Contract No.: EP-W-09-002
WA #: 054-RICO-A282

Region 2 RAC2 Remedial Action Contract

Final Quality Assurance Project Plan

Wolff-Alport Chemical Company Site

Remedial Investigation and Feasibility Study

Ridgewood, Queens, New York

June 15, 2015

CDM Smith

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PROJECT: EPA Region 2 RAC 2 Contract No.: EP-W-09-002
Work Assignment: 054-RICO-A282

DOCUMENT NO.: 3323-054-02509

SUBJECT: Final Quality Assurance Project Plan
Wolff-Alport Chemical Company Site
Remedial Investigation/Feasibility Study
Ridgewood, Queens, New York

Dear Mr. Mongelli:

CDM Federal Programs Corporation (CDM Smith) is pleased to submit an electronic copy (CD) of the Final Quality Assurance Project Plan (QAPP) for the Wolff-Alport Chemical Company Site located in Ridgewood, Queens, New York.

If you have any questions regarding this submittal, please contact me at (732) 590-4727.

Very truly yours,

CDM FEDERAL PROGRAMS CORPORATION

M. A. Rahmani

Muzaffar A. Rahmani
Site Manager

PSO:

cc: H. Eng, EPA Region 2 (Letter Only)
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J. Oxford, CDM Smith (electronic copy)
RAC2 Region 2 Document Control

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Acronyms

%	percent
µg/L	microgram per liter
µR/h	microroentgen per hour
AARST	American Association of Radon Scientists and Technologists
ACM	asbestos-containing material
AEC	Atomic Energy Commission
Am-241	Americium-241
amu	atomic mass unit
ANSETS	Analytical Services Tracking System
ARAR	applicable or relevant and appropriate requirement
ASC	Analytical Services Coordinator
ATD	alpha track detector
ATV	all-terrain vehicle
B.A.	Bachelor of Arts
bgs	below ground surface
B.S.	Bachelor of Science
BVNA	Bureau Veritas North America
°C	degrees Celsius
CCB	continuing calibration blank
CCV	continuing calibration verification
CDM Smith	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHMM	Certified Hazardous Materials Manager
CHP	Certified Health Physicist
CIH	Certified Industrial Hygienist
cm	centimeter
Co-60	cobalt-60
COC	chain of custody
CPM	count per minute
Cs-137	cesium-137
CSO	combined sewer overflow
CSP	Certified Safety Professional
DER	Data Evaluation Report
DL	detection limit
DO	dissolved oxygen
DoD	United States Department of Defense
DOE	U.S. Department of Energy
dpm/100 cm^2	disintegration per minute per hundred square centimeters
DPT	direct-push technology
DQI	data quality indicator
DQO	data quality objective

EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
EQuIS™	Environmental Quality Information System
EZ	exclusion zone
FAR	Federal Acquisition Regulation
FASTAC	Field and Analytical Services Teaming Advisory Committee
FCN	Field Change Notification
FFS	focused feasibility study
FS	feasibility study
FSS	Final Status Survey
FTL	field team leader
FWHM	full width at half maximum
GED	Greenwich Environmental Designs
GPS	Global Positioning System
HASP	health and safety plan
HDPE	high-density polyethylene
HHRA	human health risk assessment
HNO_3	nitric acid
HPGe	high purity germanium
H&S	health and safety
HSA	hollow-stem auger
HSM	Health and Safety Manager
ICAL	initial calibration
ICB	initial calibration blank
ICP-MS	inductively coupled plasma mass spectrometry
ICS	interference check solution
ICV	initial calibration verification
I.D.	inside diameter
ID	identification
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
ISOCS™	In Situ Object Counting System
keV	kiloelectron-volt
L	liter
LBA	Louis Berger and Associates
LCS	laboratory control sample
LDR	linear dynamic range
LOD	limit of detection
m^2	square meter
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols Manual
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
M.B.A.	Master of Business Administration

MCL	maximum contaminant level
MDC	minimum detectable concentration
MDL	method detection limit
M.E.	Master of Engineering
MeV	million electron-volt
mg/kg	milligram per kilogram
mL	milliliter
MLA	Master of Liberal Arts
MPC	measurement performance criterion
M.S.	Master of Science
m/s	meter per second
MS	matrix spike
MSD	matrix spike duplicate
N	normal
N_2	nitrogen gas
NA	not applicable
NaI	sodium iodide
NCP	National Contingency Plan
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NRSB	National Radon Safety Board
NYCDDC	New York City Department of Design and Construction
NYCDEP	New York City Department of Environmental Protection
NYSDOH	New York State Department of Health
ORP	oxidation-reduction potential
oz	ounce
PAL	project action limit
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
pCi/L	picocurie per liter
P.E.	Professional Engineer
P.G.	Professional Geologist
Ph.D.	Doctor of Philosophy
PIC	pressurized ion chamber
PID	photoionization detector
PO	Project Officer
PPE	personal protective equipment
PQLG	project quantitation limit goal
PTFE	polytetrafluoroethylene
PVC	polyvinyl chloride
QA	quality assurance
QAM	Quality Assurance Manager

QAO	quality assurance officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QMP	Quality Management Plan
QP	Quality Procedure
Ra-226	radium-226
RAC	Remedial Action Contract
RAS	routine analytical services
REM	Registered Environmental Manager
RI	remedial investigation
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RPM	remedial project manager
RQAS	Regional Quality Assurance Specialist
RSL	regional screening level
RSO	radiation safety officer
SDG	sample delivery group
SHSO	site health and safety officer
SM	site manager
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBD	to be determined
TCL	Target Compound List
Th-228	thorium-228
Th-229	thorium-229
Th-230	thorium-230
Th-232	thorium-232
TIC	tentatively identified compound
TSOP	Technical Standard Operating Procedure
U-234	uranium-234
U-235	uranium-235
U-238	uranium-238
UCL	upper confidence limit
UFP	Uniform Federal Policy
UST	underground storage tank
VOA	volatile organic analysis
VOC	volatile organic compound
WA	Work Assignment
WACC	Wolff-Alport Chemical Company

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1.0 Introduction

CDM Federal Programs Corporation (CDM Smith) received Work Assignment (WA) 054-RICO-A282 under United States Environmental Protection Agency (EPA) Region 2, Remedial Action Contract (RAC) 2, to complete a remedial investigation (RI) and feasibility study (FS) for the Wolff-Alport Chemical Company (WACC) site located in Ridgewood, Queens County, New York. The WACC site is shown in **Figure 1**. The purpose of this WA is to evaluate the nature and extent of radiological contamination and other chemical contamination in various media as identified in the EPA Statement of Work (SOW). The media to be investigated during the RI include soil, groundwater, sediment, and building materials. The investigations described herein are designed to gather complementary investigative data that, in conjunction with previously collected data, are appropriate to complete an RI report, a human health risk assessment (HHRA), and a focused feasibility study (FFS) report.

This Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) has been prepared in accordance with the Intergovernmental Data Quality Task Force (IDQTF) *Uniform Federal Policy for Quality Assurance Project Plans* (IDQTF 2005a) and is compliant with the EPA QAPP guidance document, EPA QA/R-5 (EPA 2001). This project will be implemented in accordance with the quality procedures (QPs) detailed in the CDM Smith Region 2 RAC2 Remedial Action Contract Quality Management Plan (QMP), Revision 2 (CDM Smith 2012) and this QAPP.

1.1 Site Overview

1.1.1 Site Description and History

The WACC site is located at 1125 to 1139 Irving Avenue and 1514 Cooper Avenue in Ridgewood, Queens County, New York, at the county border with Brooklyn (**Figure 1** and **Figure 2**). The site includes these properties as well as properties outside these boundaries where contaminants may have migrated or threaten to migrate. Onsite soils are contaminated with thorium-232 (Th-232) and uranium-238 (U-238), including their decay chain progeny.

WACC operated at the property from the 1920s until 1954, importing monazite sand via a rail spur and extracting rare earth metals from the material. Monazite contains approximately 6 percent (%) to 8% or more of thorium. Until 1947, WACC disposed of process liquors containing thorium waste from monazite sand processing in the sewer and possibly buried waste tailings on the property. According to the U.S. Department of Energy (DOE), the Atomic Energy Commission (AEC) ordered WACC to halt sewer disposal of thorium waste in the fall of 1947. Thereafter, thorium was precipitated as thorium oxalate sludge and sold to the AEC. Documents indicate that WACC sold approximately 53,000 pounds and 238 drums of thorium oxalate sludge to the AEC from 1948 to 1954 and sold 400 pounds of thorium nitrate to the AEC in 1954. During its years of operation, WACC occupied three structures at 1127 Irving Avenue. The operation also included two yard areas: one between the former company's buildings facing Irving Avenue, and the other on the eastern end of the property at the northern end of Moffat Street. These former yard areas, now occupied primarily by structures, were reportedly used as staging areas for monazite sands or waste tailings containing Th-232. Although WACC did not operate at 1125 Irving Avenue (Lot 46) or 1514 Cooper Avenue (Lot 48), these properties have been impacted by the radioactive materials at the site.

The nearly triangular property impacted by contamination, which includes Lots 31 (partial), 33, 42, 44, 46, and 48 of Queens Borough Block 3725, covers approximately 0.75 acre bound by Irving Avenue to the southwest, Cooper Avenue to the northwest, and an active cabinet manufacturer to the east. At present, the property is covered primarily with contiguous structures, except the former rail spur along its eastern edge, which is unpaved. The buildings contain a delicatessen/grocery, office space, residential apartments, tire shop, and former mini all-terrain vehicle (ATV) shop (1125 Irving Avenue; Lot 46); an automobile repair shop and office space (1514 Cooper Avenue; Lot 48); an automobile body shop (1127 Irving Avenue; Lot 44); and two warehouses (1129 Irving Avenue; Lot 42 and 1133-1139 Irving Avenue; Lot 33). The portion of the former rail spur adjacent to the WACC buildings (portion of Lot 31) is fenced, covered with gravel-like material and used as an automobile storage/ parking area by the automobile repair shop. The non-fenced portion of the former rail spur, which is not adjacent to the WACC buildings is partially vegetated.

