.45	1171370.64	
EU12	2D013	2D013-1	Radiological	1042517.67	1171468.24	Located in the eastern boundary of the site, along the perimeter road (Castle Garden); location of elevated gamma readings
EU12		2D013-2	Radiological	1042533.71	1171484.28	
EU12		2D013-3	Radiological	1042549.75	1171468.24	
EU12		2D013-4	Radiological	1042533.71	1171452.20	
EU2	na	GWS-1	Radiological	1040752.54	1172977.99	Gamma walkover survey hot spot, source unknown
EU2	na	GWS-2	Radiological	1040945.45	1173136.32	Gamma walkover survey hot spot, source unknown
EU2	na	GWS-3	Radiological	1040968.03	1173140.08	Gamma walkover survey hot spot, source unknown
EU7	na	GWS-4	Radiological	1041062.54	1172612.99	Gamma walkover survey hot spot, source unknown
EU2	na	GWS-5	Radiological	1041187.54	1172919.66	Gamma walkover survey hot spot, source unknown
EU7	na	GWS-6	Radiological	1040684.96	1172277.72	Gamma walkover survey hot spot, source unknown
EU7	na	GWS-7	Radiological	1041089.11	1172303.17	Gamma walkover survey hot spot, source unknown
EU3	na	GWS-8	Radiological	1041790.15	1173047.15	Gamma walkover survey hot spot, source unknown
EU3	na	GWS-9	Radiological	1041824.61	1172824.76	Gamma walkover survey hot spot, source unknown
EU8	na	GWS-10	Radiological	1041588.99	1172002.42	Gamma walkover survey hot spot, source unknown
EU11	na	GWS-11	Radiological	1041639.21	1170584.66	Gamma walkover survey hot spot, source unknown
EU11	na	GWS-12	Radiological	1041270.17	1170516.31	Gamma walkover survey hot spot, source unknown
EU11	na	GWS-13	Radiological	1041312.45	1170529.60	Gamma walkover survey hot spot, source unknown
EU13	na	GWS-14	Radiological	1041955.88	1171407.99	Gamma walkover survey hot spot, source unknown
EU8	na	GWS-15	Radiological	1042345.88	1171982.99	Gamma walkover survey hot spot, source unknown
EU4	na	GWS-16	Radiological	1042494.21	1172624.66	Gamma walkover survey hot spot, source unknown
EU4	na	GWS-17	Radiological	1042989.21	1173009.66	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-18	Radiological	1044167.54	1172892.99	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-19	Radiological	1044355.88	1172846.32	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-20	Radiological	1044583.47	1172617.72	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-21	Radiological	1044050.97	1173144.94	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-22	Radiological	1044099.33	1173136.08	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-23	Radiological	1044125.58	1173138.33	Gamma walkover survey hot spot, source unknown
EU6	na	GWS-24	Radiological	1044185.75	1173138.93	Gamma walkover survey hot spot, source unknown

na - not applicable

(1) Radiological: uranium-238 and thorium-230 analysis by method HASL-300 (alpha spectroscopy) and radium-226 analysis by method EPA 901.1 (gamma spectroscopy)

(2) Chemical: polycyclic aromatic hydrocarbons (PAHs) analysis by method SW 846 8310.

APPENDIX A
STANDARD OPERATING PROCEDURES

NFSS BALANCE OF PLANT OPERABLE UNIT

INVESTIGATION TO RFINE THE EXTENT OF SOIL CONTAMINATION

FIELD SAMPLING PLAN

APPENDIX A

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FIELD SAMPLING SOPS

STANDARD OPERATING PROCEDURE

TRENCHING AND TEST PITTING

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1.0 SCOPE & APPLICABILITY

This guideline presents the Standard Operating Procedure (SOP) for test pit excavations. In suitable ground, shallow excavations may provide an efficient and economic method to evaluate the shallow subsurface environment of a site.

2.0 SUMMARY OF METHODS

This SOP establishes guidelines for conducting test pit and trench excavations at hazardous waste sites.

Shallow trial pits do the following:

- Permit the in-situ condition of the ground to be examined in detail both laterally and vertically;
- Provide access for taking samples and for performing in-situ tests;
- Provide a means of determining the orientation of discontinuities in the ground; and
- Field sampling personnel are somewhat removed from the sampling site as intrusive activities are conducted, increasing safety.

3.0 DEFINITIONS

<u>DOT:</u> Department of Transportation

<u>EOD:</u> Explosive Ordinance Disposal

<u>MGM:</u> Multi-Gas Meter (including CO, O_2, H_2S, and LEL) (SOP No. MGM-1)

<u>OSO:</u> On-site Safety Officer

<u>OSHA:</u> Occupational Safety and Health Administration

<u>PID:</u> Photoionization Detector (SOP No. PID-1)

<u>SOP:</u> Standard Operating Procedure

<u>Trench or Test Pit</u>: Linear excavation, of varying width, usually used to locate landfill boundaries as well as for clearing landfill location for drilling.

<u>Ground Crew</u>: Composed of excavating support crew and sampling crew.

4.0 APPARATUS & MATERIALS

Trench and test pit excavation is carried out either manually or by using standard equipment such as backhoes, trenching machines, track dozers, track loaders, excavators, and scrapers. Operators of excavating equipment should be skilled and experienced in its safe use for digging test pits and trenches. A typical excavator with extending backhoe arm can excavate approximately 15 feet of material. If investigations are required to penetrate beyond 15 feet, soil borings may be a more feasible method.

5.0 HEALTH AND SAFETY PROCEDURES

A tailgate safety meeting shall be conducted by a designated on-site safety officer (OSO) before commencing excavation.

Prior to all excavations, the field geologist must confirm that underground utilities (electric, gas, telephone, water, etc.) within the general vicinity to nearby foundations or structures have been cleared or marked off. Certain underground services may not be picked up by detectors and careful excavation of the surface soils, with the ground crew watching for early signs, can help prevent the puncturing of any underground services.

Prior to commencing excavation, standard signals shall be used for rapid and efficient communication between the excavating equipment operator and the ground crew. Before approaching the trench/test pit or excavating equipment, the sampling and support crew must ascertain that the operator has noted their presence.

6.0 CAUTIONS

Material that is brought to the surface should be treated as hazardous and contained in an appropriate manner. If the material is wet, the liquid seeping from the stockpile should be collected and disposed of accordingly.

Entry of personnel into pits or trenches is strictly prohibited unless specifically approved. Also, strict adherence to federal and state Occupational Safety and Health Administration (OSHA) guidelines will be observed.

Personnel should never enter a trench deeper than 4 feet (chest height) unless full lateral support of the sidewalls is provided. Any personnel entering the trench may be exposed to toxic or explosive gases and an oxygen-deficient environment. Air monitoring (PID and MGM at a minimum) is required before and during entry and appropriate respiratory gear and protective clothing is mandatory. Caution should be exercised at all times. At least two people must be present at the immediate site. Ladder access out of the pit must be installed before entry.

Care should be taken to ensure that personnel do not stand too close to the edge of the trench especially during sampling or depth measurements; the combination of deposing soil adjacent to the pit and the risk of caving or toppling of the sidewalls in unstable soils can lead to unsafe conditions.

7.0 TEST PIT EXCAVATION PROCEDURES

7.1 Excavation

Upon locating the area for excavation, the excavating equipment operator shall determine wind direction and position the machine accordingly. The excavating equipment operator shall outline the area of investigation by extending the bucket arm to its maximum length, and trace a 180-degree outline around the area to be excavated. The support crew shall cordon off the exclusion zone with wooden lathes and brightly colored "caution" tape.

Once any equipment stabilizers are firmly on the ground, excavation can commence. If the area of investigation is beneath vegetative cover or surface debris, the backhoe operator shall scrape the initial 6 inches of topsoil to allow a clear and safe working area. Excavated soil shall be stockpiled away from the immediate edge to one side of the trench to prevent excavated soil from re-entering the trench or pit and to reduce pressure on the sidewalls, discouraging rotational slips involving large masses of material. The soil shall be deposited downwind of the ground crew and the machine operator. Shifting winds may cause the machine and operator and ground crew to periodically move in order to remain downwind, or to curtail further activities. The support crew should regularly check the machine operator who, if in a partially enclosed cabin, may be susceptible to fumes/gases.

7.2 Stability

Depending on the desired depth of excavation, the trench may require shoring to prevent the sides from collapsing. Lateral support may be provided by a portable aluminum frame system that uses a hydraulic pump to apply pressure to the sidewalls and that can be quickly inserted or extracted, or the sides can be benched to an appropriate angle. Any timbering or alternative support required in excavations should be installed by skilled personnel.

Groundwater may be pumped out of the pit to stabilize the sidewalls, prevent base heave, and to keep the excavation dry allowing a greater depth to be reached, especially in granular materials that are below the water table.

Near-vertical slopes can stand for seconds, or months, depending on the types of material involved and various other factors affecting their stability. Although personnel should not be entering the excavation, it is prudent to know the possible behavior of the various soil types and conditions that may be encountered. Excavations into fill are generally much more unstable than those in natural soil.

Excavations in a very soft normally consolidated clay should stand vertically, without support, to depths of approximately 12 feet in the short-term only. This critical depth increases as the clays increase in consistency. Long-term stability is dependent on a combination of factors: the type of soils, pore pressures and other forces acting within the soil; and adverse weather effects. Fissured clays can fail along well-defined shear planes and, therefore, their long-term stability is not dependent on their shear strength and is difficult to predict.

Dry sands and gravels can stand at slopes equal to their natural angle of repose no matter what the depth of the excavation (angles can range from approximately 28 to 46 degrees depending on the angularity of grains and relative density).

Damp sands and gravels possess some cohesion and can stand vertically for some time. Water-bearing sands, however, are very difficult in open excavations. If they are cut steeply, as in trench excavation, seepage of water from the face will result in erosion at the toe followed by collapse of the upper part of the face until a stable angle of approximately 15 to 20 degrees is obtained.

Dry silts should stand unsupported vertically, especially if slightly cemented. Wet silt is the most troublesome material to excavate. Seepage leads to slumping and undermining with subsequent collapse, eventually reaching a very shallow angle of repose.

It should not be taken for granted that excavations in rock will stand with vertical slopes unsupported. Their stability depends on the soundness, angle of bedding planes, and the degree of shattering. Unstable conditions can occur if bedding planes slope steeply towards the excavation, especially if groundwater is present to act as lubrication.

7.3 Backfilling

The test pits or trenches should be backfilled immediately upon completion of the hole. Poorly compacted backfill will cause settlement at the ground surface and hence the spoil should be recompacted in several thin layers using the excavator bucket and any surplus material placed over the top of the pit.

In certain areas where soil borings are not required, the pit may be used to install gas monitoring standpipes or piezometers. The granular filter is kept in place using sacking while the backfill material is carefully emplaced around the instrument.

If a sealing layer has been penetrated during excavation, resulting in a groundwater connection between contaminated and previously uncontaminated zones, the backfill material must represent the original conditions or be impermeable. Backfill material could comprise a soil-bentonite mix or a cement-bentonite grout.

7.4 Decontamination

The purpose of decontamination and cleaning procedures during sampling tasks is to prevent foreign contamination of the samples and cross contamination between sites. Before use all sampling and excavation equipment will be decontaminated by steam cleaning. Potentially, all fluids generated by decontamination should be contained in Department of Transportation (DOT)-approved 55-gallon drums.

8.0 DATA ACQUISITION, CALCULATION AND DATA REDUCTION

The field record should include a plan giving the location, dimensions, and orientation of the pit, together with dimensioned sections of the sidewalls, description of the strata encountered, and details of any sampling or testing carried out. A photographic record of the test pit, with an appropriate scale, would be ideal.

Any groundwater encountered should be noted with regard to its depth and approximate rate of seepage. If possible the groundwater level within the test pit should be monitored for 20 minutes, with readings taken at 5-minute intervals.

Working from the ground surface the technician can prepare a visual log of the strata/soil profile and decide the interval of sampling. Samples from excavations can be either disturbed or undisturbed.

Disturbed samples are taken from the excavator bucket or from the spoil. To obtain a representative sample of the material at a certain depth, care must be taken not to include scrapings from the sidewalls.

Undisturbed samples may be block samples, cut from in situ material:

- Tube samplers may be driven into the floor of the pit using a jarring link and drill rods and extracted using the hoe of the excavator;
- Soil samples may be collected from the test pit using a long-handled soil coring device;
- Test pits will be logged and screened using a PID by a qualified geologist or soil scientist;
- Samples of groundwater or leachate may be taken using telescoping poles or a small bailer; and
- If a sample is to be collected for chemical analysis, see SOP No. SS-03 for sample collection methodologies.

The required size of the disturbed samples will vary according to the intended analysis/testing to be carried out. Samples for geotechnical testing will generally need 4 to 6 ounces of material.

9.0 REFERENCES

Scientific and Technical Standards for Hazardous Waste Sites. Book 1, Volume 1, Site Characterization, August 1990.

Tomlinson, M.J., 1986. Foundation Design and Construction, 5th Edition.

STANDARD OPERATING PROCEDURES

EQUIPMENT DECONTAMINATION

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1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) provides a general framework for decontaminating equipment used as part of environmental monitoring or sampling activities. For determining the most appropriate decontamination method the primary consideration must be given to the most likely, or suspected, contaminant to be encountered during the investigation in each media.

2.0 SUMMARY OF METHOD

This SOP provides a description of the decontamination procedures used during field investigations. The project specific plans may have site-specific concerns which would require additions or adjustments to these procedures.

This document focuses on methods and equipment that are readily available and typically applied. It is not intended to provide an all-inclusive discussion of decontamination methods.

3.0 DEFINITIONS

Flight: An individual auger section, usually 5 feet in length.

Split-Spoon Sampler: A thick-walled steel tube split lengthwise used to collect soil samples. The sampler is commonly lined with metal sample sleeves and is driven or pushed downhole by the drill rig to collect samples.

Macro Core Sampler: A metal sampling tube, typically 2-inches in diameter by 4 or 5 feet long, advanced using direct push drilling. A plastic (acetate) inner sleeve is used to isolate the soil sample from the metal tube.

4.0 APPARATUS AND MATERIALS

The following equipment will be used as part of the decontamination procedures:

- Distilled/Deionized Water;
- Laboratory-grade, non-phosphate detergent (Alconox, or equivalent);
- 10% Nitric Acid solution (if required);
- Methanol or hexanes (if required);
- Steam cleaner;
- Nitrile Gloves (other PPE as required by Health & Safety Plan).

5.0 DECONTAMINATION PROCEDURES

The purpose of decontamination and cleaning procedures during an investigation is to prevent foreign contamination of the samples and cross-contamination between sites. A decontamination area and clean zone will be established for the preparation and breakdown of equipment prior to each sampling task. The decontamination area will be large enough to accommodate equipment to be used for invasive work. Decontamination rinsate will be containerized for temporary storage and subsequent characterization and disposal. Decontamination fluids containing non-aqueous phase liquids will have the non-aqueous phase liquid separated and separately containerized for subsequent characterization and disposal. Solvents and/or acids, if used, will be separately containerized for subsequent characterization and disposal.

Before use, all non-sampling equipment will be decontaminated with high-pressure steam, or scrubbed with a non-phosphate detergent and rinsed with water from the approved water source. If appropriate, equipment will be covered in plastic or aluminum foil to protect it from the elements.

All equipment that may directly contact samples will be decontaminated on-site. The following sampling-specific decontamination procedures will be observed:

1. Physical removal of gross contamination
2. Wash and scrub with detergent (laboratory grade - non-phosphate detergent)
3. Rinse with tap water
4. Rinse with distilled/deionized water
5. Air dry
6. Protect from fugitive dust and vapors.

Additional solvent (i.e., acetone, methanol, or hexanes) and/or acid rinses may be added to the procedure depending on the site sampling objectives. If these additional rinses are required the procedures for incorporation are provided below:

1. Physical removal of gross contamination
2. Wash and scrub with detergent (laboratory grade - non-phosphate detergent)

3. Rinse with tap water
4. Rinse with distilled/deionized water
5. Rinse with 10% nitric acid
6. Rinse with distilled/deionized water
7. Rinse with solvent (pesticide grade)
8. Air dry
9. Rinse with distilled/deionized water
10. Protect from fugitive dust and vapors. Any decontamination fluids that are found to contain non-aqueous phase liquids or high concentrations of decontamination acids will be separately containerized.

6.0 REFERENCES

United States Environmental Protection Agency. 1994. *Sampling Equipment Decontamination*, Emergency Response Team SOP #2006, Revision 0.0.

(www.ert.org/products/2006.PDF).

STANDARD OPERATING PROCEDURES

INVESTIGATION DERIVED WASTE MANAGEMENT

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STANDARD OPERATING PROCEDURES

INVESTIGATION DERIVED WASTE MANAGEMENT

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1.0 SCOPE AND APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to describe the policy, organization, functional activities, and investigation-derived waste (IDW) management control to be implemented for field investigation activities. The SOP should be used as a guideline for future waste management. The objective of this SOP is to describe the general procedures required to manage IDW. In addition, this SOP establishes the sampling and analytical procedures to be followed to manage the IDW as required by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Superfund Amendments and Reauthorization Act (SARA), and Resource Conservation and Recovery Act (RCRA) guidance. Detailed information presented in this SOP addresses the following:

- Typical types of IDW that will be generated and managed during investigation activities,
- Typical specific activities expected to be conducted that may generate IDW,
- Specific waste parameters or characteristics that need to be quantified to ensure safe and effective management of IDW,
- Methods of obtaining necessary data to assess IDW, such as sampling and analysis procedures, and
- Options for disposal of IDW.

2.0 SUMMARY OF IDW GENERATION ACTIVITIES

The various activities conducted during field investigations will result in the generation of IDW. Field activities may include soil-gas and geophysical surveys; drilling of soil borings; trenching or test pits; monitoring well installation and development; groundwater testing; collection of soil, surface water, and groundwater samples; and location surveys. IDW generated during field activities may include the following media and waste types:

- Soil,
- Drilling mud,
- Groundwater,
- Decontamination fluids,
- Personal protective equipment (PPE), and

- Disposable equipment.