In surveys conducted by New York City, state, and federal agencies between 2009 and 2014, elevated gamma radiation was detected along Irving Avenue, in an area of pedestrian and worker traffic. The neighborhoods surrounding the subject property contain light industry, commercial businesses, and residences. Irving Avenue is typically filled with vehicles being serviced by the businesses at the property. The intersection of Irving Avenue and Moffat Street (i.e., the southern corner of the subject property) is an active area for trailer parking and unloading. There are currently three unoccupied apartments over the delicatessen/grocery, and other housing begins across the street on both Cooper and Irving Avenues. There are indications that nearby former warehouses on Moffat Street are now used for residential purposes. The residential area is densely populated and contains multi-family homes and apartments; a public elementary school is located 900 feet to the southwest. An active rail line passes within 125 feet southeast of the property, and the Cemetery of the Evergreens is located to the east and south on the opposite side of the active rail line.

Radiological surveys have also identified radioactivity above background levels within portions of property buildings, in soils beneath and around the former WACC facility and adjacent buildings, and in adjacent sidewalks, streets, and sewers. During an investigation by the New York City Department of Design and Construction (NYCDDC) in 2009-2010, waste tailings consisting of black or gray ash-like material were found in a contaminated soil layer beneath property buildings, beneath sidewalks and asphalt surfaces of Irving Avenue and Moffat Street, and within the surface soils of the former rail spur. The depth of visibly contaminated soil is typically within the top 1 to 4 feet under the pavement or ground surface; however, a lens was reported at 8 to 10 feet beneath the automobile body shop. Th-232 concentrations up to 1,133 picocuries per gram (pCi/g) were reported for the soil samples containing waste, while background was reported to be 0.5 pCi/g to 1.0 pCi/g. The radioactive decay of Th-232, which has a half-life of 14 billion years, proceeds as follows (radioactive half-lives in parentheses): radium-228 (5.8 years), actinium-228 (6.1 hours), thorium-228 (1.9 years), radium-224 (3.7 days), radon-220 (56 seconds), polonium-216 (0.15 second), lead-212 (11 hours), bismuth-212 (61 minutes), polonium-212 (310 nanoseconds), thallium-208 (3.1 minutes), and lead-208 (stable). Due to the length of time since processing of the monazite sands began (about 60 years or more), it is reasonable to assume secular equilibrium (i.e., the activities of all radionuclides within the series are nearly equal) for these radionuclides in the waste materials abandoned at the site.

One of the key components of the Th-232 decay series is radon-220, a radioactive gas commonly and hereinafter referred to as thoron, which emanates from surfaces where Th-232 is present. During the NYCDDC investigation, thoron was detected in the delicatessen/grocery basement at a concentration of 12.7 picocuries per liter (pCi/L).

In September 2012, EPA collected gamma radiation exposure rate measurements and thoron concentration measurements on and around the perimeter of the source area and at background locations. The gamma radiation exposure rate measurements identified hot spots along the former rail spur and in the sidewalks and streets adjacent to the former facility. The contaminated area (i.e., the source area), defined as the extent to which the gamma radiation exposure rates equal or exceed two times the site-specific background gamma radiation exposure rate, extends throughout most of the property and in some of the adjacent street and sidewalk areas. Thoron gas concentrations on site exceeded two standard deviations above the mean site-specific background concentration (0.46 pCi/L). The highest thoron concentration, 366 pCi/L, was observed at the former rail spur area.

Recent investigations have indicated that residual contamination still exists in or around the sewer lines downstream of the facility. During periods of heavy flow such as rainstorms, combined sewer overflows (CSOs) discharge from this combined sewer system to Newtown Creek west of the subject property. In 2013, Bureau Veritas North America (BVNA) performed an investigation on behalf of the New York City Department of Environmental Protection (NYCDEP) to assess the current impact to the sewers in the vicinity and downgradient of the WACC property. Results of soil borings found no contaminated soils along the sewer lines with the exception of those adjacent to the WACC property. However, surveys in the sewers did detect radiological constituents above background concentrations at least as far downgradient as the intersection of Irving Avenue and Halsey Street (approximately 0.25 mile from the WACC site).

Since October 2012, EPA has conducted additional monitoring and mitigation activities at the site and vicinity. Surveys conducted in October and November 2012 confirmed elevated radiation levels in some areas. In December 2012 and February 2013, radon and thoron monitoring in onsite buildings indicated elevated readings. In April 2013, EPA installed fencing at the site and shielded portions of the radioactive soil with rock and clean fill to reduce accessibility to the waste material. Additional shielding consisting of lead, steel, and concrete was installed within several onsite structures and along a portion of the Irving Avenue sidewalk. A radon mitigation system was also installed at the property. These activities were completed in December 2013. Following the placement of the shielding and radon mitigation system, EPA conducted surveys that showed exposure rates had been reduced between 69 to 94%, and radon concentrations decreased by more than half. The site was listed on the National Priorities List (NPL) on May 12, 2014.

1.1.2 RI/FS Objectives

The purpose of the RI/FS is to select a remedy to eliminate, reduce, or control risks to human health and the environment from contaminants associated with the WACC site. The objectives of this investigation are to:

- Review and evaluate the studies and investigations performed at the site to date

- Perform the appropriate amount of additional sampling to complete characterization of the site
- Obtain sufficient data to characterize the human and ecological risk from the residual contaminants at and around the site
- Provide adequate data to support the selection of an approach for site remediation and development of a Record of Decision (ROD)

The following field activities are planned to meet the objectives of the RI/FS:

- A hydrogeological investigation, including soil sampling, down-hole geophysical testing, monitoring well installation and development, and slug testing
- Radiological soil and sewer background measurements
- A soil boring investigation
- Radiological and hazardous building materials surveys
- A sewer investigation
- Gamma exposure rate confirmation readings
- A school and daycare investigation, including soil borings, dose rate measurements, and evaluation of radon/thoron in air
- Groundwater sampling and synoptic water level measurements
- Creek sediment sampling via barge-mounted vibracore drilling
- Gamma walkover surveys

1.2 Approach to the Development of the QAPP

CDM Smith prepared this QAPP in accordance with the *Uniform Federal Policy for Implementing Environmental Quality Systems*, EPA-505-F-03-001, March 2005 (IDQTF 2005b), and the *Uniform Federal Policy for Quality Assurance Project Plans*, EPA-505-B-04-900, March 2005 (IDQTF 2005a). It includes all information required to perform the RI/FS and associated field activities in accordance with the Final Work Plan, Volume 1 (CDM Smith 2014) and Volume 2 (CDM Smith 2015a). This QAPP describes the project objectives and organization, functional activities, and quality assurance (QA)/quality control (QC) protocols that will be used to achieve the data quality objectives (DQOs). The DQOs will, at a minimum, reflect use of analytical methods for identifying and addressing contamination consistent with the National Contingency Plan (NCP). All work will be performed in accordance with CDM Smith's RAC2 QMP (CDM Smith 2012).

Because of the presence of radiological contaminants at the site, this QAPP is designed to cover sampling, measurement, and assessment of data in accordance with the guidelines in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA et al. 2000). However, this work is not a

Final Status Survey (FSS), and as a consequence there will be limited application of the MARSSIM statistical methods for placement and assessment of sample points and sample results. Where appropriate, the MARSSIM survey methodology and detection statistics will be employed for this work. Laboratory analysis by subcontractors is expected to follow the analytical guidance contained within the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) (EPA et al. 2004).

This QAPP describes the number, types, and locations of samples and types of analyses to be performed, including sampling objectives, sample locations and frequencies, sample handling and analysis procedures, and the justification for these decisions. The QAPP is written so that a field sampling team unfamiliar with the site would be able to gather the necessary samples and field information in accordance with EPA Region 2 QA requirements. CDM Smith will document any required changes in a letter, Field Change Notification (FCN), or QAPP Addendum submitted to the EPA Remedial Project Manager (RPM).

Where appropriate for non-radiological contaminants, this QAPP references the following worksheets from CDM Smith's Generic QAPP (CDM Smith 2013):

- Worksheet #12: Measurement Performance Criteria
- Worksheet #21: Project Sampling SOP References Table
- Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection Table
- Worksheet #23: Analytical SOPs
- Worksheet #24: Analytical Instrument Calibration Table
- Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
- Worksheet #26: Sample Handling, Custody, and Disposal
- Worksheet #31: Assessments and Corrective Action
- Worksheet #34: Data Verification and Validation Inputs
- Worksheet #35: Data Verification Procedures
- Worksheet #36: Data Validation Procedures

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QAPP Worksheet #1
Title and Approval Page

RAC2 CONTRACT
FINAL QUALITY ASSURANCE PROJECT PLAN (QAPP)
for
Remedial Investigation and Feasibility Study
Wolff-Alport Chemical Company (WACC) Site
Ridgewood, Queens County, New York

United States Environmental Protection Agency (EPA), Region 2

Prepared by: CDM Federal Programs Corporation (CDM Smith)
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Date: June 15, 2015

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Signature Jl Unford for

EPA Remedial Project Manager: Thomas Mongelli

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EPA Quality Assurance Officer: William Sy

Signature 2015.06.11 08:18:53 -04'00'

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project:	Wolff-Alport Chemical Company Site RI/FS
Site Location:	Ridgewood, Queens County, New York
Operable Unit:	Not applicable (NA)
Contractor Name:	CDM Smith
Contract Number:	EP-W-09-002
Contract Title:	RAC2, EPA Region 2
Work Assignment Number:	054-RICO-A282
Regulatory Program:	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Approval Entity:	EPA Region 2
Is QAPP Generic or Project Specific:	Project Specific
Dates of scoping session:	July 24, 2014

Dates and Titles of QAPP Documents Written for Previous Site Work, if Applicable:

NA

Organizational Partners (stakeholders) and Connection with Lead Organization:

EPA

Data Users:

CDM Smith, EPA Region 2

Required QAPP elements and required information that are not applicable to the project, and an explanation for their exclusions:

NA

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QAPP Worksheet #3
Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Email Address
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Muzaffar Rahmani, Certified Hazardous Materials Manager (CHMM)	Site Manager (SM)	CDM Smith	(732) 590-4727	rahmanima@cdmsmith.com
Joe Button, Professional Geologist (P.G.)	RI Task Leader	CDM Smith	(212) 377-4389	buttonjs@cdmsmith.com
Jeniffer Oxford, CHMM	Regional QA Specialist (RQAS)	CDM Smith	(212) 377-4536	oxfordjm@cdmsmith.com
Peter Collopy, Certified Health Physicist (CHP), Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP)	Senior Health Physicist/Radiation Safety Officer (RSO)	CDM Smith	(518) 859-1944	collopyp@cdmsmith.com
Patrick Connelly	Field Team Leader (FTL)/ Geologist/Site Health and Safety Officer (SHSO)	CDM Smith	(212) 377-4403	connellypc@cdmsmith.com
David Lawrence	Health Physicist	Greenwich Environmental Designs (GED)	(646) 246-3465	dlawrencenewyork@aol.com

QAPP Worksheet #4
Project Personnel Sign-Off Sheet

Organization: EPA

Project Personnel	Title	Organization	Telephone Number	Signature	Date QAPP Read
Thomas Mongelli	RPM	EPA	(212) 637-4256		
William Sy	QAO	EPA	(732) 321-6648		

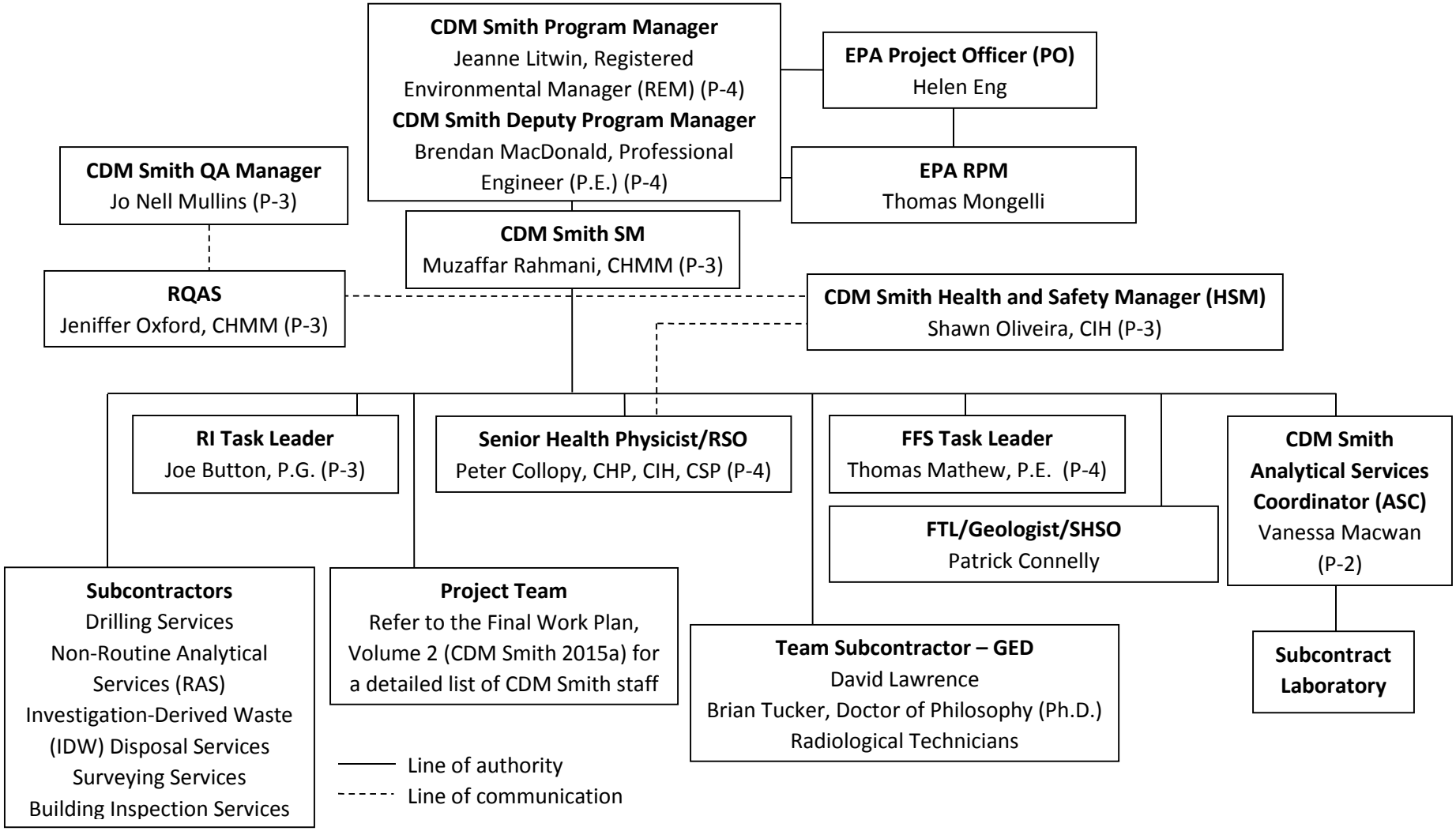
Organization: CDM Smith

Project Personnel	Title	Organization	Telephone Number	Signature	Date QAPP Read
Muzaffar Rahmani, CHMM	SM	CDM Smith	(732) 590-4727		
Joe Button, P.G.	RI Task Leader	CDM Smith	(212) 377-4389		
Jeniffer Oxford, CHMM	RQAS	CDM Smith	(212) 377-4536		
Peter Collopy, CHP, CIH, CSP	Senior Health Physicist/RSO	CDM Smith	(518) 859-1944		
Patrick Connelly	FTL/Geologist/SHSO	CDM Smith	(212) 377-4403		
David Lawrence	Health Physicist	GED	(646) 246-3465		

Organization: Laboratories

Project Personnel	Title	Organization	Telephone Number	Signature	Date QAPP Read
To be determined (TBD)	QAO	CDM Smith Subcontract Laboratory	TBD		

QAPP Worksheet #5
Project Organizational Chart



QAPP Worksheet #6
Communication Pathways

Communication Driver	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, Documentation, etc.)
Point of contact with EPA	SM	Muzaffar Rahmani, CHMM	(732) 590-4727	All information about the project will be sent to the EPA RPM by the CDM Smith SM. Field changes will be discussed with the EPA RPM prior to implementation.
Manage RI field tasks	RI Task Leader	Joe Button, P.G.	(212) 377-4389	Act as liaison to SM concerning investigation activities. Daily communication with project team and SM. Communicate implementation issues to the FTL.
Manage FFS field tasks	FFS Task Leader	Thomas Mathew, P.E.	(732) 590-4638	
QAPP changes	FTL	Patrick Connelly	(212) 377-4403	Notify Task Leader immediately and complete an FCN form and/or corrected QAPP worksheets. Send FCN forms to RQAS.
	RI Task Leader	Joe Button, P.G.	(212) 377-4389	Notify EPA RPM and ASC of delays or changes to field work. Prepare QAPP Addenda or revisions in consultation with the client.
	FFS Task Leader	Thomas Mathew, P.E.	(732) 590-4638	
Field corrective actions	FTL	Patrick Connelly	(212) 377-4403	Oversee implementation of corrective action and notify auditor, SM, and Task Leader by email. Task Leader will complete the corrective action report form.
Field progress reports	FTL	Patrick Connelly	(212) 377-4403	Complete on a daily basis and submit to SM. SM will forward to EPA RPM upon request.
Booking of analytical services	FTL	Patrick Connelly	(212) 377-4403	Submit request to ASC within the timeframe below. Initiate kick-off call with subcontract laboratory and email agenda.
	ASC	Vanessa Macwan	(732) 590-4706	Review request and send email to subcontract laboratory 3 weeks prior to sampling.

QAPP Worksheet #6
Communication Pathways

Communication Driver	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, Documentation, etc.)
Facilitate database setup and data management planning	FTL	Patrick Connelly	(212) 377-4403	Provide sample and analytical information prior to sample collection. Provide information on sample and analytical reporting groups and types of report tables required for project.
Facilitate data management	FTL	Patrick Connelly	(212) 377-4403	Provide electronic survey data and sample identifications (IDs), locations, and analyses. Transmit completed sample tracking information to data manager by the completion of each sampling case.
Incomplete electronic data deliverables (EDDs) or other EDD issues	ASC	Vanessa Macwan	(732) 590-4706	Request resubmittal of corrected EDD by email.
Data verification issues, e.g. incomplete records	ASC	Vanessa Macwan	(732) 590-4706	ASC will send an email to the FTL when an issue is found. FTL will address questions or any discrepancies.
Field corrective action	RQAS	Jeniffer Oxford, CHMM	(212) 377-4536	Per QMP, corrective actions may also be identified by the field team. FTL initiates corrective action on identified field issues immediately or within timeframe recommended by the Quality Assurance Manager (QAM).
	FTL	Patrick Connelly	(212) 377-4403	
Analytical services support	ASC	Vanessa Macwan	(732) 590-4706	Act as liaison with subcontract laboratories.
Laboratory QC variances and analytical corrective actions	Laboratory Project Manager or QC Officer	TBD	TBD	Daily communication with laboratory staff and regular communication with CDM Smith ASC, RQAS, or designee. Provide oversight and direction on technical issues as needed.

QAPP Worksheet #6
Communication Pathways

Communication Driver	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, Documentation, etc.)
Notification of analytical issues; sample receipt variances	ASC	Vanessa Macwan	(732) 590-4706	Notify FTL of any sample collection/shipment issues. Notify subcontract laboratory to initiate corrective action.
Data validation issues, e.g. non-compliance with procedures; data review corrective actions	GED Data Validator	Brian Tucker, Ph.D.	TBD	Submit a list of questions or issues to radiological subcontract laboratory as appropriate for correction or other appropriate response.
	CDM Smith Data Validator	Kristine Molloy	(617) 452-6000	Submit a list of questions or issues to chemical subcontract laboratory as appropriate for correction or other appropriate response.
Reporting of issues relating to analytical data quality (including ability to meet reporting limits [RLs] and usability of data)	ASC	Vanessa Macwan	(732) 590-4706	Communicate to SM as appropriate.
	Data Validator	Kristine Molloy	(617) 452-6000	Communicate to SM as appropriate. Document situation and effect in a data quality report.
Release of analytical data	ASC	Vanessa Macwan	(732) 590-4706	Receive and review data packages before data are used. Initiate validation of subcontract laboratory data.
Site health and safety (H&S) issues; stop work due to safety issues	SHSO	Patrick Connelly	(212) 377-4403	Make decisions regarding H&S issues and upgrading personal protective equipment (PPE). Communicate to SM, Task Leader, HSM, and field staff as appropriate.

Note: The Field and Analytical Services Teaming Advisory Committee (FASTAC) Policy for obtaining analytical services will be followed. However, due to the presence of radioactive contamination, all samples to be collected under the RI/FS will be analyzed by a subcontract laboratory.