The above wastes may or may not be considered hazardous for the purposes of handling and disposal. Section 4.3 details how the wastes will be characterized prior to determining the appropriate disposal option. In addition to the IDW listed above, refuse may be generated during field activities. This could include, for example, packaging materials and broken or cut-off well screening and casing. Typically, this refuse can be treated as nonhazardous material and disposed of as appropriate, such as in an on-site industrial dumpster.

However, the IDW generated during these activities could potentially be contaminated with various hazardous substances. Typical types of IDW generated from various field activities are presented in the subsections that follow. As part of the preplanning procedures prior to the initiation of any field effort, the individual contractors should perform site-specific calculations of the total volumes of IDW expected to be generated based on the anticipated activities as part of their project planning.

An effort should be made to reduce the amount of IDW generated during field activities because the quantity of IDW will affect the overall cost of the scope of work and potentially increase liability or exposure. IDW can be minimized through proper planning of all activities that generate IDW. The sampling equipment and method of decontamination should be selected with consideration to the volume of IDW that will be generated. Whenever possible, the number of activities conducted at a site should be reduced.

2.1 Soil-Gas and Geophysical Surveys

Soil-gas and geophysical surveys are conducted to identify and locate anomalies, potential "hot spots," and source areas. These activities potentially generate a small volume of decontamination fluid and PPE.

2.2 Drilling

The drilling technique to be used for soil boring and monitoring well installation is sonic drilling. Drilling can potentially generate large volumes of PPE and decontamination fluid. These volumes are difficult to estimate because they depend on many site-specific factors.

2.3 Hand Augering, Surface Soil Sampling Activities

Typically, hand augering is conducted using a 3.25-inch diameter auger. Surface soil sampling is usually completed using hand-held sampling tools. Due to small diameter and limited excavation depth, a small volume of soil cuttings is estimated to be generated during these activities, and a small volume of PPE would also be generated.

2.4 Trenches or Test Pits

Trenches or test pits may be excavated at sites. Following the soil sampling and visual observations of the pit, the excavated soil will generally be placed back into the test pit. In this instance the soil will be placed back into the pit in the same order it was removed. Depending on specific site conditions, the need may arise to remove the excavated soil from the area of contamination (AOC). This could potentially generate large volumes of soil to be treated and/or disposed. Decontamination of the excavation and sampling equipment could potentially generate large volumes of decontamination fluid. PPE will also be generated.

2.5 Location Surveys

Following the completion of sampling activities, the coordinates and elevations of all sampling points, including soil borings, monitoring wells, soil-gas points, and geophysical survey grids, will be surveyed. Small volumes of PPE could potentially be generated.

2.6 Monitoring Well Development and Groundwater Sampling

The volume of groundwater generated through monitoring well development, groundwater sampling, and groundwater bearing zone testing is dependent upon a number of variables, including well diameter, length of the screened interval, saturated thickness of the well, porosity of the material used as filter packing, duration and rate of pumping. PPE and decontamination fluid would also be generated as a result of these activities, but the volume is dependent on the type and duration of the activity.

Complete well development requires the removal of at least three times the amount of source water used during drilling and construction of the well plus a minimum of three times the volume of standing groundwater within the well. For example, during the development of a 4-inch diameter well with 30 feet of standing water, a minimum of 58 gallons of groundwater plus three times the amount of the source water used during drilling and construction of the well would be generated. An additional 58 gallons of groundwater would be generated while purging the well prior to groundwater sampling.

In general, purge water should be segregated by well and containerized in Department of Transportation (DOT)-approved, 55-gallon drums.

2.7 Surface Water Sampling

Surface water sampling may be conducted to determine the constituents of the surface water at the site. This activity could potentially generate a small volume of decontamination fluid and PPE.

2.8 Decontamination Fluid

The volume of IDW generated as decontamination fluid will be dependent upon a number of site-specific factors, and therefore, will vary in quantity. Site-specific factors include the number and type of field activities per site and the total number of sites being investigated. Decontamination fluid can vary from a few gallons a day for decontamination of instruments to several hundred gallons a day for decontamination of large field equipment such as drill rigs.

2.9 PPE and Disposable Equipment

The volume of IDW generated as PPE and disposable equipment will be dependent upon a number of site-specific factors and therefore, will vary in quantity. Site-specific factors include the U.S. Environmental Protection Agency (USEPA) health and safety work level (Level D versus Levels C or B), number and type of field activities per site, number of people working on-site, total number of sites being investigated, and the amount of disposable equipment that is required. PPE waste volumes generated per day will typically account for one-half of a 55-gallon drum for a crew of four.

3.0 IDW CONTAINMENT

IDW generated during field activities will be contained at the site of generation or at a designated central location. DOT-approved, 55-gallon drums for the handling of hazardous waste (DOT, USEPA-approved DOT 17-H) should be used for the containment of some of the IDW including PPE, and disposable sampling equipment. Roll-off boxes and Baker (aka frac or fractionation) tanks may be used to contain soil and liquid wastes, respectively. However, DOT-approved, 55-gallon drums may be used to containerize soil and liquid wastes, if preferred. The number of each type of container required at each site should be estimated before field work commences.

Soil cuttings and/or drilling mud will either be contained in DOT-approved, 55-gallon drums or placed in roll-off boxes located in the general area of sites being investigated. If soil cuttings are determined to be potentially hazardous while in the field (i.e., PID readings above designated levels or visible staining), soil cuttings should be segregated by site or boring, containerized in DOT-approved 55-gallon drums lined with polyethylene, and immediately secured with lids. Each drum or roll-off box will be labeled as discussed in Section 4.0. Drums or roll-off boxes will be stored at the site of generation or transported from the AOC following drilling and stored at a central location. Drums or roll-off boxes will be held until adequate characterization of the site or the contained soil or drilling mud is completed (Section 4.0).

Liquid wastes will either be stored within the AOC or transported to a central location. Liquid wastes generated during field investigation activities include fluids generated during well installation, development, purging and sampling, groundwater bearing zone testing, surface water sampling, and decontamination of equipment. Liquid wastes may be placed in DOT-approved, 55-gallon drums or consolidated in onsite poly or Baker tanks until the liquid can be characterized for disposal (see Section 4.0). Each drum will be labeled as discussed in Section 4.0. Drums will be stored at the site of generation or transported from the AOC and stored at a central location. Liquid wastes will be stored pending IDW characterization (Section 4.0).

Depending upon the suspected contaminants present, decontamination fluid generated at each site may be segregated by site and containerized in DOT-approved, 55-gallon drums or stored with other liquid wastes generated at the same site. The decontamination fluid will be stored within the AOC or a designated central location. Decontamination fluid will be held until adequate characterization is complete (Section 4.0).

PPE and disposable equipment produced through field activities will be segregated by site, double bagged in plastic bags, secured and labeled using a wire tag. The bags will then be placed in DOT-approved, 55-gallon drums and labeled as discussed in Section 4.0. Partially filled drums will be secured with lids at the completion of field activities or at the end of the work day. PPE and disposable equipment will be held at the site of generation or a designated central location. PPE and disposable equipment will be held until adequate characterization of the site or of the containerized PPE and disposable equipment is completed (Section 4.0).

4.0 IDW HANDLING AND MANAGEMENT OPTIONS

This section discusses the proper IDW management procedures to be followed in record-keeping practices, requirements for compliance with storage time limitations, and characterization of IDW. The protocols established for sampling and analysis of contaminated IDW, if required, are also presented in this section.

Following the field activities, including proper labeling and temporary storage of IDW as appropriate, the first task will be to characterize the IDW generated. Proper characterization is required to determine if disposal is necessary and, if so, the appropriate disposal options. Initially, the IDW will be characterized based on a review of analytical data generated from environmental samples collected during field activities. Based on this review, the characteristics of the IDW will be inferred. In some cases, testing containerized IDW may be required to further define disposal options. The management of investigation-derived wastes including containerization and required analyses is presented in Section 4.3 for soil and liquids.

Initially, soil and liquid IDW will be characterized based on the background data. To identify potential contamination, analytical results should be compared to the 95% Upper Tolerance Level for the background samples.

Proper IDW management requires that the following steps be completed:

- Characterize the waste generated,
- Determine the quantity of waste that is hazardous,
- Evaluate available disposal/treatment methods,
- Identify disposal facility waste acceptance criteria and schedule testing of wastes, and
- Select a disposal option and coordinate manifesting and transport.

The investigation team members will conduct the field activities that generate the IDW (Section 2.0), place the IDW in appropriate containers (Section 3.0), and complete record-keeping responsibilities (Section 4.0). Once the waste has been adequately characterized, the investigation team will also arrange for the appropriate treatment or disposal of the IDW. A technical memorandum will document the status of containerized IDW with the following information:

- A complete list of containers stored at each site of generation or at the central area,
- Unique identification of each container,
- Contents of each container,
- Analytical results of the environmental samples,
- Volume of potentially contaminated material,
- Potential contaminant(s) of concern,
- Site maps showing the location of each container at the site, and
- Recommended treatment and/or disposal options for each container.

The investigation team will sample existing containerized IDW, as required, for further characterization or disposal. Handling and managing the off-site treatment and disposal of IDW after the containers have been characterized for off-site transport would also be required. Additional tasks that would be performed include, but may not be limited to, preparing manifests, tracking containers, tracking 90-day storage limits, arranging the transport of containers, and arranging the ultimate disposal to a RCRA-permitted off-site treatment, storage, and disposal facility (TSDF).

4.1 Container Labeling and Record Keeping

Container labeling and record-keeping requirements include: (1) proper labeling of containers as waste pending receipt of analytical test results (proper labeling includes information such as source site number, boring or well number, and permissible storage period); and (2) date(s) of waste generation and type of IDW stored in the container. Drum labels will be placed on the side of the drum, not on the lid, to reduce breakdown of the label by environmental conditions and to prevent the possibility of interchanging labels if lids are reused. Plastic bags used to contain disposable PPE and disposable equipment will be identified with a drum label wrapped around a piece of wire to produce a wire tag that will be used to seal the bag.

IDW containers should be tracked using a form that includes site name, location identification, storage location, contents, source, dates of operation, capacity of container and visual observations of the wastes, odor characteristics, and PID readings. The form should be completed once each container is filled. The quantity (volume) of material in each container should be measured and recorded on the IDW container data sheet prior to sealing the container.

In addition to complying with the above requirements, as appropriate, an inventory of wastes generated, including source, media, storage location, analytical results, and final treatment or disposal will be maintained. Hazardous waste manifests and material safety data sheets will be completed as appropriate. All manifests will be signed by the generator.

4.2 Storage Time Limits

Several storage and disposal requirements are subject to time limits that begin when the IDW is generated. These include:

- removal of waste from the site (unless wastes will be stored on site within the AOC);
- notification of the USACE by the contractor following initial characterization of the IDW; and
- final treatment or disposal of the IDW.

Within 60 days of waste generation, the investigation team should provide a memorandum to the USACE documenting the initial characterization of the IDW. Sixty days is required to receive analytical results from the laboratory, review the data, interpret the data, and prepare the memorandum. The memorandum will assist in planning and compliance with environmental regulations. Documentation should contain information on quantity of waste, type (soil, water, etc.), site, source (borehole, monitoring well, etc.), contaminants detected, and concentrations. This information will be used to make an initial classification of waste (potentially hazardous, designated, or nonhazardous). The memorandum should include proposed actions to be taken concerning additional sampling and disposal.

As discussed in Section 4.0, if IDW is characterized to be potentially hazardous, additional sampling of IDW containers will be required to determine if the IDW is hazardous. If the material is defined as RCRA hazardous waste, RCRA regulations (40 CFR 262.34) requires the waste to be transported off site in 90 days. In addition, RCRA regulations (40 CFR 262.34) require that, unless IDW will be stored within the AOC, IDW will be transported to the designated storage area within 3 days. If additional sampling is performed, it is likely that the 90-day limit on RCRA waste will be exceeded. CERCLA-derived wastes may be stored at an area longer than 90 days as long as the storage area complies with RCRA substantive storage requirements (the administrative process for obtaining a permit is not required). The intent of the waste management program will be to dispose of IDW as soon as is practicable. Factors that may influence the length of time of storage include laboratory turnaround time, duration of investigations at the site, storage area volume limitations, time requirements to arrange for off-site disposal, and the degree of risk that the IDW poses to human health and the environment. If IDW is generated that is deemed by the USACE, regulatory agencies, or the contractor to present a high degree of risk by storing the IDW, arrangements will be made for immediate transfer or disposal.

4.3 IDW Container Sampling and Analysis Methods

Analytical samples collected during field activities will be analyzed and the results compared to background and regulatory limits before IDW container sampling occurs. Data collection efforts completed during the field investigation should be sufficient for determining whether IDW is potentially hazardous. The basic objective of IDW sampling is to produce a set of samples representative of the contained IDW media under investigation and suitable for subsequent analysis, if required. PPE and disposable equipment found to be potentially hazardous will be disposed as hazardous materials. The methods, techniques, and analyses used for testing hazardous field-generated wastes that will be disposed of off-installation to a RCRA-permitted facility or Class I disposal facility are presented in the following sections.

The sampling technique chosen for sampling activities will, in part, be dependent upon the physical state of the IDW media to be sampled. The physical state of the IDW will affect most aspects of the sampling effort. The sampling technique will vary according to whether the sample is liquid, solid, or multi-phasic. The generation of decontamination fluids through IDW sampling should be minimized and should be a factor considered in the final choice of sampling technique. The decontamination fluids will be minimized through selection of appropriate technique to sample the media in question and ease of cleaning. Care should be exercised to avoid the use of sampling devices plated with chrome or other materials that might contaminate the sample.

If IDW is characterized to be potentially hazardous after review of analytical data generated during field activities, IDW container sampling will be conducted. Testing is required prior to on- or off-site treatment, storage, or disposal of contaminated material. However, IDW container testing is not required if the IDW is determined to be nonhazardous. Criteria for testing protocols are presented in Section 4.0. The description of sampling techniques for containerized media is divided into two sections, which address soil and drilling mud, and containerized liquids.

4.3.1 Containerized Soil and Drilling Mud Sampling

Available options for sampling devices suitable for soil and drilling mud sampling include scoops, thin-walled tube samplers, hand augers, core samplers, and sampling tiers. The presence of rocks, debris, or other sampling-specific considerations will dictate the most suitable sampling method. The sampling technique will also vary according to whether the solid is hard or soft, powdery or clay-like (USEPA, 1986).

If the soil or drilling mud is stored in bins, one composite sample should be collected from each bin. If the IDW is stored in drums, one composite sample should be collected from the cuttings from each boring or from each site.

4.3.2 Containerized Liquid Waste Sampling

Beakers, glass tubes, extended bottle samplers, and Composite Liquid Waste Samplers (COLIWASA) are devices that may potentially be used to sample containerized liquid media. Site-specific conditions may necessitate a variety of sampling options. Site-specific conditions will include the homogeneity or heterogeneity of the liquid to be sampled and stratification and the physical nature of the liquid such as viscosity. Sampling techniques will be chosen based on properties of the liquid medium and ease of decontamination of sampling equipment. Surface water samples from drums can also be readily collected by merely submerging a sample bottle.

If the liquid waste is stored in poly or Baker Tanks, one composite sample should be collected from each tank. If the liquid waste is stored in drums, one composite sample should be collected from the drums for each sampling event.

5.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), 1984. Waste Analysis Plans. Prepared by the Office of Solid Waste, October 1984.

USEPA, 1986. Test Methods for Evaluating Solid Waste, Third Edition SW-846. Prepared by the Office of Solid Waste and Emergency Response, November 1986.

USEPA, 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. Prepared by the Office of Emergency and Remedial Response, October 1988.

USEPA, 1988b. CERCLA Compliance with Other Laws Manual, Draft Guidance. Prepared by the Office of Emergency and Remedial Response, August 1988.

USEPA, 1990. CERCLA Compliance with the RCRA Toxicity Characteristics (TC) Rule: Part II. Prepared by the Office of Solid Waste and Emergency Response, October 1990.

USEPA, 1991. Management of Investigation-Derived Wastes During Site Inspections. Prepared by the Office of Emergency and Remedial Response, Publication 9345.3-02FS, May 1991.

STANDARD OPERATING PROCEDURES

SOIL CLASSIFICATION

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1.0 INTRODUCTION

This standard operating procedure (SOP) is applicable to logging soils at all sites requiring soil investigation. The SOP is based on American Society for Testing and Materials (ASTM) D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soils Classification System - USCS) and ASTM Standard D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure - ASTM, 2000b). Variance from the logging procedures described herein shall be warranted only if specifically required by a particular stakeholder or regulatory agency. A solid working knowledge of this SOP is critical for field personnel to standardize logging procedures and to enable subsequent correlations between borings at a site, allowing for accurate and thorough site characterization.

Copies of the above-referenced ASTM standards are available for all field personnel. Other field guidance references may also be used according to personal preference; however, such references must be based on the USCS. Note that many references (for example, American Geosciences Institute (AGI) Data Sheet grain size scales) base soil classifications on the Wentworth Scale. Such scales may vary significantly from the USCS and will lead to inaccurate or inconsistent soil descriptions.

2.0 DEFINITIONS

Use of the USCS requires familiarity with the grain size ranges that define a particular type of soil, as well as several other physical characteristics. The grain size definitions and physical characteristics upon which soil descriptions are based are presented below.

2.1 Grain Sizes

USCS grain sizes are based on United States (U.S.) standard sieve sizes, which are named as follows:

- Standard sieves with larger openings are named according to the size of the openings in the sieve mesh. For example, a "3-in." sieve contains openings which are 3 inches square.

- Standard sieves with smaller openings are given numbered designations that indicate the number of openings per inch. For example, a "No. 4" sieve contains 4 openings per inch.