QAPP Worksheet #7
Personnel Responsibilities and Qualifications Table

Name	Title	Organization	Responsibilities	Education and Experience Qualifications
Muzaffar Rahmani, CHMM	SM	CDM Smith	Oversee project and respond to EPA RPM; manage subcontractors	Bachelor of Science (B.S.), Mathematics; B.S., Chemistry; Master of Engineering (M.E.), Environmental Engineering; over 20 years of experience in environmental engineering
Joe Button, P.G.	RI Task Leader	CDM Smith	Oversee RI tasks	Bachelor of Arts (B.A.), Geology; over 10 years of experience conducting environmental investigations
Thomas Mathew, P.E.	FFS Task Leader	CDM Smith	Oversee FFS tasks	B.S., Civil Engineering; Master of Science (M.S.), Sanitary Engineering; 8 years of experience conducting FS
Peter Collopy, CHP, CIH, CSP	Senior Health Physicist/RSO	CDM Smith	Provide overall guidance for radiological safety and measurement protocols for the project	B.S., Environmental Engineering; M.E., Environmental Engineering; CHP (No. 1709); CIH (No. 3360); CSP (No. 18391); 42 years of experience in radiological and environmental H&S
Patrick Connelly	FTL/Geologist/ SHSO	CDM Smith	Coordinate and oversee the field activities; coordinate daily safety activities on the project site; aid in monitoring and assessment of site hazardous conditions; maintain site safety records	B.S., Geology; 7 years of experience; trained in EPA CERCLA sampling methods and field procedures
Teddy Marcum	Risk Assessor	CDM Smith	Perform risk assessment	B.S., Environmental Science; Master of Liberal Arts (MLA); more than 25 years of experience in risk assessment, database management, and hazardous materials management
Grace Chen, P.E.	Project Engineer	CDM Smith	Perform FFS	M.S. and B.S., Environmental Engineering; 16 years of experience

QAPP Worksheet #7
Personnel Responsibilities and Qualifications Table

Name	Title	Organization	Responsibilities	Education and Experience Qualifications
Cherie Zakowski	Project Chemist	CDM Smith	Evaluate laboratory data	B.S., Biology; B.S., Environmental Studies and Human Ecology; M.S., Environmental Sciences (Toxicology); over 25 years of experience in laboratory practices
Kristine Molloy	Data Validator	CDM Smith	Perform chemical data validation	B.S., Toxicology; 14 years of experience performing data validation and assessment of the overall quality of data and report preparation
Vanessa Macwan	ASC	CDM Smith	Communicate with subcontract laboratories; coordinate validation and review of data packages	B.S., Environmental Science; B.S., Environmental Engineering Technologies; 10 years of experience as an environmental scientist
Christine Julias, P.E.	Database Manager	CDM Smith	Oversee data management; coordinate with data coordinators and validation staff	B.S., Chemical Engineering; Master of Business Administration (M.B.A.), Marketing Management; 10 years of experience in database management
Shawn Oliveira, CIH, CSP	HSM	CDM Smith	Oversee adherence to H&S requirements	B.S., Chemistry; M.S., Environmental Engineering; CSP (#18988); CIH from the American Board of Industrial Hygiene; 17 years of experience in industrial hygiene and occupational safety
Jeniffer Oxford, CHMM	RQAS	CDM Smith	Oversee adherence to QA requirements	B.S., Natural Sciences; 8 years of experience in analytical chemistry; 16 years of experience in environmental science
David Lawrence	Health Physicist	GED	Provide guidance for radiological safety and field measurement	B.S., Math and Computer Sciences; Certified Radon Measurement Technician; over 25 years of experience in environmental management and radiation protection surveillance activities
Brian Tucker, Ph.D., CHMM	Data Validator	GED	Perform radiological data validation	B.S., Chemistry; Ph.D., Analytical Chemistry; over 23 years of experience in chemical and radiological remediation; subject matter expert in environmental sampling and testing for chemical and radiological parameters and QA/QC
TBD	Radiological technicians	GED	Assist in performing field radiological measurements	TBD

Note: An individual can fill as many roles as for which he or she is qualified.

QAPP Worksheet #8
Special Personnel Training Requirements Table

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
All personnel whose work will bring them into contact with radiologically contaminated materials or expose them to airborne radiological contaminants will receive radiological safety awareness training. Training requirements are described in detail in the site-specific health and safety plan (HASP) (CDM Smith 2015b). Tasks requiring specialized skills and training, such as drilling, surveying, and well installation, will be performed by qualified subcontractors. Training, certification, and permit requirements will be outlined in separate scopes of work for each task. Résumés and training documentation are maintained by CDM Smith and will be provided upon request. Activities requiring special technical training will be performed by a subcontractor procedure in accordance with the Federal Acquisition Regulation (FAR).						

QAPP Worksheet #9
Project Scoping Session Summary

Projected Date(s) of Sampling: 5/8/15 to 10/13/15 **Site Manager:** Muzaffar Rahmani	**Site Name:** Wolff-Alport Chemical Company Site **Site Location:** Ridgewood, Queens County, New York **Operable Unit**: NA

Date of Session: July 24, 2014

Scoping Session Purpose: The purpose of the Technical Scoping Meeting was to: (1) provide an overview of the site background; (2) discuss existing data and data gaps; (3) present the technical approach to the RI; (4) discuss applicable or relevant and appropriate requirements (ARARs) for the RI; and (5) confirm the path forward. A summary of topics discussed and action items generated during the Technical Scoping Meeting can be found in the meeting minutes provided to EPA on August 7, 2014.

Participants:

Name	Affiliation	Phone #	Email Address	Project Role
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Oleg Povetko	EPA	(212) 637-3746	povetko.oleg@epa.gov	Health Physicist
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Kershu Tan	CDM Smith	(732) 590-4692	tank@cdmsmith.com	Senior Engineer
Muzaffar Rahmani	CDM Smith	(732) 590-4727	rahmanima@cdmsmith.com	SM
Joe Button	CDM Smith	(212) 377-4389	buttonjs@cdmsmith.com	RI Task Manager
Peter Collopy	CDM Smith	(518) 859-1944	collopyp@cdmsmith.com	Senior Health Physicist
James LaVelle	CDM Smith	(602) 281-7844	lavellejm@cdmsmith.com	Senior Risk Assessor

QAPP Worksheet #10
Problem Definition

Background

The WACC site is located at 1125 to 1139 Irving Avenue and 1514 Cooper Avenue in Ridgewood, Queens County, New York, at the county border with Brooklyn (**Figure 1** and **Figure 2**). The site includes these properties as well as properties outside these boundaries where contaminants may have migrated or threaten to migrate. Onsite soils are contaminated with Th-232 and U-238, including their decay chain progeny.

Problem Summary

Residual Th-232, U-238, and their decay chain progeny in soils, building materials, and the sewer system represent a radiological exposure risk from multiple pathways. These pathways are direct exposure from gamma radiation, inhalation and ingestion of radiologically contaminated particulates when soils or building materials are disturbed, and inhalation of radon and radon progeny particulates in those locations where radon gas diffuses into occupied building air spaces at levels greater than normal background concentrations. Radiological surveys by New York City, state, and federal agencies have identified radioactivity above background levels within portions of subject property buildings, in soils beneath and around the former WACC facility and adjacent buildings, and above adjacent sidewalks, streets, and sewers.

Because of the higher than normal Th-232 and U-238 concentrations in soils at the WACC property, exposure rates sufficient to trigger response actions to minimize public exposure have already been established for the site. Elevated levels of radiation exceeding these exposure rates were detected along Irving Avenue, including areas occupied and transited by workers and members of the public. Concentrations of Th-232, U-238, and their decay chain progeny in soil are several orders of magnitude above background. Thoron has been detected in air at concentrations approximately 10 times above background at selected locations within site buildings. Several state- and city-sponsored surveys have indicated that there are contaminants located within and under the sewer systems adjacent to the facility.

While numerous radiological surveys have been conducted, additional radiological survey information is needed to close data gaps and reduce the uncertainty related to performing an HHRA. These additional data will be used along with the previous survey data to develop an FFS and plans for future site remediation, including projected costs.

Land Use

The neighborhoods surrounding the property contain light industry, commercial businesses, and residences. The sidewalk and street along Irving Avenue are typically filled with vehicles being serviced by the businesses at the property. The intersection of Irving Avenue and Moffat Street (i.e., the southern corner of the subject property) is an active area for trailer parking and unloading. There are three currently

QAPP Worksheet #10
Problem Definition

unoccupied apartments over the delicatessen/grocery, and other housing begins across the street on both Cooper and Irving Avenues. There are indications that former warehouses on Moffat Street, in close proximity to the site, are now used for residential purposes. The residential area is densely populated and contains multi-family homes and apartments; a daycare facility and public elementary school are located 900 feet to the southwest. An active rail line passes within 125 feet southeast of the subject property, and the Cemetery of the Evergreens is present to the east and south on the opposite side of the active rail line.

QAPP Worksheet #11
Project Data Quality Objectives

DQOs are developed using the seven-step EPA DQO process (EPA 2006) to specify the type, quantity, and quality of data needed to answer specific environmental questions and meet project objectives. The objectives for the WACC site include decisions based on quantitative data.

DQOs were developed to provide the basis for the sampling and data collection activities outlined in this QAPP. The data will be used for the following purposes:

- Background soil data will be used to establish a range of background values for radiological, organic, and inorganic contaminants in the area
- Gamma walkover surveys of selected interior and exterior surfaces will be performed to fill data gaps in the studies performed between 2009 and 2014
- Soil samples will be analyzed to supplement previously collected data to characterize the nature and extent of contaminants on site and for use in the HHRA
- Building materials surveys will be performed to determine whether radioactive materials have become embedded in the building materials and to determine the likely presence of other hazardous building materials (e.g. asbestos, lead-based paint, or polychlorinated biphenyls [PCBs])
- A sewer investigation will be performed to determine the extent of the impact of historical discharge of radiological material
- Gamma exposure rate confirmation readings will be used to determine the accuracy of existing dose rate data
- A school and daycare investigation (soil borings and radon/thoron survey) will be performed to validate and augment data collected in the surveys performed between 2009 and 2014
- Groundwater sampling data will be used to determine the levels of radiological and chemical contamination in site groundwater, as groundwater data for the site currently do not exist
- Sediment sampling data will be used to investigate the presence of site-related radiological contaminants in Newtown Creek sediments, as radionuclide data for Newtown Creek sediments currently do not exist

QAPP Worksheet #11
Project Data Quality Objectives

Step 1: State the Problem

The WACC site has a history of radioactive material use between approximately 1940 and 1954. Monazite sand was used to extract certain rare earth elements. Thorium-containing sand was shipped to the site, treated on the premises, and disposed of in the sewer and possibly by burial on site. Site surveys performed between 2009 and 2014 indicated the presence of radiological contaminants in the soils (both on and off site), under the buildings, and in the sewer systems discharging from the facility. Building materials, such as the interior brick walls and the roof membrane, may also be contaminated, although the surveys did not provide a positive detection. In addition, there is concern that radon levels in the building and at an offsite daycare and school may exceed acceptable guidelines. The RI/FS will supplement the surveys previously performed at the site to fill data gaps and complete characterization of the site.

Step 2: Identify the Goals of the Study

The purpose of this QAPP is to guide the collection and analysis of samples in order to obtain data of sufficient quality and quantity to be used in conjunction with the 2009 through 2014 survey data for:

- fully characterizing the site and surrounding environs
- performing a human health and ecological risk assessment
- developing remedial action recommendations, including costs for each alternative

The principal study questions are:

- What is the lateral and vertical extent of the radiological contamination? How much and what types of additional data are needed to characterize the lateral and vertical extent of contamination?
- Has groundwater been impacted by contaminant migration? If yes, to what extent?
- Are there a sufficient number of gamma radiation exposure rate measurements to properly identify impacted areas?
- What is the extent of contamination in the interior of the sewer system that received discharge water from the site?

QAPP Worksheet #11
Project Data Quality Objectives

- Are there sources of soil contamination external to the sewer system that contribute to the previously identified high exposure rates within the sewers?
- Is radon impacting the site building interiors and the local daycare center and school?
- Are other non-radiological contaminants of concern present at the site?

The following decision statements were identified:

- If surveyed buildings, building materials, land areas, and subsurface soil concentrations exceed background concentrations or exposure rates by more than the applicable project action limit (PAL) of 5 pCi/g for Th-232 and radium-226 (Ra-226) combined, then those areas will be considered radiologically contaminated and included in the FFS.
- If radon/thoron levels inside the buildings exceed area background concentrations by levels greater than the typical temporal variation in the area, then those areas will be considered radiologically contaminated and included in the FFS. The typical temporal variation will be determined based on the radon levels measured in the daycare center and school using charcoal canisters and alpha track detectors (ATDs), as described in Worksheet #17i.
- If groundwater, soil, or sediment contaminant concentrations exceed applicable EPA criteria, then the groundwater/soil will be considered contaminated and included in the FS.

Step 3: Identify Information Inputs
This QAPP identifies all necessary analyses, media types, and sample locations to meet the needs and scope of the RI/FS. Additional details are included in Worksheet #17 and the Final Work Plan, Volume 1 (CDM Smith 2014). Sources of secondary project data include the four survey studies performed between 2009 and 2014, identified on Worksheet #13.

The field surveys to be conducted will utilize methodology recommended in MARSSIM (EPA et al. 2000) to the extent practical. This includes adherence to scanning rates needed for minimum detectable concentrations (MDCs) specified in this QAPP. Laboratory sample analysis consists of two phases. All samples will be analyzed in a field laboratory using the CANBERRA In Situ Object Counting System (ISOCS™).

QAPP Worksheet #11
Project Data Quality Objectives

The ISOCS™ is a portable high purity germanium (HPGe) gamma spectroscopy system capable of identifying specific gamma-emitting radionuclides at the concentrations needed for decision-making according to this QAPP. Ten percent of the ISOCS™-analyzed samples will be randomly selected and sent to an independent subcontract laboratory certified for radiological analysis. Results of the laboratory analysis will be used to validate the ISOCS™ field analysis results. Results that differ from the ISOCS™ results by more than 20% will be investigated to determine whether reanalysis or resampling is needed to accurately assess the level of contamination.

Radon and exposure rate measurements will be performed using commercially available instrumentation calibrated for the energies and types of radionuclides to be identified and quantified. For radon measurements made in the daycare center and elementary school, commercially available and certified charcoal canisters or ATDs will be used to determine concentrations and temporal variation.

In general, surveys and measurements will be performed for the following areas and media:

- Gamma exposure rate measurements inside and outside buildings, both on and off site
- Interior and exterior bulk building material sample collection and subsequent gamma analysis
- Onsite and offsite surface and subsurface soil samples
- Subsurface soil samples inside buildings
- Subsurface surveys (downhole gamma)
- Radon/thoron surveys inside buildings
- Internal surveys, gamma exposure/count rate measurements, and media samples of the sewers within an eight-block area of the site
- Groundwater sampling after monitoring well installation
- Sediment sampling at the final sewer system discharge location and background locations

QAPP Worksheet #11
Project Data Quality Objectives

The locations, numbers, and types of samples and surveys are specified in Worksheet #17 of this QAPP. The following site characteristics must be determined in order to resolve applicable decision statements:

- Concentrations of residual radioactive material, non-radiological contaminants, and gamma exposure rates will be used to determine whether an area or material exceeds the PAL for that contaminant. Obtaining these data will aid in determining the extent of the impacted areas, the impact on human health and ecological risk, and the remedial action remedies and costs.
- Concentrations of radon/thoron in indoor air will be used to determine whether a potential human health risk exists for occupants of the buildings.
- If exceedances of the applicable EPA criteria are identified in site groundwater for radiological and/or non-radiological contaminants, further evaluation to determine source location, transport, and human/ecological exposure impacts will be made.

Step 4: Define the Boundaries of the Study

The data of interest include the gamma radiation measurements inside and outside the buildings at the site; concentrations of Th-232 in surface and subsurface soil samples; concentrations of non-radiological contaminants in soil and groundwater; downhole gamma survey measurements; levels of alpha contamination on surfaces in the buildings; and radon and thoron concentrations inside buildings. These data will be further subdivided into survey areas.

Spatial and temporal boundaries of the study are as follows:

- The areal limits of the WACC site are shown in **Figure 2**.
- Sampling depths, defining the vertical limits of the study, are outlined in **Table 1**.
- The proposed project schedule is shown in **Figure 3**. Data collection and analysis for radon and groundwater measurements must be performed over a 6- to 9-month period to ensure temporal variability is captured. All other measurements are not time-dependent.
- Proposed sampling locations are described in Worksheet #17 and shown in **Figures 4** through **11**.

QAPP Worksheet #11
Project Data Quality Objectives

Constraints on data collection include the continued occupancy and use of some of the buildings for business purposes. Surveys in the streets will require traffic control. Subsurface surveys will be limited to locations free of utilities and other major obstructions. Constraints on data surveys in the yard area also exist (e.g. overgrown weeds and trees); the land will be cleared prior to survey performance.

Step 5: Develop the Analytic Approach

Applicable radiological measurements taken during sample collection, field surveys, and laboratory measurements will be consistent with guidance found in MARSSIM (EPA et al. 2000) and MARLAP (EPA et al. 2004). Non-radiological measurements will meet the requirements specified in Worksheets #13 and #17. Sampling and analysis tasks are outlined in Worksheet #14/Figure 3. EPA's FASTAC policy for obtaining laboratory resources will be utilized for all sampling events; however, due to the presence of radioactive contamination, all samples will be analyzed by a subcontract laboratory. Sample results will be compared to the measurement performance criteria (MPCs) of each DQI, outlined in Worksheet #12, to determine data quality and whether sample results are acceptable based on the established DQOs. To verify that MPCs are met, all data will be subject to validation and the outputs used to perform a data usability assessment. Definitive-level data are required for full validation. CDM Smith will perform technical review and evaluation of the analytical data and reports in order to conduct a data quality assessment for the RI data.

Step 6: Specify Performance or Acceptance Criteria

Sample results will be evaluated against the PALs using the data quality indicators (DQIs) listed on Worksheets #12 and #28. The PALs, quantitation limits (QLs), MDCs, and detection limits (DLs) are specified on Worksheet #15. Analytical data will be compared to these limits. Data must meet the DQOs specified for the site. Laboratory RLs must be less than or equal to the project quantitation limit goals (PQLGs) or the PALs. As outlined in Worksheet #15, the following PALs will be used to make decisions based on the results of this study:

- Soil or building material concentrations greater than 5 pCi/g above background for Ra-226 and Th-232 combined
- Groundwater concentrations that exceed the EPA maximum contaminant level (MCL) of 5 pCi/L for radium and/or 15 pCi/L for thorium (via gross alpha)
- Sediment concentrations greater than 5 pCi/g above background for Ra-226 and Th-232 combined
- Dose rate measurements that exceed the 95% upper confidence limit (UCL) of the area background dose rates
- Radon measurements that exceed the 95% UCL of the area background concentrations

QAPP Worksheet #11
Project Data Quality Objectives

Step 7: Develop the Plan for Obtaining Data

Field sampling procedures are described in Worksheet #17, the GED Survey Procedures Manual (**Appendix C**), and CDM Smith's Technical Standard Operating Procedures (TSOPs), which are listed on Worksheet #21 and included in **Appendix A**. Field forms provided by GED are included in **Appendix B**. CDM Smith will be responsible for all sample collection, shipment, and management. CDM Smith will prepare, package, and ship the samples to the subcontract laboratory. CDM Smith's subcontract laboratory will generate the data.

Data reporting procedures include the following:

- Sampling data will be emailed to CDM Smith by CDM Smith's subcontract laboratory.
- Data validation will be performed by GED for radiological data and by CDM Smith for chemical data. Following validation, the EDDs will be updated with any data qualifiers.
- Following completion of laboratory analyses, receipt of all data, and completion of data validation, CDM Smith will conduct a data usability assessment, which will be performed to evaluate achievement of the project DQOs. The results of the data usability assessment, including a discussion of the data quality, will be included in the Data Evaluation Report (DER).

Data archiving procedures include the following:

- Electronic data will be input into the project's Environmental Quality Information System (EQuIS™) database.
- Hard copies of field data, including field logs, will be archived in the project files.
- Hard copies of analytical data will be archived in the project files and maintained for the period specified in the contact.

The variability of the data will have an effect on the sampling design. If necessary, the sampling frequency and analytical procedures will be modified to optimize the sampling design. Changes will occur concurrently for several steps within the DQO process. The design options, such as sample collection procedure, sample size, and analytical procedure, will be evaluated based on their ability to meet the DQOs. The proposed numbers of measurements and samples are provided in Worksheet #17.