The following grain size definitions are paraphrased from the ASTM Standard D 2488 - 90. Field personnel should familiarize themselves with the grain size definitions and refer to an appropriate field guide for a visual reference.

Boulders - Particles of rock that will not pass a 12-in. (300-millimeter [mm]) square opening.

Cobbles - Particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve.

Gravel - Particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

Coarse Gravel	Passes a 3-in. (75-mm) sieve and is retained on a 3/4-in. (19-mm) sieve
Fine Gravel	Passes a 3/4-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

Sand - Particles of rock that will pass a No. 4 (0.19 in. or 4.75-mm) sieve and be retained on a No. 200 (0.003 in. or 75-micrometer (μm)) sieve with the following subdivisions:

Coarse Sand	Passes a No. 4 (0.19 in. or 4.75-mm) sieve and is retained on a No. 10 (0.08 in. or 2-mm) sieve
Medium Sand	Passes a No. 10 (0.08 in. or 2-mm) sieve and is retained on a No. 40 (0.017 in. or 425-μm) sieve
Fine Sand	Passes a No. 40 (0.017 in. or 425-μm) sieve and is retained on a No. 200 (0.003 in. or 75-micrometer [μm]) sieve.

Silt - Soil passing a No. 200 (0.003 in. or 75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dried. Individual silt particles are not visible to the naked eye.

Clay - Soil passing a No. 200 (0.003 in. or 75-μm) sieve that can be made to exhibit plasticity within a range of water contents and that exhibits considerable strength when air-dried. Individual clay particles are not visible to the naked eye.

2.2 Physical Characteristics

The following physical characteristics are used in the USCS classification for fine-grained soils. A brief definition of each physical characteristic is presented below. Tables 1 through 4 present descriptions of field tests that may be performed to estimate these properties in a field sample. However, with the exception of plasticity, the tests are generally too time-consuming to perform regularly in the field. A determination of the type of fine-grained soil present in the sample can generally be made on the basis of plasticity, as described in Section 3.1.2.

Dry Strength - The ease with which a dry lump of soil crushes between the fingers (Table 1).

Dilatancy Reaction - The speed with which water appears in a moist pat of soil when shaking in the hand, and disappears while squeezing (Table 2).

Toughness - The strength of a soil, moistened near its plastic limit, when rolled into a 1/8 in. diameter thread (Table 3).

Plasticity - The extent to which a soil may be rolled into a 1/8 in. thread, and re-rolled when drier than the plastic limit (Table 4).

3.0 SOIL LOGGING PROCEDURES

The following aspects of a project must be considered before sampling and soil logging commences. This information is generally summarized in a project-specific work plan or field sampling plan, which must be thoroughly reviewed by all field personnel prior to the initiation of work.

- Purpose of the soil logging (e.g., initial investigation, subsequent investigation, remediation);
- Known or anticipated hydrogeologic setting including lithology (consolidated/unconsolidated, depositional environment, presence of fill material), recharge/discharge conditions and ground water/surface water interrelationships;
- Drilling conditions;
- Previous soil boring or borehole geophysical logs;

- Soil sampling and geotechnical testing program;
- Characteristics of potential chemical release(s) (chemistry, density, viscosity, reactivity, and concentration);
- Health and Safety protection requirements; and
- Regulatory requirements.

The procedures used to determine the correct soil sample classification are described below.

3.1 Field Classification of Soils

The following soil classification procedures are based on the ASTM Standard D 2488 for visual-manual identification of soils (ASTM, 2000b). When naming soils, the proper USCS soil group name is given, followed by the group symbol. For clarity, it is recommended that the group symbol be placed in parentheses after the written soil group name.

Soil identification using the visual-manual procedures is based on naming the portion of the soil sample that will pass a 3-in. (75-mm) sieve. Therefore, before classifying a soil, any particles larger than 3 inches (cobbles and boulders) should be removed, if possible. Estimate and note the percentage of cobbles and boulders.

Using the remaining soil, the next step of the procedure is to estimate the percentages, by dry weight, of the gravel, sand, and fine fractions (particles passing a No. 200 sieve). The percentages shall be estimated to the closest 5%. In general, the soil is *fine-grained* (e.g., a silt or a clay) if it contains 50% or more fines, and *coarse-grained* (e.g., a sand or a gravel) if it contains less than 50% fines. If one of the components is present but estimated to be less than 5%, its presence is indicated by the term *trace*. For example, 'trace of fines' would be added as additional information following the formal USCS soil description.

3.1.1 Procedure for Identifying Coarse-Grained Soils (contain less than 50% fines)

If it has been determined that the soil contains less than 50% fines, the soil is a *gravel* ***if*** the percentage of gravel is estimated to be more than the percentage of sand. The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

If the soil is predominantly sand or gravel but contains an estimated 15% or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "gravel with sand (GP)." If the sample contains any cobbles or boulders, the words "with cobbles" or "with cobbles and boulders" shall be added to group name. For example: "silty gravel with cobbles (GM)."

5% or less fines. The soil is a 'clean gravel' or 'clean sand' if the percentage of fines is estimated to be 5% or less. 'Clean' is not a formal USCS name, but rather a general descriptor for implying little to no fines. Clean sands and gravels are given the USCS designation as either *well-graded* or *poorly-graded*, as described below.

Identify the soil as a *well-graded gravel (*GW), or as a *well-graded sand* (SW), if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes. Identify the soil as a *poorly-graded gravel* (GP) or as a *poorly-graded sand (*SP) if it consists predominantly of one grain size (uniformly graded), or has a wide range of sizes with some intermediate sizes obviously missing (gap- or skip-graded).

NOTE: When using the USCS, keep in mind the difference between grading and sorting. The term grading is used to indicate the range of particles contained in the sample. For example, a poorly-graded sand containing predominantly one grain size would be considered well-sorted, and vice-versa. One notable exception to this general rule is a skip-graded (bimodally distributed) sample: a sand containing two distinct grain sizes would be considered both poorly-sorted and poorly-graded. The USCS uses only the *GRADING* descriptor in soil naming, not the sorting descriptor.

<u>≥ 15% fines.</u> The soil is a *silty or clayey gravel* or a *silty* or *clayey sand* if the percentage of fines is estimated to be 15% or more. For example, identify the soil as *clayey gravel* (GC) or a *clayey sand* (SC) if the fines are clayey. Identify the soil as a *silty gravel* (GM) or a *silty sand* (SM) if the fines are silty. The coarse-grained descriptor "poorly-graded" or "well-graded" is not included in the soil name, but rather, should be included as additional information following the formal USCS soil description.

<u>>5% but <15% fines.</u> If the soil is estimated to contain greater than 5% and less than 15% fines, give the soil a dual identification using two group symbols. The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a clayey/silty gravel or sand (GC, GM, SC, SM). The group name shall correspond to the first group symbol, and include the words "poorly-graded" or "well-graded", plus the words "with clay" or "with silt" to indicate the character of the fines. For example, "poorly-graded gravel with silt (GP-GM)".

3.1.2 Procedure for Identifying Fine-Grained Soils (contain 50% or more fines)

The USCS classifies inorganic fine-grained soils according to their degree of plasticity (no or low plasticity - indicated with an "L", or high plasticity - indicated with an "H") and other physical characteristics (defined in Section 2.2/Tables 1 through 4). As indicated in Section 2.2, the field tests used to determine dry strength, dilatancy, and toughness are generally too time consuming to be performed on a routine basis. Field personnel should be familiar with the definitions of the physical characteristics and the concepts of the field tests; however, field classifications will generally be based primarily on plasticity. <u>NOTE:</u> if precise engineering properties are necessary for the project (i.e., construction, modeling, etc.) geotechnical samples should be collected for laboratory testing. The results of the laboratory tests should be compared to the field logging results.

Lean clay (CL) -	soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity.
Fat clay (CH)	soil has high to very high dry strength, no dilatancy, and high toughness and plasticity.

Silt (ML) - the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic.

Elastic silt (MH) - the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity; will air dry more quickly than lean clay and have a smooth, silky feel when dry.

Organic soil (OL or OH) - the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, from black to brown, when exposed to the air. Organic soils normally will not have a high toughness or plasticity.

Other Modifiers for use with Fine-Grained Soils:

15% to 25% coarse-grained material. If the soil is estimated to have 15% to 25% sand or gravel, or both, the words "with sand" or "with gravel" (whichever is predominant) shall be added to the group name. For example: "lean clay with sand (CL)" or "silt with gravel (ML)". If the percentage of sand is equal to the percentage of gravel, use "with sand."

≥30% coarse-grained material. If the soil is estimated to have 30% or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be the same or more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy silt (ML)", or "gravelly fat clay (CH)".

3.1.3 Procedure for Identifying Borderline Soils

To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example, a soil containing an estimated 50% silt and 50% fine-grained sand may be assigned a borderline symbol "SM/ML". Borderline symbols should not be used indiscriminately. Every effort shall be made to first place the soil into a single group and then to estimate percentages following the USCS soil description.

3.2 Descriptive Information for Soils

After the soil name and symbol are assigned, the soil color, consistency/density, and moisture content shall be described in that order. Other information is presented later in the description, as applicable.

3.2.1 Color

Describe the color. Color is an important property in identifying organic soils, and may also be useful in identifying materials of similar geologic or depositional origin in a given location. The Munsell Soil Color Charts should be used, if possible.

When using the Munsell Soil Color Charts, first attempt to assign the soil a general color, such as brown, gray, red, etc. Then go to the correct area in the charts and assign the applicable color name and Munsell symbol. The ability to detect minor color differences varies among people, and the chance of finding a perfect color match in the charts is rare. Keeping this in mind should help field personnel avoid spending unnecessary time and confusion going through the chart pages. In addition, attempting to describe detail beyond the reasonable accuracy of field observations could lead to making poorer soil descriptions than by expressing the dominant colors simply.

If the color charts are not being used or are unavailable, again attempt to assign general colors to soils. Comparing a particular soil sample to samples from different locations in the borehole will help keep the eye "calibrated". For example, by holding two soils together, it may become evident that one is obviously greenish-brown, while another is reddish.

3.2.2 Consistency/Density

For intact fine-grained soil, describe consistency as very soft, soft, medium stiff, stiff, very stiff, or hard, based on the blows per foot using a 140-pound hammer dropped 30 in. (Table 5). If blow counts are not available, perform the field test described in Table 6 to determine consistency.

For coarse-grained soils, describe density based on blows per foot as very loose, loose, medium dense, dense, and very dense (Table 5). If blow counts are not available, attempt to estimate the soil density by observation, since a practical field test is not available. Be sure to clearly indicate on the field boring log if blow counts could not be obtained.

3.2.3 Moisture

Describe the moisture condition of the soil as dry (absence of moisture, dusty, dry to the touch), moist (damp but no visible water), or wet (visible free water, saturated).

3.2.4 Grain Size

Describe the predominant particle size found in the sample in accordance with the following information:

Sand Size -	If the predominant particle size is a sand size, describe as fine, medium, or coarse. (see Section 2 for sand size definitions.)
Gravel Size -	If the predominant particle size is a gravel size, describe the diameter of the maximum particle size in inches.
Cobble or Boulder Size -	If the predominant particle size is a cobble or boulder size, describe the maximum dimension of the predominant particle size.

For gravel and sand components, describe the range of particle sizes within each component. For example, "about 20% fine to coarse gravel, about 40% fine to coarse sand".

3.2.5 Odor

Due to health and safety concerns, NEVER intentionally smell the soil. This could result in exposure to volatile contaminants that may be present in the soil. If, however, an odor is noticed, it should be described if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation (sometimes a hydrogen sulfide ["rotten egg"] smell). If the odor is unusual (petroleum product, chemical, etc.), it shall be described. Organic vapor readings from a PID or similar instrument should be noted on the field boring log. The project-specific health and safety plan should then be consulted to determine the appropriate level of protection necessary for the continuation of field work.

3.2.6 Cementation

Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the following criteria:

Weak - Crumbles or breaks with handling or little finger pressure
Moderate - Crumbles or breaks with considerable finger pressure
Strong - Will not crumble or break with finger pressure

The presence of calcium carbonate may be confirmed on the basis of effervescence with dilute hydrochloric acid (HCl), if calcium carbonate or caliche is believed to be present in the soil. Proper health and safety precautions must be followed when mixing, handling, storing, or transporting HCl. For further information, see I/HW Health and Safety Procedure 630.24, "Procedure for Hydrochloric Acid Handling for Soil Logging."

3.2.7 Angularity

Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the following criteria:

Angular -	Particles have sharp edges and relatively planar sides with unpolished surfaces
Subangular -	Particles are similar to angular description but have rounded edges
Subrounded -	Particles have nearly plane sides but have well-rounded corners and edges
Rounded -	Particles have smoothly curved sides and no edges

A range of angularity may be stated, such as "subrounded to rounded."

3.2.8 Structure

Describe the structure of intact soils in accordance with the criteria in Table 7.

3.2.9 Lithology

Describe the lithology (rock or mineral type) of the sand, gravel, cobbles, and boulders, if possible. It may be difficult to determine the lithology of fine- and medium-grained sand or particles that have undergone alteration.

3.2.10 Additional Comments

Additional comments may include: the presence of roots or other vegetation, fossils or organic debris, staining, mottling, or oxidation; difficulty in drilling; and caving or sloughing of the borehole walls. Also, when drilling in an area known or suspected to contain imported fill material, every effort should be made to identify the contact between fill and native soils. If a soil is suspected to be fill, this should be clearly indicated on the log following the soil description. Stratigraphic units and their contacts should be noted wherever possible.

3.2.11 Bedrock Descriptions

If the soil boring penetrates bedrock, the boring log should indicate the rock type, color, weathering, fracturing, competency, mineralogy, age (if known), and any other miscellaneous information available. Definitions of these terms are not included in this SOP, because only a small percentage of drilling activities conducted penetrate bedrock. If bedrock drilling is planned, the field team leader, with the concurrence of the project manager, should make arrangements to provide the field team with appropriate definitions and indicate the types with information that should be collected.

3.3 Additional Boring Log Information

In addition to soil descriptions, there are several other items that should be included on all boring logs. Information in the log heading should be complete and accurate. The following information should be recorded, at a minimum:

- Boring or monitoring well number
- Project name and job number
- Site name
- Name of individual who logged the boring
- Name of boring log reviewer
- Drilling contractor
- Drill rig type and method of drilling (for example, "CME 75, hollow stem auger")
- Name of drilling company
- Name of driller and helper
- Borehole diameter and drill bit type
- Type of soil sampler (for example, continuous core, etc.)
- Time and date that drilling started and finished
- Time and date that the well was completed or the soil boring backfilled, as appropriate
- Method of borehole backfilling
- In the field notebook, a sketch map of boring or well location with estimated distances to major site features such as property lines or buildings, and north arrow.

Soil sample information should include the depth interval that was sampled, the blow counts per six inches, the amount of soil recovered, and the portion submitted for analysis or testing, if any. The sample identification number may also be noted on the log.

The degree to which soil samples are collected during a field effort depends on the overall scope and purpose of the investigation, which should be clearly defined before the field effort commences. Additional soil samples may need to be collected if, for example, soils are very heterogeneous or unexpected conditions such as perched water zones or zones of contamination are encountered.

If groundwater is encountered during drilling, the depth to water and the time and date of the observation should be recorded. If the first water encountered is a perched zone, the depth, time, and date that any additional groundwater zones are encountered should also be recorded. Depth to water after drilling, the measuring point, and the date and time of the measurement(s) must be noted. Additional measurements of depth to groundwater, including depth and time, may be beneficial.

If a monitoring well is installed, the construction details such as casing material type, screen length and slot size should be noted on a Monitoring Well Construction Detail sheet. The annulus fill material (sand pack, bentonite, grout, etc.) shall also be recorded.

If the soil boring is backfilled, the backfill material used (e.g., grout, bentonite, etc.) and volume used should be recorded on the boring log.

4.0 REFERENCES

ASTM, 2000b, Standard D 2488 - 00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Greteg-Macbeth, 2000, Munsell Soil Color Charts.

STANDARD OPERATING PROCEDURE

TRENCHING AND TEST PITTING

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1.0 SCOPE & APPLICABILITY

This guideline presents the Standard Operating Procedure (SOP) for test pit excavations. In suitable ground, shallow excavations may provide an efficient and economic method to evaluate the shallow subsurface environment of a site.

2.0 SUMMARY OF METHODS

This SOP establishes guidelines for conducting test pit and trench excavations at hazardous waste sites.

Shallow trial pits do the following:

- Permit the in-situ condition of the ground to be examined in detail both laterally and vertically;
- Provide access for taking samples and for performing in-situ tests;
- Provide a means of determining the orientation of discontinuities in the ground; and
- Field sampling personnel are somewhat removed from the sampling site as intrusive activities are conducted, increasing safety.

3.0 DEFINITIONS

DOT: Department of Transportation

EOD: Explosive Ordinance Disposal

MGM: Multi-Gas Meter (including CO, O_2, H_2S, and LEL) (SOP No. MGM-1)

OSO: On-site Safety Officer

OSHA: Occupational Safety and Health Administration

PID: Photoionization Detector (SOP No. PID-1)

SOP: Standard Operating Procedure

Trench or Test Pit: Linear excavation, of varying width, usually used to locate landfill boundaries as well as for clearing landfill location for drilling.

Ground Crew: Composed of excavating support crew and sampling crew.

4.0 APPARATUS & MATERIALS

Trench and test pit excavation is carried out either manually or by using standard equipment such as backhoes, trenching machines, track dozers, track loaders, excavators, and scrapers. Operators of excavating equipment should be skilled and experienced in its safe use for digging test pits and trenches. A typical excavator with extending backhoe arm can excavate approximately 15 feet of material. If investigations are required to penetrate beyond 15 feet, soil borings may be a more feasible method.

5.0 HEALTH AND SAFETY PROCEDURES

A tailgate safety meeting shall be conducted by a designated on-site safety officer (OSO) before commencing excavation.

Prior to all excavations, the field geologist must confirm that underground utilities (electric, gas, telephone, water, etc.) within the general vicinity to nearby foundations or structures have been cleared or marked off. Certain underground services may not be picked up by detectors and careful excavation of the surface soils, with the ground crew watching for early signs, can help prevent the puncturing of any underground services.

Prior to commencing excavation, standard signals shall be used for rapid and efficient communication between the excavating equipment operator and the ground crew. Before approaching the trench/test pit or excavating equipment, the sampling and support crew must ascertain that the operator has noted their presence.

6.0 CAUTIONS

Material that is brought to the surface should be treated as hazardous and contained in an appropriate manner. If the material is wet, the liquid seeping from the stockpile should be collected and disposed of accordingly.

Entry of personnel into pits or trenches is strictly prohibited unless specifically approved. Also, strict adherence to federal and state Occupational Safety and Health Administration (OSHA) guidelines will be observed.

Personnel should never enter a trench deeper than 4 feet (chest height) unless full lateral support of the sidewalls is provided. Any personnel entering the trench may be exposed to toxic or explosive gases and an oxygen-deficient environment. Air monitoring (PID and MGM at a minimum) is required before and during entry and appropriate respiratory gear and protective clothing is mandatory. Caution should be exercised at all times. At least two people must be present at the immediate site. Ladder access out of the pit must be installed before entry.

Care should be taken to ensure that personnel do not stand too close to the edge of the trench especially during sampling or depth measurements; the combination of deposing soil adjacent to the pit and the risk of caving or toppling of the sidewalls in unstable soils can lead to unsafe conditions.

7.0 TEST PIT EXCAVATION PROCEDURES

7.1 Excavation

Upon locating the area for excavation, the excavating equipment operator shall determine wind direction and position the machine accordingly. The excavating equipment operator shall outline the area of investigation by extending the bucket arm to its maximum length, and trace a 180-degree outline around the area to be excavated. The support crew shall cordon off the exclusion zone with wooden lathes and brightly colored "caution" tape.

Once any equipment stabilizers are firmly on the ground, excavation can commence. If the area of investigation is beneath vegetative cover or surface debris, the backhoe operator shall scrape the initial 6 inches of topsoil to allow a clear and safe working area. Excavated soil shall be stockpiled away from the immediate edge to one side of the trench to prevent excavated soil from re-entering the trench or pit and to reduce pressure on the sidewalls, discouraging rotational slips involving large masses of material. The soil shall be deposited downwind of the ground crew and the machine operator. Shifting winds may cause the machine and operator and ground crew to periodically move in order to remain downwind, or to curtail further activities. The support crew should regularly check the machine operator who, if in a partially enclosed cabin, may be susceptible to fumes/gases.

7.2 Stability

Depending on the desired depth of excavation, the trench may require shoring to prevent the sides from collapsing. Lateral support may be provided by a portable aluminum frame system that uses a hydraulic pump to apply pressure to the sidewalls and that can be quickly inserted or extracted, or the sides can be benched to an appropriate angle. Any timbering or alternative support required in excavations should be installed by skilled personnel.

Groundwater may be pumped out of the pit to stabilize the sidewalls, prevent base heave, and to keep the excavation dry allowing a greater depth to be reached, especially in granular materials that are below the water table.

Near-vertical slopes can stand for seconds, or months, depending on the types of material involved and various other factors affecting their stability. Although personnel should not be entering the excavation, it is prudent to know the possible behavior of the various soil types and conditions that may be encountered. Excavations into fill are generally much more unstable than those in natural soil.

Excavations in a very soft normally consolidated clay should stand vertically, without support, to depths of approximately 12 feet in the short-term only. This critical depth increases as the clays increase in consistency. Long-term stability is dependent on a combination of factors: the type of soils, pore pressures and other forces acting within the soil; and adverse weather effects. Fissured clays can fail along well-defined shear planes and, therefore, their long-term stability is not dependent on their shear strength and is difficult to predict.

Dry sands and gravels can stand at slopes equal to their natural angle of repose no matter what the depth of the excavation (angles can range from approximately 28 to 46 degrees depending on the angularity of grains and relative density).

Damp sands and gravels possess some cohesion and can stand vertically for some time. Water-bearing sands, however, are very difficult in open excavations. If they are cut steeply, as in trench excavation, seepage of water from the face will result in erosion at the toe followed by collapse of the upper part of the face until a stable angle of approximately 15 to 20 degrees is obtained.

Dry silts should stand unsupported vertically, especially if slightly cemented. Wet silt is the most troublesome material to excavate. Seepage leads to slumping and undermining with subsequent collapse, eventually reaching a very shallow angle of repose.

It should not be taken for granted that excavations in rock will stand with vertical slopes unsupported. Their stability depends on the soundness, angle of bedding planes, and the degree of shattering. Unstable conditions can occur if bedding planes slope steeply towards the excavation, especially if groundwater is present to act as lubrication.

7.3 Backfilling

The test pits or trenches should be backfilled immediately upon completion of the hole. Poorly compacted backfill will cause settlement at the ground surface and hence the spoil should be recompacted in several thin layers using the excavator bucket and any surplus material placed over the top of the pit.

In certain areas where soil borings are not required, the pit may be used to install gas monitoring standpipes or piezometers. The granular filter is kept in place using sacking while the backfill material is carefully emplaced around the instrument.

If a sealing layer has been penetrated during excavation, resulting in a groundwater connection between contaminated and previously uncontaminated zones, the backfill material must represent the original conditions or be impermeable. Backfill material could comprise a soil-bentonite mix or a cement-bentonite grout.

7.4 Decontamination

The purpose of decontamination and cleaning procedures during sampling tasks is to prevent foreign contamination of the samples and cross contamination between sites. Before use all sampling and excavation equipment will be decontaminated by steam cleaning. Potentially, all fluids generated by decontamination should be contained in Department of Transportation (DOT)-approved 55-gallon drums.

8.0 DATA ACQUISITION, CALCULATION AND DATA REDUCTION

The field record should include a plan giving the location, dimensions, and orientation of the pit, together with dimensioned sections of the sidewalls, description of the strata encountered, and details of any sampling or testing carried out. A photographic record of the test pit, with an appropriate scale, would be ideal.

Any groundwater encountered should be noted with regard to its depth and approximate rate of seepage. If possible the groundwater level within the test pit should be monitored for 20 minutes, with readings taken at 5-minute intervals.

Working from the ground surface the technician can prepare a visual log of the strata/soil profile and decide the interval of sampling. Samples from excavations can be either disturbed or undisturbed.

Disturbed samples are taken from the excavator bucket or from the spoil. To obtain a representative sample of the material at a certain depth, care must be taken not to include scrapings from the sidewalls.

Undisturbed samples may be block samples, cut from in situ material:

- Tube samplers may be driven into the floor of the pit using a jarring link and drill rods and extracted using the hoe of the excavator;
- Soil samples may be collected from the test pit using a long-handled soil coring device;
- Test pits will be logged and screened using a PID by a qualified geologist or soil scientist;
- Samples of groundwater or leachate may be taken using telescoping poles or a small bailer; and
- If a sample is to be collected for chemical analysis, see SOP No. SS-03 for sample collection methodologies.

The required size of the disturbed samples will vary according to the intended analysis/testing to be carried out. Samples for geotechnical testing will generally need 4 to 6 ounces of material.

9.0 REFERENCES

Scientific and Technical Standards for Hazardous Waste Sites. Book 1, Volume 1, Site Characterization, August 1990.

Tomlinson, M.J., 1986. Foundation Design and Construction, 5th Edition.

STANDARD OPERATING PROCEDURE

DIRECT PUSH DRILLING AND SAMPLING METHODS

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1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a general framework for conducting direct push sampling methodologies and collecting analytical soil samples obtained from direct push samplers.

2.0 SUMMARY OF METHOD

Geoprobe™/Earth Probe™ type direct push soil sampling methods utilize a hydraulic hammer mounted on a truck, all-terrain vehicle or other mobile platforms to advance sampling devices into the subsurface. This method eliminates the need for a drilled borehole, and minimizes the exposure to and storage and disposal of potentially hazardous drill cuttings.

This method is most appropriate for loosely compacted fine to coarse unconsolidated sediments less than 40 feet below grade. Depths greater than 40 feet and the presence of greater than sand-sized sediments and tight clays severely impact the performance of this method. Soil sampling is accomplished using large bore (LB) or macro core (MC) samplers.

The MC samplers are open-tube design and typically measure approximately 2 inches in diameter by 4 or 5 feet long and are designed for continuous soil sample collection. Larger diameters (e.g., 3 inches) are available. If probe hole "cave-in" is significant, it may be necessary to use a closed-piston assembly that fits into the MC or to switch to the LB drive point sampler. Both the closed-piston assembly MC sampler and the LB sampler remain completely closed when driven to depth and are opened by releasing a stop pin from the surface. Releasing a stop pin allows a piston to retract inside of the sample tube as it is being displaced by the sample core. The LB sampler will be used when subsurface conditions prevent the use of the MC sampler or when continuous sampling is not required. The MC sampler is hydraulically advanced in 4- to -5 foot intervals and the LB sampler is advanced in 2-foot intervals. To assist in the removal of the soil sample and to protect sample integrity, each of the samplers is fitted with a new acetate liner prior to each use.

3.0 DEFINITIONS

ASTM - American Society for Testing and Materials

LB: Large Bore

MC: Macro-Core

PID: Photoionization Detector

VOCs: Volatile organic compounds.

4.0 APPARATUS AND MATERIALS

The following equipment (or equivalent) will be used while conducting direct push sampling:

- Geoprobe™/Earth Probe™ type direct push sampling equipment with acetate liners;
- Photoionization Detector (PID);
- Stainless steel mixing bowl and spatula;
- Decontamination equipment (see SOP No. (EQPDCN-1));
- Personal Protective Equipment – including but not limited to hard hat, steel-toe boots, safety glasses, and nitrile gloves; and
- Field Notebook and/or Boring Log Form.

5.0 INSTRUMENT CALIBRATION

The air quality equipment will be calibrated at the beginning of each day in accordance with SOP No. PID-1 in Appendix E.

6.0 SAMPLE COLLECTION

After the acetate liner is removed from the sampler, it is opened for visual inspection and classification. If an adequate volume of sample has not been retrieved, additional sample shall be collected from a second sampler from the interval immediately below the preceding interval. The field geologist/technician will use the following sampling procedures:

- Sample intervals will be selected for analyses as specified in the site-specific planning documents.
- The soil sampler will be removed from the borehole, and the acetate liner carefully opened using a manufacturer's razor knife specifically designed to safely open acetate liners.
- The sample will then be scanned with a portable PID and the results will be recorded.
- If the sample is to be collected for chemical analysis, sample aliquots for VOC analysis will be collected first using ENCOR-1 or METH-1, depending on soil type. Additionally, a grab sample for percent solids analysis will be collected. Sample aliquots for all other analyses will be removed from the sampling device and placed in a decontaminated stainless steel mixing bowl or tray prior to transferring the sample aliquot to appropriate sample containers. Field duplicate samples will be collected from the same interval as the original sample. Sample aliquots for VOC analysis will be collected before homogenizing the sample. An equipment blank sample should be collected using all non-dedicated decontaminated sampling equipment (i.e., acetate liner, mixing bowls and spoons.)
- The field geologist will prepare a boring log for each borehole. Information recorded on the boring log will include soil descriptions and classifications, as well as other pertinent data regarding the sampling event and subsurface conditions (i.e., color, apparent staining or discoloration, moisture content, presence of fill material or organic matter, etc.)(SOILLOG-1).
- Soil samples submitted for chemical analysis will be immediately placed in appropriate laboratory-supplied containers, labeled, maintained in coolers at 4°C, and delivered to an off-site laboratory for analysis using EPA-approved chain-of-custody procedures.

7.0 REFERENCES

ASTM, 2000. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), D2488-00.

STANDARD OPERATING PROCEDURE

MULTI-GAS METER

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1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) provides a description of the established step-by-step methodology for monitoring combustible environments using a multi-gas meter. The multi-gas meter is capable of measuring oxygen (O_2), carbon monoxide (CO_2), hydrogen sulfide (H_2S), and lower explosive limit (LEL). It is not intended to provide an all-inclusive discussion of screening methods.

2.0 SUMMARY OF METHOD

The multi-gas meter (MGM) determines the presence of combustible or toxic constituents or oxygen-rich or deficient atmospheres so that appropriate field decisions can be conducted. Ambient air monitoring at hazardous waste sites is a common safety practice. Activity at a site may cause disturbances that release hazardous vapors into the ambient air. These releases can be detected by commercially available portable air monitoring devices that register real-time data. This data can be used to establish the existence of hazards such as oxygen deficient, toxic, or explosive atmospheres. Personnel protective levels may be based on these readings.

The combustible gas sensor of the MGM is designed to measure combustible gas or vapor content in air. It will not indicate the combustible gas content in an inert gas background, furnace stack, or in other atmospheres with less than 10 percent oxygen. Further, these instruments should not be used where the oxygen concentrations exceed that of fresh air (oxygen enriched atmospheres) because the extra oxygen makes any combustible mix easier to ignite and, thus, more dangerous.

Combustible gases will burn or explode only when the fuel/air mixtures are within certain proportions. The minimum concentration of a particular combustible gas in air which will burn and continue to burn when ignited is defined as the lower explosive limit (LEL). The maximum concentration that can be ignited is defined as the upper explosive limit (UEL).

A small pump pulls the atmospheric sample through a filter and pushes it through the flow indicator and the manifold blocks in which the toxic gas, combustible gas, and oxygen sensors are mounted. The flow is then exhausted to the side of the case. The approximate flow rate is 0.5 liters/minute.

3.0 DEFINITIONS

MGM – Multi-Gas Meter

LEL – Lower Explosive Limit

O_2 - Oxygen

CO_2 - Carbon monoxide

H_2S - hydrogen sulfide

UEL - upper explosive limit

4.0 CAUTIONS

Exposing the MGM to very humid and rainy weather can result in inaccurate readings and equipment damage. Caution should be taken to avoid use in such conditions.

5.0 APPARATUS AND MATERIALS

The field screening will be accomplished utilizing a MGM. Additional supplies will include:

- field log book or field data sheet
- calibration gas and associated equipment.

6.0 INSTRUMENT CALIBRATION

The MGM will be calibrated and operated in accordance with the manufacturer's specifications printed on the meter at the beginning of each day and recorded in a field log book or field data sheet. Below is a summary of the calibration verification procedure.

Initial and End-of-Day Calibration Verification

1.) Measure known concentration of calibration gas.

2.) The readings should be within the limits stated on the gas cylinder, or within 2% of the known concentration of the calibration gas, whichever is larger.

7.0 ATTACHMENTS

None

STANDARD OPERATING PROCEDURE

PHOTOIONIZATION DETECTOR

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1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) provides a description of the established step-by-step methodology for screening soil samples and well headspace using a photoionization detector (PID). It is not intended to provide an all inclusive discussion of screening methods.

Ambient air is drawn into the instrument detector chambers with the aid of a small fan. The PID uses an ultraviolet light source to ionize individual molecules that have an ionization potential less than or equal to that rated for the ultraviolet light source. Gaseous compounds are ionized as they emerge from the ionization chamber, and the ions are then attracted to an oppositely charged electrode, causing a current and finally an electric signal that is proportional to the number of ions.

PID Limitations – A PID does not detect methane. Also, it does not detect a compound if the lamp used has a lower energy level than the compound's ionization potential. The instrument response may change when gases are mixed. Other voltage sources such as power lines may interfere with the measurements. Readings can only be reported relative to the calibration standard used. Response is affected by high humidity. During cold weather, condensation may form on the UV light source window, resulting in erroneous results. Total concentrations are relative to the calibration gas used. Therefore, contaminant concentrations cannot be identified. Also, while the instrument scale reads 0 to 2,000 parts per million (ppm), response is linear to the calibration gas. Greater concentrations may be "read" at a higher or lower level than the true value. Wind speeds of greater than 3 miles an hour may affect fan speed and readings, depending on the position of the probe relative to wind direction.

2.0 SUMMARY OF METHOD

Screening soil samples and well headspace with the PID provides rapid determination of the presence of volatile organic compounds (VOC) constituents so that appropriate field decisions can be conducted.

3.0 DEFINITIONS

PID: Photoionization Detector
ppmv: parts per million volume
VOC: Volatile Organic Compound

4.0 CAUTIONS

Exposing the PID to very humid and rainy weather can result in inaccurate readings and equipment damage. Caution should be taken to avoid use in such conditions.

5.0 APPARATUS AND MATERIALS

The field screening will be accomplished with a PID utilizing a standard 10.6 electron volt (eV) lamp. In the event VOC constituents with an ionization potential greater than 10.6 eV such as methylene chloride are anticipated, a suitable lamp (11.8eV) will be exchanged.

Additional supplies will include:

- 100 ppmv isobutylene calibration gas and regulator;
- sealable plastic baggies; and
- field log book or field data sheet.

6.0 INSTRUMENT CALIBRATION

The PID will be calibrated and operated in accordance to the manufacturer's specifications at the beginning of each day using the appropriate calibration gas for the suspected contaminant and documented in a field log book or field data sheet.

7.0 SAMPLE COLLECTION

7.1 Soil Screening

Generally, soil samples will be collected and placed in dedicated sealable plastic bags. The samples will be maintained in a temperature range of 10°C - 30°C. The headspace will then be screened using a PID. The screening method will consist of filling a sealable plastic bag approximately halfway with soil. The bag will be set down to rest for a minimum of 15 minutes. The PID will be inserted in the bag to measure concentrations of VOCs in the headspace above the soil sample. The results of the field screening will be documented in the field log book. Care should be taken when sampling over solids and liquids so that it is not drawn into the instrument.

8.0 REFERENCES

Appropriate PID operations manual will be kept with the PID carrying case.