QAPP Worksheet #12
Measurement Performance Criteria

The following worksheets from CDM Smith's Generic QAPP (CDM Smith 2013) are applicable to this project:

- Worksheet #12ar – Target Compound List (TCL) volatile organic compounds (VOCs) in solid samples by EPA 8260
- Worksheet #12g – TCL VOCs in aqueous samples by EPA 8260
- Worksheet #12au – TCL semivolatile organic compounds (SVOCs) in solid samples by EPA 8270
- Worksheet #12j – TCL SVOCs in aqueous samples by EPA 8270
- Worksheet #12ay – TCL pesticides/PCBs in solid samples by EPA 8081/8082
- Worksheet #12n – TCL pesticides/PCBs in aqueous samples by EPA 8081/8082
- Worksheet #12bf – Target Analyte List (TAL) metals in solid samples by EPA 6010
- Worksheet #12v – TAL metals in aqueous samples by EPA 6010

In addition, the following worksheets are included in this QAPP:

- Worksheet #12-1 – Field analysis of solid samples for Th-232 and Ra-226 using ISOCS™
- Worksheet #12-2 – Gamma spectroscopy for solid samples by EPA 901.1M
- Worksheet #12-3 – Gamma spectroscopy for aqueous samples by EPA 901.1
- Worksheet #12-4 – Radon/thoron in air samples using ATDs and charcoal canisters
- Worksheet #12-5 – Isotopic uranium in solid samples by inductively coupled plasma mass spectrometry (ICP-MS) (SW846 6020A) or HASL 300
- Worksheet #12-6 – Isotopic thorium in solid samples by alpha spectroscopy (HASL 300 A-01-R)

Note: Information labeled "TBD" in the following worksheets will be provided upon procurement of a subcontract laboratory. Due to the presence of radioactive contamination, all samples to be collected under the RI/FS will be analyzed by a subcontract laboratory.

QAPP Worksheet #12-1
Measurement Performance Criteria Table

Matrix: Solid
Analytical Group/Method: ISOCS™
Concentration Level: Low

DQI	QC Sample or Measurement Performance Activity	Frequency	MPC
Accuracy	QC replicate count	10% of field measurement locations	| Normalized Difference | < 1.96

QAPP Worksheet #12-2
Measurement Performance Criteria Table

Matrix: Solid
Analytical Group/Method: Gamma spectroscopy/EPA 901.1M
Concentration Level: Low

DQI	QC Sample or Measurement Performance Activity	Frequency	MPC
Accuracy/Bias	Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	No radionuclides detected above the target MDC
Accuracy	Laboratory Control Sample (LCS)		Acceptable recoveries as shown in Worksheet #28-2 for acceptance limits.
Precision	Laboratory Sample Duplicate		| Normalized Difference | < 1.96

QAPP Worksheet #12-3
Measurement Performance Criteria Table

Matrix: Aqueous
Analytical Group/Method: Gamma spectroscopy/EPA 901.1
Concentration Level: Low

DQI	QC Sample or Measurement Performance Activity	Frequency	MPC
Accuracy/Bias	Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	No radionuclides detected above the target MDC
Accuracy	LCS		Acceptable recoveries. See Worksheet #28-3 for acceptance limits.
Precision	Laboratory Sample Duplicate		| Normalized Difference | < 1.96

QAPP Worksheet #12-4
Measurement Performance Criteria Table

Matrix: Air
Analytical Group/Method: Radon/thoron – ATDs and charcoal canisters
Concentration Level: Low

DQI	QC Sample or Measurement Performance Activity	Frequency	MPC
Precision	Duplicate (collocated) detectors	10% of the number of ATDs/canisters deployed	RPD ≤ 25%
Precision/Accuracy	Known exposure measurements (spiked samples)	3 per 100 measurements; minimum of 3 per year and maximum of 6 per month	Recovery within 75-125%
Accuracy	Laboratory control detectors	TBD	Recovery within 80-120%

QAPP Worksheet #12-5
Measurement Performance Criteria Table

Matrix: Solid
Analytical Group/Method: Isotopic uranium/ICP-MS – SW846 6020A or HASL 300
Concentration Level: Low

DQI	QC Sample or Measurement Performance Activity	Frequency	MPC
Accuracy/Bias	Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	No radionuclides detected above the target MDC
Accuracy	LCS		Acceptable recoveries. See Worksheet #28-5 for acceptance limits.
Precision/Accuracy	Matrix Spike (MS)/Matrix Spike Duplicate (MSD)		Acceptable recoveries. See Worksheet #28-5 for acceptance limits.

QAPP Worksheet #12-6
Measurement Performance Criteria Table

Matrix: Solid
Analytical Group/Method: Isotopic thorium/alpha spectroscopy – HASL 300 A-01-R
Concentration Level: Low

DQI	QC Sample or Measurement Performance Activity	Frequency	MPC
Accuracy/Bias	Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	No radionuclides detected above the target MDC
Accuracy	LCS		Acceptable recoveries. See Worksheet #28-6 for acceptance limits.
Precision	Laboratory Sample Duplicate		| Normalized Difference | < 1.96
Accuracy/Bias	Chemical Tracer (Thorium-229 [Th-229])	Every sample	Acceptable tracer recovery within 30-110%

QAPP Worksheet #13
Secondary Data Criteria and Limitations Table

Data Type	Data Source	Data Use Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Phase I survey and Phase II TCL/TAL soil sample data	2010 NYCDDC Phase I/Phase II Environmental Site Assessment Reports for the Former Wolff-Alport Chemical Corporation Site (Louis Berger and Associates [LBA] 2010a/b)	Historical data will be used in conjunction with RI data to characterize the nature and extent of contaminants in site soils for use in the risk assessments. Data do not cover the full extent of the potentially impacted areas. The RI will fill these data gaps.	No known quality issues with data. Will be reviewed prior to use in RI and associated risk assessments.
Exterior and interior gamma survey data	2010 NYCDDC Final Draft Radiological Scoping Survey for the Former Wolff-Alport Chemical Corporation Site (LBA 2010c)	Historical gamma survey data will be used in conjunction with RI data to aid in the final dose/risk assessment and ensure that the most accurate data are used in the risk assessment.	Exposure data generated are almost 5 years old. These surveys will be repeated in areas of potential exposure. No known quality issues with data. Will be reviewed prior to use in RI and associated risk assessments.
Radiological measurements of sewer sediments and in-sewer exposure rates	2014 BVNA/NYCDEP Assessment of Potential Radiological Impact Within and Adjacent to Combined Sewer System near the Former Wolff-Alport Chemical Corporation Facility (BVNA 2014)	Historical sewer data will be used in conjunction with RI data to fully characterize the extent of the sewer system impacted by historical discharge of radiological materials.	No known quality issues with data. Will be reviewed prior to use in RI and associated risk assessments.

QAPP Worksheet #13
Secondary Data Criteria and Limitations Table

Data Type	Data Source	Data Use Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Radiological measurements of soils and exposure rates	2014 Multi-Agency Former Wolff Alport Chemical Company Neighborhood Radiological Assessment (New York State Department of Health [NYSDOH] et al. 2014)	Historical data will be used in conjunction with RI data to characterize the nature and extent of contaminants in site soils for use in the risk assessments.	Radiological measurements of soils were limited primarily to shallow soils. Additional data are needed to confirm depth.
Exposure rates both on and off site, radiological soil concentrations both on and off site, and radon concentrations in air for areas exterior to the WACC site	2014 Weston Solutions, Inc./EPA Radiation Assessment and Response Action Report for the Former Wolff-Alport Chemical Company Site (Weston Solutions, Inc. 2014)	Historical data will be used in conjunction with RI data to characterize the nature and extent of contaminants in site soils and air for use in the risk assessments.	None; the data are recent (2013) and can be used to meet the objectives of the RI/FS when combined with additional measurements to be collected in accordance with this QAPP.

QAPP Worksheet #14
Summary of Project Tasks

Refer to **Figure 3** for project tasks and schedule.

QAPP Worksheet #15
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

The following worksheets are included in this QAPP:

- Worksheet #15a – Field analysis of solid samples for Th-232 and Ra-226 using ISOCS™
- Worksheet #15b – Gamma spectroscopy for solid samples by EPA 901.1M
- Worksheet #15c – Gamma spectroscopy for aqueous samples by EPA 901.1
- Worksheet #15d – Radon/thoron in air samples
- Worksheet #15e – Isotopic uranium in solid samples by ICP-MS (SW846 6020A) or HASL 300
- Worksheet #15f – Isotopic thorium in solid samples by alpha spectroscopy (HASL 300 A-01-R)
- Worksheet #15g – TCL VOCs in solid samples by EPA 8260C
- Worksheet #15h – TCL VOCs in aqueous samples by EPA 8260C
- Worksheet #15i – TCL SVOCs in solid samples by EPA 8270D
- Worksheet #15j – TCL SVOCs in aqueous samples by EPA 8270D
- Worksheet #15k – TCL PCBs in solid samples by EPA 8082A
- Worksheet #15l – TCL PCBs in aqueous samples by EPA 8082A
- Worksheet #15m – TCL pesticides in solid samples by EPA 8081B
- Worksheet #15n – TCL pesticides in aqueous samples by EPA 8081B
- Worksheet #15o – TAL metals in solid samples by EPA 6010C
- Worksheet #15p – TAL metals in aqueous samples by EPA 6010C

Note: Information labeled “TBD” in the following worksheets will be provided upon procurement of a subcontract laboratory. Due to the presence of radioactive contamination, all samples to be collected under the RI/FS will be analyzed by a subcontract laboratory. PQLGs will be finalized when laboratory-specific QLs are determined. In cases where the laboratory-specific QL is above the PQLG, lower laboratory limits will only be requested for radiochemical analyses. In cases where the laboratory-specific QL is below the PQLG, the laboratory-specific QL will be requested.

QAPP Worksheet #15a
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: ISOCS™
Concentration Level: Low

Analyte	PAL (pCi/g)	PAL Reference	PQLG (pCi/g)	Laboratory-Specific QL	Laboratory-Specific MDC
Ra-226	5	EPA 1998	2.5	TBD	TBD
Th-232				TBD	TBD

Note: PQLG based on identification of contaminant concentrations that may approach or exceed the EPA health-based standard of 5 pCi/g. PAL of 5 pCi/g is for Ra-226 and Th-232 combined.

QAPP Worksheet #15b
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: EPA 901.1M
Concentration Level: Low (pCi/g)

Analyte	PAL (pCi/g)	PAL Reference	PQLG (pCi/g)	Laboratory-Specific QL	Laboratory-Specific MDC
Ra-226	5	EPA 1998	0.7	TBD	TBD
Th-232			1.0	TBD	TBD

Note: PQGLs are based on background concentrations for the WACC site. PAL of 5 pCi/g is for Ra-226 and Th-232 combined.