STANDARD OPERATING PROCEDURES

SAMPLE MANAGEMENT AND PRESERVATION

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STANDARD OPERATING PROCEDURES

SAMPLE MANAGEMENT AND PRESERVATION

TABLE OF CONTENTS

1.0 INTRODUCTION

This standard operating procedure (SOP) for sample management describes the requirements for sample identification, chain-of-custody (COC), and sample handling, storage, and shipping. The purpose of this SOP is to define sample management activities as performed from the time of sample collection to the time they are received by the laboratory.

2.0 DEFINITIONS

Sample: Physical evidence collected for environmental measuring and monitoring. For the purposes of this SOP, sample is restricted to solid, aqueous, air, or waste matrices. This SOP does not cover samples collected for lithologic description nor does it include remote sensing imagery or photographs.

Field Team Leader: The individual responsible for the supervision of field work at the site during a given phase of investigation or monitoring.

Sampler: The individual who collects environmental samples during field work.

3.0 SAMPLE MANAGEMENT

3.1 Sample Containers

The sample containers to be used will be dependent on the sample matrix and analyses desired. Unless specified otherwise by the project plan, the containers to be used for various analyses are provided in EPA SW-846. Sample containers are to be filled (approximately 90 percent), with adequate headspace for safe handling upon opening, except containers for volatile organic compound (VOC) analyses, which are to be filled completely with no headspace. This applies to soil samples as well as water samples.

Once opened, the containers are to be used immediately. If the container has been received unsealed or is not used upon opening, it is to be recycled. If the container is used for any reason in the field (i.e., screening) and not sent to the laboratory for analysis, it should be discarded. The contents of the used container and the container itself may require disposal as a hazardous material. When storing before and after sampling, the containers must remain separate from solvents. Sample containers with preservatives added by the laboratory should not be used if held for an extended period on the job site or exposed to extreme heat conditions.

3.2 Numbering and Labeling

Sample Label: A sample label will be affixed to all sample containers. Labels provided by the laboratory may be used. The sample label will be completed with the following information:

- Client name, project title, or project location
- Sample location
- Sample identification number
- Date and time of sample collection
- Type of sample (grab or composite)
- Initials of sampler
- Preservative used
- Analyte(s) of interest

If a sample is split with another party, identical labels will be attached to each sample container. After labeling, each sample will be refrigerated or placed in a cooler containing wet ice to maintain the sample temperature at 4 degrees Celsius (˚C).

Custody Seals: Custody seals will be used on each sample and/or shipping container to ensure custody. Custody seals used during the course of the project will consist of security tape with the date and initials of the sampler. As a minimum, one custody seal will be placed on the front of the cooler overlapping the strapping tape and one on the side of the cooler. If required by the client, a seal will be placed on each sample container so that it must be broken to gain access to the contents. Since VOC samples may be subject to contamination by the tape, VOC sample containers will first be secured in a "zip-lock" plastic bag. The plastic bag will be sealed with a completed custody seal.

3.3 Chain-of-Custody

COC procedures require a written record of the possession of individual samples from the time of collection through laboratory analyses. A sample is considered to be in custody if it is:

- In a person's possession.
- In view after being in physical possession.
- In a secured condition after having been in physical custody.
- In a designated secure area, restricted to authorized personnel.

The COC record is used to document the samples taken and the analyses requested. Information recorded by field personnel on the COC record includes the following:

- Client name
- Project name
- Project location
- Sampling location
- Signature of sampler(s)
- Sample identification number
- Date and time of collection
- Sample designation (grab or composite)
- Sample matrix
- Signature of individuals involved in custody transfer (including date and time of transfer)
- Airbill number (if appropriate)
- Number and type of bottles collected for each analysis
- Type of analysis and laboratory method number
- Any comments regarding individual samples (e.g., PID readings, special instructions)

COC records will be placed in a plastic bag, secured to the inner lid of the cooler, and transported with the samples. When the sample(s) are transferred, the record is signed by both the receiving and relinquishing individuals. Signed airbills will serve as evidence of custody transfer between the field sampler and carrier as well as carrier and laboratory. Copies of the COC record and airbill will be retained by the sampler. If the COC records are sequentially numbered, the record number and airbill number will be cross-referenced in both the field logbook and the sample register. If the COC record is not previously numbered, a tracking number of four digits or more should be added to the top of the form and recorded as above.

3.4 Sample Register/Sample Tracking

A sample tracking database, which includes the information below is used to record the samples collected and when.

- Client name
- Project name and location
- Job number
- Date and time of collection
- Sample identification number
- Sample designation (grab or composite)
- Sample matrix
- Number and type of bottles
- Type of analysis
- Sample destination
- Sampler's initials

3.5 Sample Preservation/Storage

The requirements for sample preservation are dependent on the analyses desired and the sample matrix.

(Note: An important step in the sample management process is recording activities performed at each sampling location in the field logbook).

3.6 Shipping

Procedures for packaging and transporting samples to the laboratory will be based on an estimation of contaminant concentrations in the samples to be shipped. Samples will be identified as either environmental, high concentration, geotechnical, or other samples. Environmental samples are defined as soil or water samples that are not saturated or mixed with product material. Those samples that are saturated in product or are free product samples are defined as high concentration samples.

3.6.1 Environmental Samples. Environmental samples will be shipped in the following manner:

- Each sample will be placed in a separate plastic or "bubble-wrap" bag. As much air as possible is squeezed from the bag before sealing. Bags may be sealed with evidence tape for additional security.
- An ice chest (sturdy construction) is typically used as the shipping container. In preparation for shipping samples, the drain plug is taped shut from the inside and outside and a large plastic bag is used as a liner for the cooler. Approximately 1 inch of packing material, such as vermiculite or bubble wrap, is placed in the bottom of the liner. Sufficient packing material should be used to prevent sample containers from making contact during shipment.
- The bottles are placed in the lined ice chest. Cardboard or foam separators may be placed between the bottles at the discretion of the shipper.
- Water samples for organic analysis and inorganic analysis will be cooled to 4˚C with ice during shipment. The ice will be contained such that the water will not fill the cooler as the ice melts.
- As described previously, the COC record will be placed inside a plastic bag, sealed, and taped to the inside of the cooler lid if a carrier (e.g., Federal Express) is used.
- The cooler is closed and taped shut with strapping tape (filament type) around both ends.
- Two signed custody seals will be placed on the cooler, one on the front and one on the side overlapping strapping tape if possible. Additional seals may be used if the sampler and shipper think more seals are necessary. Wide clear tape will be placed over the seals to ensure against accidental breakage.
- The cooler is handed over to the overnight carrier, typically a cargo-only air service. A standard airbill is necessary for shipping environmental samples.
- No samples shall be held on-site for more than 24 hours, except during weekend field activities. Samples collected on the weekend will be stored under refrigeration and shipped the following Monday. Sampling activities for analytes with extremely short holding times, such as 24 hours, will not be scheduled for weekend collection. All DOT regulations will be followed for packaging and shipping.

- Occasionally, multiple coolers will be sent in one shipment to the laboratory. One cooler will have the original COC record and the other coolers will have copies. The plastic bag in which the COC Records are placed will be marked appropriately "ORIGINAL" or "COPY." In addition, the outside of the coolers will be marked to indicate how many coolers are in the shipment.

3.6.2 High Concentration Samples. High concentration samples will be shipped in compliance with URS Safety Management Standard 048. Individuals involved in the process of shipping hazardous materials/dangerous goods (i.e., high concentration samples) must have received function-specific training. Samples to be shipped by air must be classified, identified, packaged, marked, labeled, and have documentation in accordance with the International Air Transportation Association (IATA) *Dangerous Goods Regulations,* current edition.

3.6.3 Geotechnical Samples. Geotechnical samples will be collected in tubes as undisturbed samples or in plastic bags or glass jars as bulk samples. Proper labeling procedures are described in Section 3.2.2. Holding times do not apply; however, samples should be shipped as soon as possible and kept cool to prevent drying and mold growth. Undisturbed samples should be sealed in resealable plastic bags to maintain sample moisture content.

Geotechnical samples may be shipped in a sturdy box or other container. No ice is necessary. Enough packing material should be added so that samples remain undisturbed. COC procedures are necessary to generate defensible data. Hazardous nature of the samples, including any PID readings, name of the suspected contaminants present, and the approximate range of concentrations, if known, should be noted on the COC record.

3.6.4 Other Samples. Samples other than environmental or high concentration samples must be shipped according to the requirements of 49 CFR, IATA, and other applicable state and local regulations. Prior to the collection and shipment of these samples, shipment requirements shall be researched; a written description of shipment procedures shall be prepared; and the description reviewed and approved by a URS Shipping Specialist (e.g., URS HAZMAT hotline: 1-800-381-0664). These shipment procedures will be included in the project plan (if applicable). Examples of such samples include potential asbestos containing material and transformer fluids.

3.7 Holding Times

The holding times for samples will depend on the analysis and the sample matrix.

4.0 REFERENCES

URS. March 2004. Safety Management Standard 048-Hazardous Materials/Dangerous Goods Shipping, Revision 2.

5.0 ATTACHMENTS

1 - Sample Label
2 - Custody Seal
3 - Chain-of-Custody Record

Attachment 1 - Sample Label

<table>
<tr><td>URS</td><td colspan="4">LABEL NUMBER</td></tr>
<tr><td rowspan="2">PROJECT NAME/LOCATION</td><td colspan="2">SAMPLE DATE</td><td colspan="2">SAMPLE TIME</td></tr>
<tr><td colspan="4">PRESERVATIVE</td></tr>
<tr><td>SAMPLE LOCATION</td><td colspan="4"></td></tr>
<tr><td rowspan="2">FIELD NUMBER</td><td colspan="4">SAMPLER’S INITIALS</td></tr>
<tr><td>GRAB</td><td></td><td>COMPOSITE</td><td></td></tr>
<tr><td colspan="5">ANALYSIS</td></tr>
</table>

Attachment 2 - Custody Seal

Attachment 3 - Chain-of-Custody

CHAIN OF CUSTODY RECORD

URS

PROJECT NO.

SITE NAME

SAMPLERS (PRINT/SIGNATURE)

DELIVERY SERVICE:__________ AIRBILL NO.:__________

LAB__________

COOLER _____ of _____

PAGE _____ of _____

LOCATION IDENTIFIER	DATE	TIME	COMP/ GRAB	SAMPLE ID	MATRIX	TOTAL NO.# OF CONTAINERS	TESTS / BOTTLE TYPE AND PRESERVATIVE								REMARKS	SAMPLE TYPE	BEGINNING DEPTH (IN FEET)	ENDING DEPTH (IN FEET)	FIELD LOT NO.# (IRPIMS ONLY)

MATRIX CODES
AA - AMBIENT AIR
SE - SEDIMENT
SH - HAZARDOUS SOLID WASTE
SL - SLUDGE
WP - DRINKING WATER
WW - WASTE WATER
WG - GROUND WATER
SO - SOIL
DC - DRILL CUTTINGS
WL - LEACHATE
GS - SOIL GAS
WC - DRILLING WATER
WO - OCEAN WATER
WS - SURFACE WATER
WQ - WATER FIELD QC
LH - HAZARDOUS LIQUID WASTE
LF - FLOATING/FREE PRODUCT ON GW TABLE

SAMPLE TYPE CODES
TB# - TRIP BLANK
SD# - MATRIX SPIKE DUPLICATE
RB# - RINSE BLANK
FR# - FIELD REPLICATE
N# - NORMAL ENVIRONMENTAL SAMPLE
MS# - MATRIX SPIKE
(# - SEQUENTIAL NUMBER (FROM 1 TO 9) TO ACCOMMODATE MULTIPLE SAMPLES IN A SINGLE DAY)

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY (SIGNATURE)	DATE	TIME
RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED FOR LAB BY (SIGNATURE)	DATE	TIME

SPECIAL INSTRUCTIONS

Distribution: Original accompanies shipment, copy to coordinator field files

URSF-075C/1 OF 1/CofCR/GCM

STANDARD OPERATING PROCEDURE

CALIBRATION OF FIELD INSTRUMENTS

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CONTENTS

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for groundwater and surface water. Water quality parameters include temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation/reduction potential (ORP), and turbidity. This SOP has been based upon the USEPA Region 1 *Draft Calibration of Field Instruments* (1998).

This SOP is written for instruments that utilize multiple probes, (temperature, pH, DO, conductivity/specific conductance, and/or ORP) and the probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature. Communications to the instrument (programming and displaying the measurement values) are performed using a display/logger or computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. It is desirable that the display/logger or computer have data storage capabilities. If the instrument does not have a keypad, follow the manufacturer's instruction for entering information into the instrument.

For groundwater monitoring, the instrument must be equipped with a flow-through-cell, and the display/logger or computer display screen needs to be large enough to simultaneously contain the readouts of each probe in the instrument. Turbidity is measured using a separate instrument because turbidity cannot be measured in a flow-through-cell. This procedure is applicable for use with the USEPA Region I Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

2.0 SUMMARY OF METHODS

All monitoring instruments must be calibrated before they are used to measure environmental samples. Part of the calibration is performed prior to the field event. For instrument probes that rely on the temperature sensor (pH, DO, conductivity/specific conductance, and ORP), each temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instruction.

Most instruments will require at least two standards to bracket the expected measurement range, that is, one standard less than the expected value and one higher. Calibration must be performed at the beginning of each sampling day prior to sample collection. When an environmental sample measurement falls outside the calibration range, the instrument must be recalibrated to bracket the new range before continuing measurements.

3.0 DEFINITIONS

DO: Dissolved Oxygen

Low-flow: Pumping rates low enough to minimize drawdown, usually less than 1 liter/minute.

mg/l: Milligrams per Liter

mV: Millivolts

ORP: Oxidation/Reduction Potential

NIST: National Institute of Standards and Technology

NTU: Nephelometric Turbidity Unit

Parameters: Groundwater variables, i.e., pH, specific conductivity, temperature, and turbidity.

Purge water: Any water removed from the well via bailing, pumping, or air lift.

SOP: Standard Operating Procedure

USEPA: United States Environmental Protection Agency

Yield: The rate at which a well will produce water.

4.0 APPARATUS AND MATERIALS

The following equipment (or equivalent) will be utilized to collect water quality field data:

- YSI Model 6820 Multi-Parameter flow cell (pH, conductivity, ORP, temperature, dissolved oxygen);
- Lamotte 2020 Portable Turbidimeter;
- Solinst Model 101 (water level measurement);
- Solinst Model 122 (interface probe);
- Nitrile Gloves;
- Deionized Water
- Distilled Water; and

- Field logbook.

5.0 CALIBRATION PROCEDURES

Calibration will be conducted in accordance with the procedures outlined below. Prior to calibration, all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements.

Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, pH, dissolved oxygen (% and mg/l), conductivity/specific conductance, and ORP.

The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor (see manufacturer's instruction for additional information).

While calibrating or measuring, make sure there are no air bubbles lodged between the probe and the probe guard.

5.1 Temperature

Most instrument manuals state there is no calibration of the temperature sensor, but the temperature sensor must be checked to determine its accuracy. This accuracy check is performed at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was over a year, the temperature sensor accuracy needs to be checked at the beginning of each sampling event.

Verification Procedure

- Allow a container filled with water to come to room temperature;
- Place a thermometer that is traceable to the NIST and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.
- Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the range of the sensor

(usually ± 3%). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

5.2 pH (electrometric)

The pH of a sample is determined electrometrically using a glass electrode. Choose the appropriate buffered standards that will bracket the expected value at the sampling locations. For groundwater, the pH will usually be close to seven. The pH probe should be calibrated daily before use, and as necessary if the probe appears to be malfunctioning.

Calibration Procedure

- Place approximately 150 ml of pH 7 buffer in a clean calibration cup (250 ml if using the 6026 "wiped turbidity" probe and extended probe). Carefully immerse the probe end of the sonde into the solution.
- Allow at least 1 minute for temperature equilibration before proceeding.
- From the Calibration menu, select 4-ISE1 pH to access the pH calibration choices and then 2-2-Point. Press ENTER and input the value of the buffer (7 in this case) at the prompt. Press ENTER and the current values of all enabled sensors will appear on the screen and will change with time as they stabilize in the solution. Observe the readings under pH and when they show no significant change for approximately 30 seconds, press ENTER. The display will indicate that the calibration is accepted.
- After the pH 7 calibration is complete, press ENTER again, as instructed on the screen, to continue.
- Press ENTER again as instructed on the screen, to return to the Calibration menu.
- Rinse the sonde in water and dry.
- Repeat the above steps for the second pH buffer solution.
- Rinse the sonde in water and dry the sonde.
- Thoroughly rinse and dry the calibration cups for future use.

5.3 Dissolved Oxygen

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements. The DO probe should be calibrated daily before use, and as necessary if probe appears to be malfunctioning.

Calibration Procedure

- Place approximately 1/8 inch (3mm) of water or a wet sponge in the bottom of the Calibration Cup or Transport Cup. Place the probe end of the sonde into the cup. Make certain that the DO and the temperature probes are not immersed in the water. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperatures of the thermistor and the oxygen probe to equilibrate. (Caution: If the Transport Cup is use, make certain that the cup is vented to the atmosphere by loosening the connection until only 1 or 2 threads are engaged).

- From the Calibration menu, select 2-Dissolved Oxy to access the DO% calibration procedure.
- Enter the current barometric pressure in mm of Hg (Inches of Hg x 25.4 = mm Hg). (Note The barometric readings which appear in meteorological reports are generally corrected to sea level and are therefore not useful for calibration unless they are uncorrected).
- Press ENTER and the current values of all enabled sensors will appear on the screen and will change with time as they stabilize. Observe the readings under DO% and when they show no significant change for approximately 30 seconds, press ENTER. The screen will indicate that the calibration has been accepted and prompt you to press ENTER again to return to the Calibration menu.
- Rinse the sonde in water and dry the sonde.
- Remove the probe from the container and place it into a 0.0 mg/L DO standard (see note). The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no headspace). Check temperature readings. They must stabilize before continuing.
- Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact the manufacturer.

5.4 Specific Conductance

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C.