QAPP Worksheet #15c
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: EPA 901.1
Concentration Level: Low

Analyte	PAL (pCi/L)	PAL Reference	PQLG (pCi/L)	Laboratory-Specific QL	Laboratory-Specific MDC
Ra-226	5	EPA 1976	1	TBD	TBD
Th-232	15	EPA 1976	1	TBD	TBD

QAPP Worksheet #15d
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Air
Analytical Method: Track Etch/Charcoal Canister/E-PERM®
Concentration Level: Low

Analyte	PAL (pCi/L)	PAL Reference	PQLG (pCi/L)	Laboratory-Specific QL	Laboratory-Specific MDC
Radon	4	EPA 2012	1	N/A	0.5 pCi/L
Thoron	12	Dose equivalent to radon PAL	1	N/A	0.5 pCi/L

QAPP Worksheet #15e
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: ICP-MS – SW846 6020A or HASL 300
Concentration Level: Low

Analyte	PAL (pCi/g)	PAL Reference	PQLG (pCi/g)	Laboratory-Specific QL	Laboratory-Specific MDC
Uranium-234 (U-234)	5	Surrogate for radium (EPA 1998)	0.7	TBD	TBD
Uranium-325 (U-235)			0.07	TBD	TBD
U-238			0.7	TBD	TBD

Note: PQLGs are based on background concentrations for the WACC site. The PAL of 5 pCi/g is for all isotopes combined.

QAPP Worksheet #15f
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: Alpha spectroscopy – HASL 300 A-01-R
Concentration Level: Low

Analyte	PAL (pCi/g)	PAL Reference	PQLG (pCi/g)	Laboratory-Specific QL	Laboratory-Specific MDC
Thorium-228 (Th-228)	5	EPA 1998	1.0	TBD	TBD
Thorium-230 (Th-230)			0.7	TBD	TBD
Th-232			1.0	TBD	TBD

Note: PQLGs are based on background concentrations for the WACC site. The PAL of 5 pCi/g is for all isotopes combined.

QAPP Worksheet #15g
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL VOCs – EPA 8260C
Concentration Level: Trace (milligram per kilogram [mg/kg])

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
1,1,1-Trichloroethane	810	EPA 2015	100	TBD	TBD
1,1,2,2-Tetrachloroethane	0.6	EPA 2015	0.1	TBD	TBD
1,1,2-Trichloro-1,2,2-trifluoroethane	4,000	EPA 2015	1,000	TBD	TBD
1,1,2-Trichloroethane	0.15	EPA 2015	0.075	TBD	TBD
1,1-Dichloroethane	3.6	EPA 2015	1	TBD	TBD
1,1-Dichloroethene	23	EPA 2015	10	TBD	TBD
1,2,3-Trichlorobenzene	4.9	EPA 2015	1	TBD	TBD
1,2,4-Trichlorobenzene	5.8	EPA 2015	1	TBD	TBD
1,2-Dibromo-3-chloropropane	0.0053	EPA 2015	0.005	TBD	TBD
1,2-Dibromoethane	0.036	EPA 2015	0.01	TBD	TBD
1,2-Dichlorobenzene	180	EPA 2015	10	TBD	TBD
1,2-Dichloroethane	0.46	EPA 2015	0.1	TBD	TBD
1,2-Dichloropropane	1	EPA 2015	0.5	TBD	TBD
1,3-Dichlorobenzene	NA	EPA 2015	NA	TBD	TBD
1,4-Dichlorobenzene	2.6	EPA 2015	1	TBD	TBD
1,4-Dioxane	5.3	EPA 2015	1	TBD	TBD
2-Butanone	2,700	EPA 2015	1,000	TBD	TBD
2-Hexanone	20	EPA 2015	1	TBD	TBD
4-Methyl-2-pentanone	530	EPA 2015	100	TBD	TBD
Acetone	6,100	EPA 2015	1,000	TBD	TBD
Benzene	1.2	EPA 2015	0.1	TBD	TBD
Bromochloromethane	15	EPA 2015	1	TBD	TBD
Bromodichloromethane	0.29	EPA 2015	0.1	TBD	TBD

QAPP Worksheet #15g

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL VOCs – EPA 8260C
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
Bromoform	67	EPA 2015	10	TBD	TBD
Bromomethane	0.68	EPA 2015	0.25	TBD	TBD
Carbon disulfide	77	EPA 2015	10	TBD	TBD
Carbon tetrachloride	0.65	EPA 2015	0.25	TBD	TBD
Chlorobenzene	28	EPA 2015	10	TBD	TBD
Chloroethane	1,400	EPA 2015	100	TBD	TBD
Chloroform	0.32	EPA 2015	0.1	TBD	TBD
Chloromethane	11	EPA 2015	1	TBD	TBD
cis-1,2-Dichloroethene	16	EPA 2015	1	TBD	TBD
cis-1,3-Dichloropropene[1]	1.8	EPA 2015	1	TBD	TBD
Cyclohexane	650	EPA 2015	100	TBD	TBD
Dibromochloromethane	0.73	EPA 2015	0.25	TBD	TBD
Dichlorodifluoromethane	8.7	EPA 2015	1	TBD	TBD
Ethylbenzene	5.8	EPA 2015	1	TBD	TBD
Isopropylbenzene	190	EPA 2015	10	TBD	TBD
m,p-Xylene[2]	58	EPA 2015	10	TBD	TBD
Methyl acetate	7,800	EPA 2015	1,000	TBD	TBD
Methyl tert-butyl ether	47	EPA 2015	10	TBD	TBD
Methylcyclohexane	NA	EPA 2015	NA	TBD	TBD
Methylene chloride	35	EPA 2015	10	TBD	TBD
o-Xylene	65	EPA 2015	10	TBD	TBD
Styrene	600	EPA 2015	100	TBD	TBD
Tetrachloroethene	8.1	EPA 2015	0.25	TBD	TBD

QAPP Worksheet #15g

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL VOCs – EPA 8260C
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
Toluene	490	EPA 2015	100	TBD	TBD
trans-1,2-Dichloroethene	160	EPA 2015	10	TBD	TBD
trans-1,3-Dichloropropene[1]	1.8	EPA 2015	1	TBD	TBD
Trichloroethene	0.41	EPA 2015	0.25	TBD	TBD
Trichlorofluoromethane	73	EPA 2015	1	TBD	TBD
Vinyl chloride	0.059	EPA 2015	0.005	TBD	TBD

[1]The PAL for cis- and trans-1,3-dichloropropene is the EPA regional screening level (RSL) for 1,3-dichloropropene as there are no RSLs for these compounds individually.

[2]The PAL for m,p-xylene is the EPA RSL for xylenes as there is no RSL for m,p-xylene alone.

QAPP Worksheet #15h

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL VOCs – EPA 8260C
Concentration Level: Trace (microgram per liter [µg/L])

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
1,1,1-Trichloroethane[1]	200	EPA 2015	100	TBD	TBD
1,1,2,2-Tetrachloroethane	0.076	EPA 2015	0.076	TBD	TBD
1,1,2-Trichloro-1,2,2-trifluoroethane	5,500	EPA 2015	1,000	TBD	TBD
1,1,2-Trichloroethane	0.041	EPA 2015	0.041	TBD	TBD
1,1-Dichloroethane	2.7	EPA 2015	0.5	TBD	TBD
1,1-Dichloroethene[1]	7	EPA 2015	1	TBD	TBD
1,2,3-Trichlorobenzene	0.7	EPA 2015	0.5	TBD	TBD
1,2,4-Trichlorobenzene	0.4	EPA 2015	0.4	TBD	TBD
1,2-Dibromo-3-chloropropane	0.00033	EPA 2015	0.00033	TBD	TBD
1,2-Dibromoethane	0.0075	EPA 2015	0.0075	TBD	TBD
1,2-Dichlorobenzene	30	EPA 2015	10	TBD	TBD
1,2-Dichloroethane	0.17	EPA 2015	0.17	TBD	TBD
1,2-Dichloropropane	0.44	EPA 2015	0.44	TBD	TBD
1,3-Dichlorobenzene	NA	EPA 2015	NA	TBD	TBD
1,4-Dichlorobenzene	0.48	EPA 2015	0.48	TBD	TBD
1,4-Dioxane	0.78	EPA 2015	0.78	TBD	TBD
2-Butanone	560	EPA 2015	100	TBD	TBD
2-Hexanone	3.8	EPA 2015	3.8	TBD	TBD
4-Methyl-2-pentanone	120	EPA 2015	10	TBD	TBD
Acetone	1,400	EPA 2015	100	TBD	TBD
Benzene	0.45	EPA 2015	0.45	TBD	TBD
Bromochloromethane	8.3	EPA 2015	1	TBD	TBD
Bromodichloromethane	0.13	EPA 2015	0.13	TBD	TBD

QAPP Worksheet #15h

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL VOCs – EPA 8260C
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
Bromoform	9.2	EPA 2015	1	TBD	TBD
Bromomethane	0.75	EPA 2015	0.5	TBD	TBD
Carbon disulfide	81	EPA 2015	10	TBD	TBD
Carbon tetrachloride	0.45	EPA 2015	0.45	TBD	TBD
Chlorobenzene	7.8	EPA 2015	1	TBD	TBD
Chloroethane	2,100	EPA 2015	1,000	TBD	TBD
Chloroform	0.22	EPA 2015	0.22	TBD	TBD
Chloromethane	19	EPA 2015	1	TBD	TBD
cis-1,2-Dichloroethene	3.6	EPA 2015	1	TBD	TBD
cis-1,3-Dichloropropene[2]	0.47	EPA 2015	0.47	TBD	TBD
Cyclohexane	1,300	EPA 2015	100	TBD	TBD
Dibromochloromethane	0.17	EPA 2015	0.17	TBD	TBD
Dichlorodifluoromethane	20	EPA 2015	1	TBD	TBD
Ethylbenzene	1.5	EPA 2015	0.5	TBD	TBD
Isopropylbenzene	45	EPA 2015	10	TBD	TBD
m,p-Xylene	19	EPA 2015	1	TBD	TBD
Methyl acetate	2,000	EPA 2015	100	TBD	TBD
Methyl tert-butyl ether	14	EPA 2015	1	TBD	TBD
Methylcyclohexane	NA	EPA 2015	NA	TBD	TBD
Methylene chloride[1]	5	EPA 2015	1	TBD	TBD
o-Xylene	19	EPA 2015	1	TBD	TBD
Styrene[1]	100	EPA 2015	10	TBD	TBD
Tetrachloroethene	4.1	EPA 2015	0.5	TBD	TBD

QAPP Worksheet #15h

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL VOCs – EPA 8260C
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
Toluene	110	EPA 2015	10	TBD	TBD
trans-1,2-Dichloroethene	36	EPA 2015	1	TBD	TBD
trans-1,3-Dichloropropene[2]	0.47	EPA 2015	0.47	TBD	TBD
Trichloroethene	0.28	EPA 2015	0.28	TBD	TBD
Trichlorofluoromethane	110	EPA 2015	10	TBD	TBD
Vinyl chloride	0.019	EPA 2015	0.019	TBD	TBD

[1]The PALs for these compounds are the EPA MCLs as they are lower than the tap water RSLs.
[2]The PAL for cis- and trans-1,3-dichloropropene is the EPA RSL for 1,3-dichloropropene.