Most instruments are calibrated against a single standard which is near, but below, the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements. The specific conductance probe should be calibrated daily before use, and as necessary if the probe appears to be malfunctioning.

<u>Calibration Procedure</u>

- Place approximately 300 ml of conductivity standard in a clean and dry calibration cup.

- The conductivity standard you choose should be within the same conductivity range as the water you are preparing to sample. However, we do not recommend using standards less than 1 millisiemens per centimeter (mS/cm). For example:
  - For fresh water choose a 1 mS/cm conductivity standard.
  - For brackish water choose a 10 mS/cm conductivity standard.
  - For sea water choose a 50 mS/cm conductivity standard.
- Caution: Before proceeding insure that the sensor is as dry as possible. Ideally rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid cross contamination of standard solutions with other solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP probes, particularly if you are employing standards of low conductivity.
- Without removing the probe guard, carefully immerse the probe end of the sonde into the solution. Gently rotate and/or move the sonde up and down to remove any bubbles from the conductivity cell. The probe must be completely immersed past its vent hole.
- Allow at least one minute for temperature equilibration before proceeding.
- From the Calibration menu, select 1-Conductivity to access the conductivity calibration procedure and then 1-SpCond to access the specific conductance calibration procedure. Enter the calibration value of the standard you are using (mS/cm at 25 C) and press ENTER. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- Observe the readings under the Specific Conductance or Conductivity and when they show no significant change for approximately 30 seconds, press ENTER. The screen will indicate that the calibration has been accepted and prompt you to press ENTER again to return to the Calibrate menu.
- Rinse the sonde in tap or purified water and dry the sonde.

5.5 Oxidation/Reduction Potential (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent. The ORP usually does not require calibration; however, older probes that have been deployed extensively may show some deviation from the theoretical ORP value. This deviation is usually due to a change in the concentration of the potassium chloride (KCl) in the reference electrode gel. To determine whether the sensor is functioning correctly, place the ORP probe in 3628 Zobell solution and monitor the millivolt reading. If the probe is functioning within specifications, the ORP reading should be within the range of 221 – 241 at normal ambient temperature. If the reading is outside of this range, the probe can be calibrated to the correct value (231 mV at 25˚ C) as follows:

- Select the **ISE2-ORP** option in the calibration menu.
- Immerse the sonde in a solution with a known oxidation reduction potential value (i.e. Zobell solution) and press ENTER.
- Enter the ORP value of the solution.
- Press ENTER and monitor the stabilization of the ORP and temperature readings.
- After no changes occur for approximately 30 seconds, press ENTER to confirm the calibration.
- Press ENTER again to return to the Calibration menu.

5.6 Turbidity

The LaMotte 2020 turbidimeter has been pre-calibrated in the range of 0 – 1100 NTU with AMCO™ primary standards manufactured by Advanced Polymer Systems, Inc. This allows the 2020 to be used for treated water, natural water, or waste water. Recalibration of the 2020 by the user is not required. However, a procedure to standardize the calibration should be performed to obtain the most accurate reading over a narrow range.

- Select a LaMotte AMCO 2020™ Standard in the range of the samples to be tested.
- Fill a turbidity tube with the standard, cap and wipe the tube clean with a lint-free cloth.
- Open the lid of the meter. Align the indexing arrow mark on the tube with the indexing arrow mark on the meter, and inset the tube into the chamber.
- Close the lid. Push the READ button. If the displayed value is not the same as the value of the reacted standard (within the specification limits), continue with the calibration procedure.
- Push CAL button for 5 seconds until CAL is displayed. Release button. The display will flash. Adjust the display with the up and down arrows buttons until the value of the standard is displayed.
- Push the CAL button again to memorize the calibration. The 202˚ display will stop flashing. Calibration is complete.

5.7 Water Level Meter

An electronic water level meter will be verified daily before use by the procedure detailed below:

<u>Verification Procedure</u>

- The calibration procedure will be to compare the water level meter tape to a known linear measurement standard such as a tape measure at the 10-foot interval. If there is a difference between the water level tape and the tape measure of > 0.1 ft, the difference will be recorded on the field calibration log or in the field notebook and all data will be adjusted accordingly.
- The water level meter probe will be lowered into an aqueous solution to confirm that the electronic sounder functions.

5.8 Interface Probe

An electronic interface probe will be verified daily before use by the procedure detailed below.

Verification Procedure

- The calibration procedure will be to compare the interface probe tape to a known linear measurement standard such as a tape measure at the 10 foot interval. If there is a difference between the interface probe tape and the tape measure of > 0.1 ft, the difference will be recorded on the field calibration log or in the field notebook and all data will be adjusted accordingly.
- The interface probe will be lowered into an aqueous solution to confirm that the electronic sounder functions.

6.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

All calibration records must be documented in the project's logbook. At a minimum, include the instrument manufacturer, model number, instrument identification number, standards used to calibrate the instruments (including the source), calibration date, and instrument readings.

7.0 REFERENCES

USEPA Region I, 1998. *Draft Calibration of Field Instruments*

8.0 ATTACHMENTS

None

STANDARD OPERATING PROCEDURE

FIELD ANALYTICAL PARAMETERS

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1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) provides the general framework for collecting groundwater elevation and groundwater quality measurements. To be valid, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of collection to the time of analysis in order to minimize changes in water quality parameters. The primary considerations in obtaining a representative sample of the groundwater are to avoid collecting stagnant (standing) water in the well, to avoid physically or chemically altering the water due to improper sampling techniques, sample handling, or transport, and to document that proper sampling procedures have been followed.

2.0 SUMMARY OF METHOD

This guideline is a general reference for the proper equipment and techniques for measuring water sampling field parameters. The purpose of these procedures is to enable the user to collect representative and defensible groundwater samples and to facilitate planning of the field sampling effort. These techniques should be followed whenever applicable, although site-specific conditions or project-specific plans may require adjustments in methodology.

This guideline describes suggested field measurement, decontamination, and documentation procedures.

3.0 DEFINITIONS

Conductivity (electrical): A measure of the quantity of electricity transferred across a unit area, per unit potential gradient, per unit time. It is the reciprocal of resistivity.

Decontamination: A variety of processes used to clean equipment that contacted formation material or groundwater that is known to be or suspected of being contaminated.

Monitoring Well: A well that is constructed by one of a variety of techniques for the purpose of extracting groundwater for physical, chemical, or biological testing, or for measuring water levels.

pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. (Original designation for potential of hydrogen.)

Piezometer: An instrument used to measure head at a point in the subsurface; a non-pumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface.

Static Water Level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

Turbidity: Cloudiness in water due to suspended and colloidal organic and inorganic material.

4.0 APPARATUS AND MATERIALS

The following equipment (or equivalent) is typically used while collecting water quality field measurements:

- YSI 6820 or YSI 600XLM,
- Lamotte 2020 Portable Turbidimeter,
- Solinst Model 101 water level meter,
- Solinst 122 Interface Probe,
- Nitrile Gloves, and
- Groundwater Sampling Log and Field Logbook.

5.0 INSTRUMENT CALIBRATION

All water quality measurement equipment will be calibrated at the beginning of each day in accordance with SOP No. CAL-1. Calibration information and calibration verifications shall be recorded in a calibration logbook or field logbook.

6.0 SAMPLE COLLECTION AND RECORDING OF DATA

A variety of field measurements are commonly made during the sampling of groundwater including: water level, pH, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, and temperature. The accuracy, precision, and usefulness of these measurements are dependent on the proper use and care of the field instruments. Valid and useful data can only be collected if consistent practices (in accordance with SOP No. CAL-1 and recommended manufacturers instructions) are followed. The instruments should be handled carefully at the well site and during transportation to the field and between sampling sites. Instrument manufacturer's instruction manuals will be kept in the URS on-site office and be readily accessible to field crews.

The quality and usefulness of these measurements are limited, based upon the accuracy and precision of the instruments. The primary data quality objectives (DQO) for field measurements collected are to demonstrate general trends in geochemistry. The precision of recording measured field data will be based upon the manufacturer-reported accuracy for the individual field instruments.

6.1 Water Level

Water levels can be measured by several techniques, but the same steps should be followed in each case. The proper sequence is as follows:

1. Check operation of measurement equipment aboveground. Prior to opening the well, don personal protective equipment as required.

2. Record all information specified below on a sampling form or in the field notebook.

3. Record well number, the time and day of the measurement, and top of casing and surface elevations if available.

4. Measure and record static water level and total depth (or top of pump) to the nearest 0.01 foot from the surveyed reference mark on the top edge of the inner well casing. If no reference mark is present, record in the logbook where the measurement was taken from (i.e., from the north side of the inner casing).

5. If the water level is below the top of the dedicated bladder pump, the pump will be removed from the well and placed on clean plastic while the water level measurement is recorded. If a sufficient quantity of water is measured below the top of the pump for sample collection, the pump will be lowered such that the pump intake is located in the center of the standing water column or 6 inches above the bottom of the well, whichever is higher.

6. If the well is artesian, the water level will be measured by temporarily installing a polyvinyl chloride (PVC) riser extension. The well with extension will be allowed to equilibrate for a minimum of 15 minutes. The water level should be measured from the top of the extension and a negative value should be recorded based on the length of the PVC extension. If the well contains a packer device,

the water level will be measured by temporarily installing a length of tubing to the discharge line.

7. If there is evidence of light non-aqueous phase liquid (LNAPL) in the well, the LNAPL surface level and water surface level measurements will be measured using an interface probe.

8. The water level tape should be cleaned by wiping the tape with a paper towel moistened with a water and Alconox solution each time the tape is used.

6.1.1 Electric Water Level Indicators. This device consists of a spool of small diameter graduated polyethylene tape with a weighted stainless-steel probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact. This is the recommended method for obtaining accurate water level measurements.

In conditions where there is oil on the water, groundwater with high specific conductance, water cascading into the well, or a turbulent water surface in the well, measuring with an electric sounder may be difficult. A Solinst Model 101 is the recommended water level meter to be used for this project.

For accurate readings, the probe should be lowered slowly into the well. The tape is marked at the measuring point where contact with the water surface was indicated. The depth to water indicated on the graduated tape is recorded to the nearest 0.01 foot.

6.1.2 Interface Probes. Similar to the electronic water level indicators, this device consists of a spool of small diameter polyethylene tape with a weighted stainless steel probe attached to the end. The probe uses an optical sensor to determine if it is in LNAPL, and a conductivity sensor to determine if it is in water. The Solinst Sonic Interface Probe Model 122 is the recommended instrument for obtaining accurate LNAPL and water-level measurements.

For accurate readings, the probe should be lowered slowly into the well. The LNAPL-air interface reading should be taken first going from the air to the LNAPL surface to prevent dripping LNAPL from enhancing the thickness of the reading. The LNAPL-water reading is best taken going up from the water to the LNAPL layer to prevent LNAPLs from coating the conductivity probe which would also enhance the LNAPL thickness reading. This is best done by lowering the probe quickly through the LNAPL layer, minimizing the contact time of the probe in the LNAPL.

6.2 pH

The pH will be measured using the YSI 6820 or YSI 600XLM. Specific calibration instructions are included in SOP No. CAL-1. In general, the meter should be calibrated against two standard pH solutions (7 and >7 or <7). The meter readings will be adjusted, and the probe should then be rinsed thoroughly with distilled water. After calibration, the probe should be used in conjunction with the flow cell for groundwater measurements. All measurements should be recorded in the field log or on the sampling form. The manufacturer's directions for calibration, maintenance, and use should be read and closely followed. Any problems with the functioning of the meter should be noted in the field log and reported to the office equipment manager.

6.3 Conductivity

The specific conductivity will be measured using the YSI 6820 or YSI 600XLM. The specific conductivity meter should be calibrated in accordance with SOP No. CAL-1. The conductivity of the standard solution should be within the same order of magnitude as anticipated for the water sample. The meter reading will be adjusted to the buffer solution value, and the probe will then by thoroughly rinsed with distilled water. After calibration, the probe should be used in conjunction with the flow cell for groundwater measurements. All measurements should be recorded in the field log or on the sampling form. The manufacturer's directions for calibration, maintenance, and use should be read and closely followed. Calibration solutions should be dated and discarded on their expiration date. Any problems with the functioning of the meter should be noted in the field log and reported to the office equipment manager.

6.4 Temperature

The temperature will be measured using the YSI 6820 or YSI 600XLM. The temperature probe should be calibrated in accordance with SOP No. CAL-1. After calibration, the probe should be used in conjunction with the flow cell for groundwater measurements. The temperature reading should be recorded in the field log or on the sampling form.

6.5 Oxidation-Reduction Potential (ORP)

The ORP will be measured using the YSI 6820 or YSI 600XLM. Specific calibration instructions are included in SOP No. CAL-1. The ORP readings should be recorded in the field log or on the sampling form.

6.6 Dissolved Oxygen (DO)

The DO will be measured using a flow-through YSI 6820 or YSI 600XLM. Specific calibration instructions are included in SOP No. CAL-1. The DO meter should be calibrated using the current barometric pressure at the site. The manufacturer's directions for calibration, maintenance, and use should be read and closely followed. Any problems with the functioning of the meter should be noted in the field log and reported to the field team leader. The DO reading should be recorded in the field log or on the sampling form.

6.7 Turbidity

The turbidity will be measured using a Lamotte 2020 Portable Turbidimeter. The accuracy of the turbidity meter should be verified using a solution provided by the manufacturer in accordance with SOP No. CAL-1. The manufacturer's directions should be read and closely followed. Any problems with the functioning of the meter should be noted in the field log and reported to the field team leader. The turbidity reading should be recorded in the field log or on the sampling form.

7.0 DECONTAMINATION

The general decontamination procedure for non-dedicated groundwater sampling equipment (bailers, pumps, water level probes) consists of the following steps (also see SOP No. EQPDCN-1):

1. Scrub and wash with laboratory-grade detergent (such as Alconox) and tap water;
2. Rinse with distilled/deionized water; and

If available, a steam cleaner can also be used for decontaminating some sampling equipment. Steam cleaning is a desired method since it does not introduce any additional chemicals into the system. As with other procedures documented in this SOP, decontamination procedures may be determined by the client or regulatory agency involved in the project.

PROCEDURE APPROVALS:		
[redacted]	[redacted]	October 1, 2013
(printed name)	Site Radiation Safety Officer *(signature)*	Date
[redacted]	[redacted]	October 1, 2013
(printed name)	Certified Health Physicist *(signature)*	Date

1.0 Purpose

To describe the method for performing subsurface gamma logging measurements in boreholes. This procedure is general and applicable to multiple job and project sites. Specific detailed information on scanning intervals and sampling requirements is included in the Project Sampling and Analysis Plan.

2.0 Equipment

2.1 NaI detector, examples: Ludlum 44-10 (2”x2”) or Ludlum 44-62 (0.5”x1”). Detector choice depends upon borehole diameter and detection requirements.

2.2 Meter: Ludlum Model 2221 Portable ratemeter-scaler or equivalent, calibrated with the detectors and a cable of sufficient length for borehole depth.

2.3 Capped plastic (PVC) pipe of sufficient length to case the borehole to desired logging depth. Pipe diameter will be determined by the dimensions of the drill bit and detector size (optional).

2.4 Plastic bags (optional).

2.5 Rope of sufficient length for borehole depth.

2.6 Strapping tape.

3.0 Procedure

3.1 Assemble Equipment.

3.1.1 Create a handle on the gamma detector using strapping tape and rope. **Do not** use the detector cable to lower the detector into the borehole.

3.1.2 Mark the cable and/or rope at six-inch intervals, with the bottom of the detector as 0. This will be used to measure the depth of the borehole.

3.2 Borehole Setup.

3.2.1 Insert PVC or plastic pipe into the borehole prior to logging. The pipe should not extend more than 1 ft above the ground surface.

3.2.1.1 Record the height of the pipe above the ground surface.

3.2.2 If the hole does not contain water and will stay open, the borehole can be logged without inserting the pipe.

3.2.3 Enclose the detector in a double layer of plastic bags to protect the detector from contamination and contact with ground water.

3.3 Gamma Logging.

3.3.1 Lower the detector assembly to the bottom of the borehole, watching the count rate response for indications of locations of elevated gamma activity, and note these locations.

3.3.2 When the detector reaches the bottom of the borehole or borehole liner pipe, record the depth of the hole.

3.3.3 Collect and record the first timed count.

3.3.3.1 Move the detector up to the next interval and record the next timed count, then repeat.

3.3.4 If elevated measurements were identified during the core scan or when lowering the detector, ensure timed counts are taken in those locations.

3.3.5 Take a measurement with the detector bottom at the ground surface. If the pipe extends above the ground surface take the final measurement above the ground surface inside the pipe.

3.4 Collect Samples.

3.4.1 Review the borehole and core data to identify intervals for collection of samples.

3.4.2 Collect samples from the core material as necessary.

4.0 Documents Generated by this Procedure

Any forms included in this procedure are examples that show the minimum amount of information necessary to ensure the procedure is appropriately followed. The exact form included in this procedure does not need to be used as long as all of the information shown in the example is included. As needed, forms may be modified to include additional applicable information for different projects.

4.1 Borehole Logs.

5.0 References

5.1 URS Safety Management Standard 52 Radiation Protection Program.

Borehole Log

PROJECT ______________________________ Page ___ of ____

Borehole ID# ____________ **Date** ____________

Drilled Depth ____________ **Liner Height** ____________

Technician ____________

Meter Type ____________ **PROBE** ________ **Meter Type** ________

METER S/N ____________ **PROBE S/N** ________ **METER S/N** ________

Measured depth to bottom (ft) ____________________

Depth (ft)	Count (cpm)	Sam X	Notes	Depth (ft)	Count (cpm)	Sam X	Notes

PROCEDURE APPROVALS:		
[redacted]	[redacted]	October 1, 2013
(printed name)	Site Radiation Safety Officer *(signature)*	Date
[redacted]	[redacted]	October 1, 2013
(printed name)	Certified Health Physicist *(signature)*	Date

1.0 Purpose

To describe the method for radiological scanning of soil cores or collected soil sample materials. This procedure is specific to the scanning activities for the Niagara Falls Balance of Plant Operable Unit Investigation to Refine the Extent of Soil Contamination.

2.0 Equipment

2.1 Ludlum Model 2221 Portable ratemeter-scaler or equivalent, with Ludlum 44-10.

2.2 Ludlum Model 2221 Portable ratemeter-scaler or equivalent, with Ludlum 44-9.

2.3 Ludlum Model 2360, Dual Channel scaler or equivalent, with Ludlum 43-93.

3.0 Procedure

3.1 Prior to sampling collect and record a 30-second timed count using the Ludlum 44-10 at the sample location and record the results on the field data sheet.

3.2 Surface Interval Scanning (0-15cm).

3.2.1 The initial 15 cm of soil will be placed by the driller on plastic for scanning.

3.2.2 Spread the collected material out on the plastic to consistent thickness. Ensure there are no sticks or other items which may puncture the detector.

3.2.3 Using the 44-9 slowly scan the material while collecting a 30-second timed count. Ensure the scan covers the entire sample, and record the results on the field data sheet.

3.2.4 Using the 43-93 slowly scan the material while collecting a 30-second timed count. Ensure the scan covers the entire sample and record the results on the field data sheet.

3.3 Core Scanning (15 cm-61 cm, and 61-91cm).

3.3.1 Have the driller open the core, and mark the 15-61cm interval and the 61-91 cm interval.

3.3.2 Using the 44-9 slowly scan each interval while collecting a 30-second timed count. Ensure the scan covers the entire interval, and record the results on the field data sheet.

3.3.3 Using the 43-93 slowly scan each interval while collecting a 30-second timed count. Ensure the scan covers the entire interval, and record the results on the field data sheet.

3.4 Core Scanning (>91cm-).

3.4.1 Have the driller open the core, and mark each 30-cm interval to the final depth.

3.4.2 Using the 44-9 slowly scan each interval while collecting a 30-second timed count. Ensure the scan covers the entire interval, and record the results on the field data sheet.

3.4.3 Using the 43-93 slowly scan each interval while collecting a 30-second timed count. Ensure the scan covers the entire interval, and record the results on the field data sheet.

3.5 Reporting.

3.5.1 Immediately report to the field geologist any measurement that is more than 3 times the site background level.

4.0 Documents Generated by this Procedure

Any forms included in this procedure are examples that show the minimum amount of information necessary to ensure the procedure is appropriately followed. The exact form included in this procedure does not need to be used as long as all of the information shown in the example is included. As needed, forms may be modified to include additional applicable information for different projects.

4.1 Sample Radiation Scanning Logs.

5.0 References

5.1 URS Safety Management Standard 52 Radiation Protection Program.

Sample Scanning Log

NFSS Soil Sample Scan 3ft

Page ___ of _____

Date	____________	**Technician**	____________		
Meter Type	Ludlum 2221	**PROBE**	Ludlum 44-10		
METER S/N	____________	**PROBE S/N**	____________	**Count time**	________
Meter Type	____________	**PROBE**	Ludlum 44-9		
METER S/N	____________	**PROBE S/N**	____________	**Count time**	________
Meter Type	Ludlum 2360	**PROBE**	Ludlum 43-93		
METER S/N	____________	**PROBE S/N**	____________	**Count time**	________

EU	**Boring ID**	**Depth (ft)**	**44-10 Counts**	**44-9 Counts**	**43-93 alpha**	**43-93 both**	**43-93 beta**	**Notes**
Background								
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						

NFSS Soil Sample Scan 5ft **Page ___ of _____**

Date ____________________ **Technician** ____________________

Meter Type **Ludlum 2221** **PROBE** **Ludlum 44-10**
METER S/N ____________________ **PROBE S/N** ____________________ **Count time** __________

Meter Type ____________________ **PROBE** **Ludlum 44-9**
METER S/N ____________________ **PROBE S/N** ____________________ **Count time** __________

Meter Type **Ludlum 2360** **PROBE** **Ludlum 43-93**
METER S/N ____________________ **PROBE S/N** ____________________ **Count time** __________

EU	Boring ID	Depth (cm)	44-10 Counts	44-9 Counts	43-93 alpha	43-93 both	43-93 beta	Notes
Background								
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						
		3.0-4.0						
		4.0-5.0						
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						
		3.0-4.0						
		4.0-5.0						
		Surface						
		0-0.5						
		0.5-2.0						
		2.0-3.0						
		3.0-4.0						
		4.0-5.0						

PROCEDURE APPROVALS:		
[redacted]	[redacted]	October 1, 2013
(printed name)	Site Radiation Safety Officer *(signature)*	Date
[redacted]	[redacted]	October 1, 2013
(printed name)	Certified Health Physicist *(signature)*	Date

1.0 Purpose

This procedure details the setup of the GPS datalogger with radiation survey equipment, collection of radiological data, downloading, and field data processing. These instructions assume the user already knows how to set up and use radiation survey equipment. Due to instrument and software-specific variations, this procedure provides only the specific information necessary to conduct the work. It also assumes the user is familiar with the use and operation of Trimble GPS Pro XRS or Geo XT GPS units.

2.0 Equipment

2.1 Ludlum 2221 with Data Port.

2.2 Detector/Probe Ludlum 44-10.

2.3 Data Port Cable (L9 to RS232 9 pin).

2.4 Instrument Probe Cables (various lengths).

- 3 ft for stroller
- 3-5 ft for backpack
- 10-15 ft for staff mode

2.5 Check Source.

2.6 Meter and Probe Calibration Sheets.

2.7 D-Cell Batteries (for the meter).

2.8 Daily Instrument Calibration Sheets.

2.9 Laptop with Trimble Pathfinder Office Software and Serial Port or USB Serial Converter.

2.10 GPS Data Logger (including backpack, cables and batteries if applicable).

2.11 External GPS Antenna with Cable and Pole.

2.12 GPS Serial Connection.

2.13 Three-Wheel Jogging Stroller

2.14 GPS Antenna Pole or Other Walking Staff.

2.15 Backpack, Fanny Pack, Shoulder Straps as Appropriate to Carry Instruments.

3.0 Procedure

3.1 Configuring the GPS to Accept Ludlum Data.

Note: Refer to the GPS setting spreadsheet to identify settings for a variety of GPS systems.

3.1.1 Turn on GPS Logger.

3.1.2 Configure the following project-specific settings:

3.1.2.1 Site Coordinate System.

3.1.2.2 GPS Rover Options.

3.1.2.3 GPS Base Station Options.

3.1.2.4 GPS Logging Options.

3.1.3 External Sensors. Sets the options for the Ludlum to communicate to the GPS. Set as detailed below.

Auto Connect:	YES
Name:	Ludlum
Channel:	0
Connect:	?
Disconnect:	(blank
Data Request:	? Intervals:
Point Feature:	All
Line/Area:	All
Not in Feature:	All
Attribute:	None
Data Received:	
Prefix:	?
Suffix:	?

Max Bytes:	9 (for Ludlum 2221), 12 (for Ludlum 2350-1)
Time Out:	0.100 seconds
Audible Click:	YES
Status Line:	YES

3.1.4 Connect the radiation instrument using the RS232 serial cable to the GPS data logger. Depending on the specific GPS system, this may require a serial cable clip or a second GPS cable.

3.1.5 Ensure the GPS data logger is receiving data from the Ludlum instrument. To do this, check the Status menu and Sensor submenu to see if data points are being stored by the logger. Software on some GPS units will allow you to display the sensor reading.

3.2 Stroller Configuration.

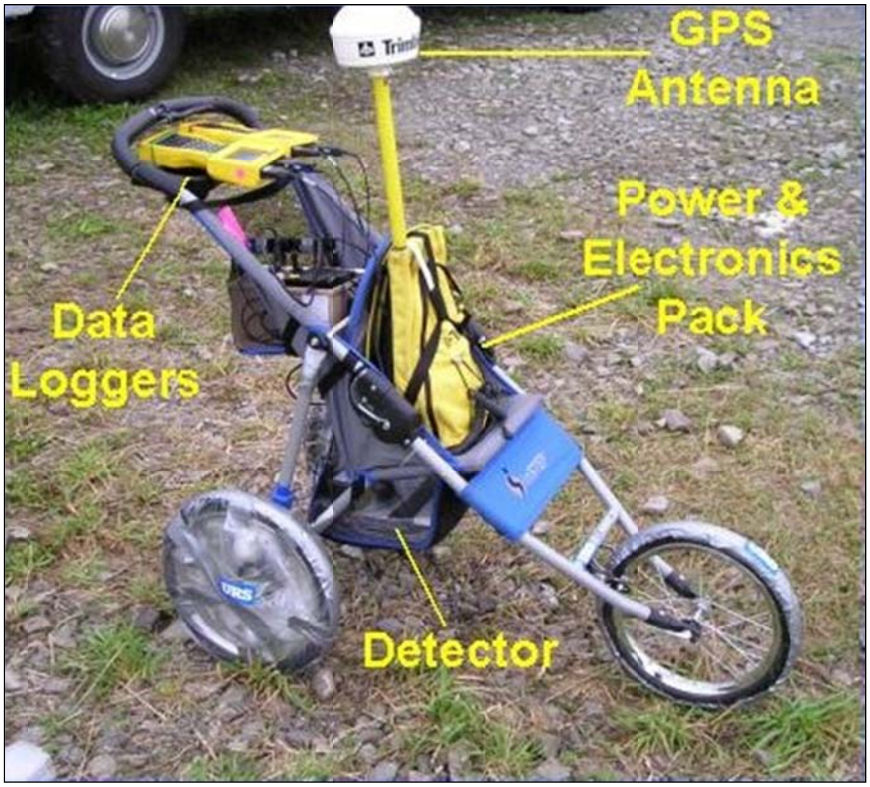
3.2.1 Set up the jogging carriage per manufacturer’s instructions. Ensure the rear wheels are locked and all tires are properly inflated.

3.2.2 Place reinforcing bar in front of side supports such that the back of the child seat makes a 90-degree angle with the ground. Tape or clamp the reinforcing bar in place. This allows the GPS antenna to be directly over the probe.

3.2.3 Place the fully assembled GPS backpack in the carriage with the antenna pointing straight up. Strap the GPS backpack into place using the child restraints. The antenna should be in the center of the carriage.

3.2.4 Place the foam pad in the bottom net basket. Gently place the probe on the foam pad. The pad may be hollowed out to fit the probe. Tighten/loosen the net so that the probe face is exactly 12 inches (±1-inch is good) off of the ground. The probe should be positioned directly under the top of the GPS antenna (the probe and/or the antenna can be moved to accommodate this).

3.2.5 Place the scaler in the top net and connect it to the probe and GPS logger. Turn on the scaler and logger. The system should be ready for operation.



3.3 Staff or Backpack Configuration.

Note: In this mode, the GPS system is worn by the surveyor and the radiation detector is either placed at a fixed distance above the ground on a walking staff, or carried by the surveyor.

3.3.1 Secure the GPS system backpack (if applicable) and radiation instrument to the surveyor.

3.3.2 Use shoulder straps, fanny packs, or other backpacks as necessary to safely support the equipment.

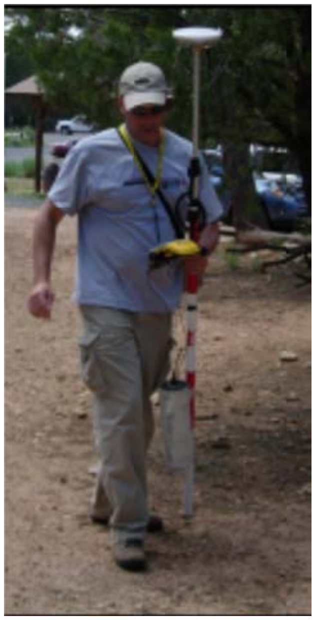
3.3.3 Secure cables and cord in a manner to prevent tripping hazards, but not restrict the movement of the surveyor.

3.3.4 Securely attach the detector to the staff, ensuring the detector is one foot above the ground.

3.3.5 Attach the GPS antenna to the top of the staff or to the backpack.

3.3.6 Measure the distance from the antenna to the ground and input this value into the GPS setup as the antenna height.

3.3.7 Turn on the scaler and logger. The system should be ready for operation.




3.4 Data Collection.

3.4.1 Ensure all required daily instrument checks have been completed, and instrument and GPS are communicating properly.

3.4.2 Start a new survey file. Input the file name, as described below:

XX######cY

XX= gamma survey group designator
######= identifies the sample location
c= unique identifier if more than one file is generated for the survey area ("a" would be the first, "b" would be the second, etc.)
Y= a QC flag if applicable for Duplicates (D)

3.4.3 Ensure the actual antenna height is entered (as measured from the ground to the middle band on the round antenna end).

3.4.4 Radiological data is collected as "not in feature data". Confirm the instrument is collecting data, and the volume is loud enough to be heard.

3.4.5 Begin the survey area transects.

3.4.5.1 Start at a corner and walk a serpentine transect approximately 1 meter apart, with a survey velocity between 0.5-1.5 meters per second.

3.4.5.2 Use the GPS display or visual cues to direct transects.

3.4.5.3 If the audio indicates unusual measurements the surveyor should slow down to pinpoint the elevated measurements.

3.4.5.4 Ensure the data gathered is representative of the entire survey area with a measurement collected for each $1m^2$ area.

3.4.5.5 Place a pin flag at the location with the highest gamma radiation measurement seen during the survey.

3.4.6 Line, area, or point features data may be collected during the radiological data collection. Use a point features to identify the proposed sample location stake.

3.4.6.1 Select the appropriate feature (point, line, area) and record a descriptive comment such as “pin flag xxx” or other information that details the object..

3.4.6.2 Select Enter when the feature is complete.

3.4.7 Stop the data collection from the Files menu.

3.4.8 If necessary, generate additional data files until the entire area has been surveyed.

3.4.9 Complete the GPS Master Survey Log with the following information: survey date, surveyor initials, any relevant notes, and the number of GPS files generated for that area.

3.4.10 Repeat for remaining areas to be surveyed.

3.5 Download Data.

Note: The steps and selections may be slightly different due to changes in the specific software versions.

3.5.1 Daily, or more often if necessary, transport the data logger to the field office for data transfer.

3.5.2 If using the TSC-1 Controller: Select Data Manager→File Transfer.

3.5.3 Open GPS Pathfinder Office and select the current project file.

3.5.4 Connect the logger to the computer.

3.5.5 If not already running, start the GPS Pathfinder Office program on the computer.

3.5.6 In GPS Pathfinder Office program, select Utilities→Data Transfer.

3.5.7 In the Data Transfer window, select the appropriate connection port.

3.5.8 Select TSC-1→GIS Datalogger on COMX (actual COM port varies on each computer).

3.5.9 Select the green Connect button in the Data Transfer window.

3.5.10 Ensure the Receive tab is selected.

3.5.11 Select the Add button and then Data Files.

3.5.12 In the file dialogue window, select all of the files that are ready for download.

3.5.13 Once per day, also download the Almanac file from one of the loggers. This only needs to be downloaded once per day from any of the loggers. This is found under the Add button.

3.5.14 In the Data Transfer window, select Transfer All.

3.5.15 Select OK after all of the files have been successfully transferred to the computer.

3.5.16 Close the Data Transfer window.

3.5.17 Document the data transfer on the Orphan Mine GPS Gamma Survey Master Processing spreadsheet. (Attachment 1).

4.0 Documents Generated by this Procedure

Any forms included in this procedure are examples that show the minimum amount of information necessary to ensure the procedure is appropriately followed. The exact form included in this procedure does not need to be used as long as all of the information shown in the example is included. As needed, forms may be modified to include additional applicable information for different projects.

5.0 References

5.1 URS Safety Management Standard 52 Radiation Protection Program.

Master File Name List

EU	GPS Area ID	Boring ID	Site Coor		Proposed Survey Name
			Easting	Northing	

Master Survey List

EU	GPS Area ID	Boring ID	GPS Survey File Name	Scan Date	Initials	# of files	Notes, Indicate # of files for AOC if more than 1
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					
0	0	0					

PROCEDURE APPROVALS:		
[redacted]	[redacted]	October 1, 2013
(printed name)	Site Radiation Safety Officer *(signature)*	Date
[redacted]	[redacted]	October 1, 2013
(printed name)	Certified Health Physicist *(signature)*	Date

1.0 Purpose

This procedure details field processing and management of GPS gamma radiation survey data. These instructions assume the data has been transferred from the GPS data logger to a laptop computer, which has been set up with the project-specific GPS templates. These instructions assume the user is familiar with the following software packages: GPS Pathfinder Office, Microsoft Excel, ProUCL, and Surfer.

2.0 Equipment

2.1 Laptop with the following software:

- GPS Pathfinder Office (with full activation)
- Microsoft Excel 2010
- ProUCL
- Surfer

3.0 Procedure

3.1 Pathfinder Office – View Data, and Export.

3.1.1 Ensure Pathfinder office has been properly configured for the project. The data files should be stored in C:drive in a folder labeled pfdata/NFSS2013.

3.1.2 View GPS position Data. Under File tab select Open.

3.1.3 When viewing files you should only view the raw data files .ssf extension, or the corrected data which has a .cor file extension.

3.1.4 You can open either an individual file or a group of files.

3.2 Pathfinder Office – Differentially Correct Data

3.2.1 For field processing the data will be exported and processed before differential correction. Final processed data used in reports will be differentially corrected.

3.3 Pathfinder Office – Export

3.3.1 Select Export from the Utilities menu.

3.3.2 Make sure that the files in the Selection menu are the files you want to export. Dialog box settings.

3.3.3 Confirm the output folder.

3.3.4 Choose an export Setup and confirm the following properties:

Data Tab
- Under **Type of Data to Export:**
  - Select Features – Positions and Attributes
  - Select Export All Features
  - Check Include Not In Feature Positions
  - Select One point per Not in Feature position from the dropdown menu
- Under **Create Point Features From:**
  - Check Sensor Records
- Under **Starting Feature ID**
  - Enter 1 in the Value box
  - Select Start Each Session with this Value

Output Tab
- Under **Output Files:**
  - Select the button that is appropriate for the project
- Under **System File Format:**
  - Select Windows Files

Attributes Tab
- Under **Export Menu Attributes As:**
  - Select Attribute Value
- Under **Generated Attributes:**
  - In the **All Feature Types** window select the following:
    - PDOP
    - Connection Status
    - Date Recorded
    - Time Recorded
    - Feature Name
    - Data File Name
    - GPS Week
    - GPS Second

In the **Point Features** window select the following:
Point ID
In the **Line Features** window select the following:
Line ID
In the **Area Features** window select the following:
Area ID

Units Tab
Select Use Current Display Units

Position Filter Tab
Under **Position Filter Criteria**
Select Filter by GPS Position Info
In the **Minimum Satellites** dropdown menu, select 2D (3 or more SVs
Under **Include Positions That Are**
Check all boxes
Check Include Non-GPS Positions
Check Export Features That Have No Positions

Coordinate System Tab
Select Use Current Display Coordinate System
Under **Export Coordinates As**
Select XYZ

Microsoft Access MDB Tab
Select Access 97 from the dropdown box

3.3.5 Once you confirm or correct the above settings, select Export.

3.3.6 When the export is complete a dialog box appears that provides you with detail on the export.

3.3.7 Document the data transfer on the NFSS2013 Data tracking spreadsheet.

3.4 Excel Data Import and Processing

3.4.1 Open the NFSS GPS template spreadsheet

3.4.2 Import the following data from the exported data file, starting in Cell A-1 in the appropriate tab.

Sensor Data from the exported data file
Position Data
Point Data
Line Data, if present
Area Data, if present

3.4.3 Save file using the project specific naming convention.

3.4.4 Evaluate the sensor data

3.4.4.1 The sensor data is stored as a text string and must have any leading text characters removed and converted to a number value.

3.4.4.2 Review all the data values to identify any data points that have values split across rows or invalid data.

3.4.5 Evaluate scan velocity

3.4.5.1 Copy and paste the scan velocity formula in Column O, and paste values the data from Column O into P. Delete the formulas in the rows without data.

3.4.5.2 Readings outside the velocity range (0.05<2) will be flagged, in column N.

3.4.6 Save all files in two formats both excel 2010, and excel 2003.

3.4.7 Update the appropriate sections of the GPS Master Survey Log.

3.5 Generate Summary Statistics

3.5.1 Open ProUCL, and import the excel 2003 formatted sensor data

3.5.2 Generated Summary Raw Statistics for the cpm and velocity data by survey file name

3.5.3 Copy the applicable statistics in the GPS Master Survey Log, for each of the data files.

3.6 Generate Surfer Maps.

3.6.1 These maps will generally be combined to evaluate an gamma survey group or other group of data files.

3.6.2 The class post map will provide a visual display of both the distribution of radiological data points and the activity across the survey area.

3.6.3 Open an NFSS blank surfer map.

3.6.4 Create a Class Post Map.

3.6.4.1 Use the appropriate Excel data file.

3.6.4.2 Use the northing and easting for the (x,y) coordinates and the numeric radiation value for the Z value.

3.6.4.3 Maps should have at least three classes, additional classes may be added for data with abroad range of measurements.

3.6.4.3.1 Lowest value measured.

3.6.4.3.2 Site-specific background value.

3.6.4.3.3 Highest value measured.

3.6.4.4 Adjust the size of the displayed symbol to represent the measurement area. (i.e., nominally $1m^2$).

3.6.5 Use post maps to over lay the locations of the sample stake and pin flag points that were gathered.

3.6.6 Print the map and review it to identify any areas with significant undocumented data gaps.

3.7 Field Data Evaluation.

3.7.1 The URS Radiological Survey Team Lead or designee will review the field data on a daily basis, including the following:

3.7.1.1 Summary radiological statistics – minimum, maximum and mean values for each file.

3.7.1.2 Surfer maps – ensure appropriate survey coverage.

3.7.2 Areas may be resurveyed or additional data gathered based on the results of this data review.

3.8 Field Data Backup.

3.8.1 All field-generated data files will be backed up to an external project hard drive daily.

4.0 Documents Generated by this Procedure

A significant number of data files are generated as part of this procedure. These data files will be managed and maintained in the project specific field directory. Any forms included in this procedure are examples that show the minimum amount of information necessary to ensure the procedure is appropriately followed. The exact form included in this procedure does not need to be used as long as all of the information shown in the example is included. As needed, forms may be modified to include additional applicable information for different projects.

4.1 GPS Master Survey Log

5.0 References

5.1 URS Safety Management Standard 52 Radiation Protection Program.

Master Process Form

EU	GPS Area ID	Boring ID	Scan	# of files	Pathfinder			Excel			ProUCL			Surfer	Back	Eval	Notes, Indicate merged files
					Dwnld (.ssf)	Corr (.cor)	Export (MDB)	Strp (.xlsx)	Stat (.xls)	Stat (.xls)	Stats (.ost)	Stat (.xls)	Stat (.pdf)				
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													
0	0	0	1/0/1900	0													

Master Statistics Form

EU	GPS Area ID	Site Coor	GPS Survey File Name	Scan Date	# of			V f/s			Gamma cpm						Eval	Notes, Indicate merged files
		x			GPS	Sensor	Discard	Avg	Stdev	% in	Min	Max	Mean	St Dev	Median	Mode		
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
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0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														
0		0		1/0/1900														

PROCEDURE APPROVALS:		
[redacted]	[redacted]	October 1, 2013
(printed name)	Site Radiation Safety Officer *(signature)*	Date
[redacted]	[redacted]	October 1, 2013
(printed name)	Certified Health Physicist *(signature)*	Date

1.0 Purpose

To describe the method for scanning soils or trenches with shield radiation instruments. The shield restricts the instrument field of view significantly reducing the overall count rate. The meter, probe, shield, and appropriate length cable MUST be calibrated together prior to use. This procedure assumes the daily operation check set up has been completed per RP-3.0.

2.0 Equipment

2.1 NaI detector, examples: Ludlum 44-10 (2”x2”).

2.2 Collimator Shield.

2.3 Meter: Ludlum Model 2221 Portable ratemeter-scaler or equivalent.

2.4 Detector cable of sufficient length for trench depth.

2.5 Plastic bags (optional).

2.6 Detector cradle and lifting support mechanism designed to support the detector and shield in both a vertical and horizontal position.

3.0 Procedure

3.1 General Setup and Use.

3.1.1 Do not use the instrument cable to hold the detector.

3.1.2 Position the detector approximately 6 inches from the surface being surveyed, with the unshielded end facing the material to be measured.

3.2 Trench Scanning.

3.2.1 Mark the cable and/or rope or other handle at six-inch intervals, with the bottom of the detector as 0.

3.2.2 Use ropes or other markers to nominally grid the excavation, so each grid represents an area with a depth of 1 ft and a length of 5 ft.

3.2.3 Record the approximate dimensions of each trench wall, and the general orientation on the trench field sheets,

3.2.3.1 Complete page 1 of the trench survey data sheet with detailed information for each trench. Complete a separate data sheet for each face surveyed. If the trench has an unusual shape, use as many data sheets as necessary to accurately represent the trench.

3.2.4 A three-dimensional coordinate system will be used to identify each measurement location.

3.2.5 The walls are numbered sequentially with walls 1 and 3 the long walls, and walls 2 and 4 the sidewalls, the wall number will be used as the z coordinate.

3.2.6 Each wall is nominally gridded assuming the 0,0 point is in the upper-left corner when you are facing the wall. The bottom assumes the 0,0, point also the upper-left corner when looking down on the trench. See the trench orientation key.

3.2.7 The long walls have an additional identifier of Left, Center and Right, to identify the grid interval on the long axis. A similar approach is used for the Bottom but the identifier is Front, Center, Back.

3.2.8 If practical, scan the entire trench bottom first.

3.2.8.1 Position the detector vertically so the open face is approximately 6 inches from the excavation floor.

3.2.8.2 The detector/shield can be covered with a plastic bag to reduce contamination.

3.2.8.3 Make note of any water that is present in the excavation. Grids that are underwater will not be scanned.

3.2.8.4 Slowly move the detector across the grid in a systematic manner to cover the entire grid while collecting a timed count.

3.2.8.5 Record the measurement on the appropriate location on the trench form.

3.2.9 Scan trench walls.

3.2.9.1 Change the detector orientation to a horizontal position, open face towards trench wall.

3.2.9.2 Lower the detector cradle to the bottom of the trench and scan each wall grid starting at the bottom of the trench.

3.2.9.3 Slowly move the detector across the grid in a systematic manner to cover the entire grid while collecting a timed count.

3.2.9.4 Record the measurement on the appropriate location on the trench form.

3.2.9.5 Scan all the walls in a systematic manner. Note any problems or the presence of pipes or other anomalies on the trench forms.

3.3 Collect Samples.

3.3.1 Review the trench data to identify sample locations.

3.4 Complete all entries on the trench field data package.

4.0 Documents Generated by this Procedure

Any forms included in this procedure are examples that show the minimum amount of information necessary to ensure the procedure is appropriately followed. The exact form included in this procedure does not need to be used as long as all of the information shown in the example is included. As needed, forms may be modified to include additional applicable information for different projects.

4.1 Trench Data Sheets

5.0 References

5.1 URS Safety Management Standard 52 Radiation Protection Program.

Trench Survey Key

Project **NFSS 2013 Investigation** **URS Trench Survey Key**

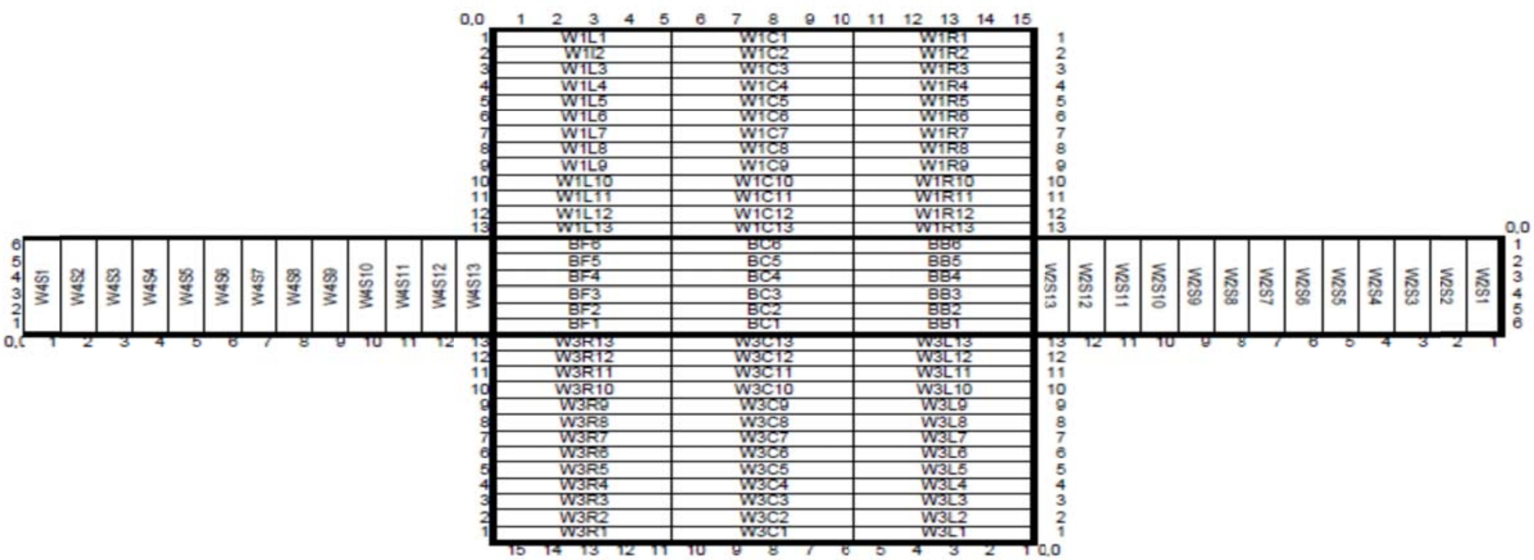
Description ______________________ **Meter/Probe** ________ **Meter/Probe** ________

Survey Type ______________________ **Serial#** ________ **Serial#** ________

* Denotes Contact Readings **Cal Due** ________ **Cal Due** ________

Tech ______________________ All readings in cpm unless otherwise noted **Bkg** ________ **Bkg** ________

Date **Units** **Units**



Notes

Wall Data Sheet

Date ______________ Count Time ______________

Wall Description ______________ Technician ______________

Measured Length ______ Depth ______ Technician ______________

0,0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	WL					WC					WR				
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															

Notes ____

Side Wall Data Sheet

URS Trench ID ____________________

Date ____________________ Count time ________________

Side Wall Description ____________________ Technician ________________

Measured Length ____ Depth ____________ Technician ________________

S

0,0	1	2	3	4	5	6	Ground surface
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							

Notes ____

____

____

APPENDIX B
FIELD FORMS

URS *Corporation*

TEST BORING LOG

PROJECT/PROJECT LOCATION:	BORING NO. :
	SHEET: 1 OF 1
CLIENT:	JOB NO. :
BORING CONTRACTOR:	NORTHING: EASTING:

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE	GROUND ELEVATION:
DATE	TIME	LEVEL	TYPE	TYPE					DATE STARTED:
				DIA.					DATE FINISHED:
				WT.					DRILLER:
				FALL					GEOLOGIST:
									REVIEWED BY:

ELEVATION (FEET)	DEPTH (FEET)	STRATA	SAMPLE		REC (%)	RQD (%)	POCKET PENETRO-METER	MATERIAL DESCRIPTION	WELL CONSTRUCTION	REMARKS
			NUMBER	DEPTH (ft)						
0	0									
-5	5									
-10	10									
-15	15									
-20	20									
-25	25									

COMMENTS:

BORING NO. :

URS

77 Goodell Street
Buffalo, New York 14203
(716) 856-5636

DATE ______________________

DAY	S	M	T	W	TH	F	S

WEATHER	Bright Sun	Clear	Overcast	Rain	Snow
TEMP	To 32	32-50	50-70	70-85	85 up
WIND	Still	Moder	High	Report No.	
HUMIDITY	Dry	Moder	Humid		

PROJECT MANAGER ______________________

PROJECT ______________________

JOB No. ______________________

CONTRACT No. ______________________

SUB-CONTRACTORS ON SITE:
EQUIPMENT ON SITE:
WORK PERFORMED (INCLUDING SAMPLING):

SHEET_______ OF_______

DAILY QUALITY CONTROL REPORT

PROJECT ______________________ REPORT No. ______________

JOB No. ______________________ DATE ______________

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATIONS):
HEALTH AND SAFETY LEVELS AND ACTIVITIES:
PROBLEMS ENCOUNTERED/CORRECTION ACTION TAKEN:
SPECIAL NOTES:
TOMORROW'S EXPECTATIONS:

BY ______________ TITLE ______________

DAILY DRILLING RECORD ***URS Corporation***

PROJECT TITLE: ____________________ DATE: ____________________

CLIENT: ____________________ CONTRACTOR: ____________________

FROM	TO	PRODUCTIVE HOURS	ACTIVITIES/COMMENTS
TOTAL PRODUCTIVE HOURS			LEVEL B / LEVEL C / LEVEL D (CIRCLE ONE SELCTION)

LABOR:		MATERIALS / SUPPLIES:	
UNITS		UNITS	

WEATHER:

____________________ URS ONSITE COORDINATOR

____________________ CONTRACTOR REPRESENTATIVE

CHAIN OF CUSTODY RECORD

URS

PROJECT NO.	SITE NAME

SAMPLERS (PRINT/SIGNATURE)

TESTS

BOTTLE TYPE AND PRESERVATIVE

LAB ____________

COOLER ________ of ________

PAGE ________ of ________

DELIVERY SERVICE: ____________ AIRBILL NO.: ____________

LOCATION IDENTIFIER	DATE	TIME	COMP/ GRAB	SAMPLE ID	MATRIX	TOTAL NO.# OF CONTAINERS									REMARKS	SAMPLE TYPE	BEGINNING DEPTH (IN FEET)	ENDING DEPTH (IN FEET)	FIELD LOT NO.# (IRPIMS ONLY)

MATRIX CODES	AA - AMBIENT AIR SE - SEDIMENT SH - HAZARDOUS SOLID WASTE	SL - SLUDGE WP - DRINKING WATER WW - WASTE WATER	WG - GROUND WATER SO - SOIL DC - DRILL CUTTINGS	WL - LEACHATE GS - SOIL GAS WC - DRILLING WATER	WO - OCEAN WATER WS - SURFACE WATER WQ - WATER FIELD QC	LH - HAZARDOUS LIQUID WASTE LF - FLOATING/FREE PRODUCT ON GW TABLE
SAMPLE TYPE CODES	TB# - TRIP BLANK SD# - MATRIX SPIKE DUPLICATE	RB# - RINSE BLANK FR# - FIELD REPLICATE	N# - NORMAL ENVIRONMENTAL SAMPLE MS# - MATRIX SPIKE	(# - SEQUENTIAL NUMBER (FROM 1 TO 9) TO ACCOMMODATE MULTIPLE SAMPLES IN A SINGLE DAY)		

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY (SIGNATURE)	DATE	TIME	SPECIAL INSTRUCTIONS
RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED FOR LAB BY (SIGNATURE)	DATE	TIME	

Distribution: Original accompanies shipment, copy to coordinator field files

URSF-075C/1 OF 1/CofCR/GCM

Figure C4-1

PROJECT ____________________

PROJECT No. ____________________

URS JOB No. ____________________

BY ____________________

URS
77 Goodell Street
Buffalo, New York 14203
(716) 856-5636

PHOTO LOG

PHOTO & ROLL No.	DATE TAKEN	DIRECTION FACING	DESCRIPTION