QAPP Worksheet #15i
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL SVOCs – EPA 8270D
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
1,1'-Biphenyl	4.7	EPA 2015	1	TBD	TBD
1,2,4,5-Tetrachlorobenzene	1.8	EPA 2015	1	TBD	TBD
1,4-Dioxane	5.3	EPA 2015	1	TBD	TBD
2,2'-Oxybis (1-chloropropane)	4.9	EPA 2015	1	TBD	TBD
2,3,4,6-Tetrachlorophenol	180	EPA 2015	10	TBD	TBD
2,4,5-Trichlorophenol	620	EPA 2015	100	TBD	TBD
2,4,6-Trichlorophenol	6.2	EPA 2015	1	TBD	TBD
2,4-Dichlorophenol	18	EPA 2015	1	TBD	TBD
2,4-Dimethylphenol	120	EPA 2015	10	TBD	TBD
2,4-Dinitrophenol	12	EPA 2015	1	TBD	TBD
2,4-Dinitrotoluene	1.7	EPA 2015	1	TBD	TBD
2,6-Dinitrotoluene	0.36	EPA 2015	0.17	TBD	TBD
2-Chloronaphthalene	630	EPA 2015	100	TBD	TBD
2-Chlorophenol	39	EPA 2015	10	TBD	TBD
2-Methylnaphthalene	23	EPA 2015	10	TBD	TBD
2-Methylphenol	310	EPA 2015	100	TBD	TBD
2-Nitroaniline	61	EPA 2015	10	TBD	TBD
2-Nitrophenol	NA	EPA 2015	NA	TBD	TBD
3,3'-Dichlorobenzidine	1.2	EPA 2015	0.4	TBD	TBD
3-Nitroaniline	NA	EPA 2015	NA	TBD	TBD
4,6-Dinitro-2-methylphenol	0.49	EPA 2015	0.49	TBD	TBD
4-Bromophenyl-phenylether	NA	EPA 2015	NA	TBD	TBD
4-Chloro-3-methylphenol	620	EPA 2015	100	TBD	TBD

QAPP Worksheet #15i
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL SVOCs – EPA 8270D
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
4-Chloroaniline	2.7	EPA 2015	1	TBD	TBD
4-Chlorophenyl-phenyl ether	NA	EPA 2015	NA	TBD	TBD
4-Methylphenol	620	EPA 2015	100	TBD	TBD
4-Nitroaniline	25	EPA 2015	10	TBD	TBD
4-Nitrophenol	NA	EPA 2015	NA	TBD	TBD
Acenaphthene	350	EPA 2015	100	TBD	TBD
Acenaphthylene	NA	EPA 2015	NA	TBD	TBD
Acetophenone	780	EPA 2015	100	TBD	TBD
Anthracene	1,700	EPA 2015	100	TBD	TBD
Atrazine	2.3	EPA 2015	1	TBD	TBD
Benzaldehyde	780	EPA 2015	100	TBD	TBD
Benzo(a) anthracene	0.15	EPA 2015	0.15	TBD	TBD
Benzo(a) pyrene	0.015	EPA 2015	0.015	TBD	TBD
Benzo(b) fluoranthene	0.15	EPA 2015	0.15	TBD	TBD
Benzo(g,h,i) perylene	NA	EPA 2015	NA	TBD	TBD
Benzo(k) fluoranthene	1.5	EPA 2015	0.2	TBD	TBD
Bis(2-chloroethoxy) methane	18	EPA 2015	1	TBD	TBD
Bis(2-chloroethyl) ether	0.23	EPA 2015	0.17	TBD	TBD
Bis(2-ethylhexyl) phthalate	38	EPA 2015	1	TBD	TBD
Butylbenzylphthalate	280	EPA 2015	100	TBD	TBD
Caprolactam	3,100	EPA 2015	100	TBD	TBD
Carbazole	NA	EPA 2015	NA	TBD	TBD
Chrysene	15	EPA 2015	1	TBD	TBD

QAPP Worksheet #15i
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL SVOCs – EPA 8270D
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
Dibenzo(a,h) anthracene	0.015	EPA 2015	0.015	TBD	TBD
Dibenzofuran	7.2	EPA 2015	7.2	TBD	TBD
Diethylphthalate	4,900	EPA 2015	1,000	TBD	TBD
Dimethylphthalate	NA	EPA 2015	NA	TBD	TBD
Di-n-butylphthalate	620	EPA 2015	100	TBD	TBD
Di-n-octylphthalate	62	EPA 2015	10	TBD	TBD
Fluoranthene	230	EPA 2015	100	TBD	TBD
Fluorene	230	EPA 2015	100	TBD	TBD
Hexachlorobenzene	0.33	EPA 2015	0.17	TBD	TBD
Hexachlorobutadiene	6.2	EPA 2015	1	TBD	TBD
Hexachlorocyclopentadiene	37	EPA 2015	10	TBD	TBD
Hexachloroethane	4.3	EPA 2015	1	TBD	TBD
Indeno(1,2,3-cd) pyrene	0.15	EPA 2015	0.10	TBD	TBD
Isophorone	560	EPA 2015	100	TBD	TBD
Naphthalene	3.8	EPA 2015	1	TBD	TBD
Nitrobenzene	5.1	EPA 2015	1	TBD	TBD
N-Nitroso-di-n-propylamine	0.076	EPA 2015	0.076	TBD	TBD
N-Nitrosodiphenylamine	110	EPA 2015	10	TBD	TBD
Pentachlorophenol	0.99	EPA 2015	0.33	TBD	TBD
Phenanthrene	NA	EPA 2015	NA	TBD	TBD
Phenol	1,800	EPA 2015	100	TBD	TBD
Pyrene	170	EPA 2015	10	TBD	TBD

QAPP Worksheet #15j
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL SVOCs – EPA 8270D
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
1,1'-Biphenyl	0.083	EPA 2015	0.083	TBD	TBD
1,2,4,5-Tetrachlorobenzene	0.17	EPA 2015	0.17	TBD	TBD
1,4-Dioxane	0.78	EPA 2015	0.78	TBD	TBD
2,2'-Oxybis (1-chloropropane)	0.36	EPA 2015	0.36	TBD	TBD
2,3,4,6-Tetrachlorophenol	24	EPA 2015	24	TBD	TBD
2,4,5-Trichlorophenol	120	EPA 2015	33	TBD	TBD
2,4,6-Trichlorophenol	1.2	EPA 2015	1.2	TBD	TBD
2,4-Dichlorophenol	4.6	EPA 2015	4.6	TBD	TBD
2,4-Dimethylphenol	36	EPA 2015	17	TBD	TBD
2,4-Dinitrophenol	3.9	EPA 2015	3.9	TBD	TBD
2,4-Dinitrotoluene	0.24	EPA 2015	0.24	TBD	TBD
2,6-Dinitrotoluene	0.048	EPA 2015	0.048	TBD	TBD
2-Chloronaphthalene	75	EPA 2015	33	TBD	TBD
2-Chlorophenol	9.1	EPA 2015	9.1	TBD	TBD
2-Methylnaphthalene	3.6	EPA 2015	3.6	TBD	TBD
2-Methylphenol	93	EPA 2015	33	TBD	TBD
2-Nitroaniline	19	EPA 2015	19	TBD	TBD
2-Nitrophenol	NA	EPA 2015	NA	TBD	TBD
3,3'-Dichlorobenzidine	0.12	EPA 2015	0.12	TBD	TBD
3-Nitroaniline	NA	EPA 2015	NA	TBD	TBD
4,6-Dinitro-2-methylphenol	0.15	EPA 2015	0.15	TBD	TBD
4-Bromophenyl-phenylether	NA	EPA 2015	NA	TBD	TBD
4-Chloro-3-methylphenol	140	EPA 2015	20	TBD	TBD

QAPP Worksheet #15j
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL SVOCs – EPA 8270D
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
4-Chloroaniline	0.36	EPA 2015	0.36	TBD	TBD
4-Chlorophenyl-phenyl ether	NA	EPA 2015	NA	TBD	TBD
4-Methylphenol	190	EPA 2015	33	TBD	TBD
4-Nitroaniline	3.8	EPA 2015	3.8	TBD	TBD
4-Nitrophenol	NA	EPA 2015	NA	TBD	TBD
Acenaphthene	53	EPA 2015	17	TBD	TBD
Acenaphthylene	NA	EPA 2015	NA	TBD	TBD
Acetophenone	190	EPA 2015	17	TBD	TBD
Anthracene	180	EPA 2015	17	TBD	TBD
Atrazine	0.3	EPA 2015	0.3	TBD	TBD
Benzaldehyde	190	EPA 2015	17	TBD	TBD
Benzo(a) anthracene	0.034	EPA 2015	0.034	TBD	TBD
Benzo(a) pyrene	0.0034	EPA 2015	0.0034	TBD	TBD
Benzo(b) fluoranthene	0.034	EPA 2015	0.034	TBD	TBD
Benzo(g,h,i) perylene	NA	EPA 2015	NA	TBD	TBD
Benzo(k) fluoranthene	0.34	EPA 2015	0.34	TBD	TBD
Bis(2-chloroethoxy) methane	5.9	EPA 2015	5.9	TBD	TBD
Bis(2-chloroethyl) ether	0.014	EPA 2015	0.014	TBD	TBD
Bis(2-ethylhexyl) phthalate	5.6	EPA 2015	5.6	TBD	TBD
Butylbenzylphthalate	16	EPA 2015	16	TBD	TBD
Caprolactam	990	EPA 2015	100	TBD	TBD
Carbazole	NA	EPA 2015	NA	TBD	TBD
Chrysene	3.4	EPA 2015	3.4	TBD	TBD

QAPP Worksheet #15j
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL SVOCs – EPA 8270D
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
Dibenzo(a,h) anthracene	0.0034	EPA 2015	0.0034	TBD	TBD
Dibenzofuran	0.79	EPA 2015	0.79	TBD	TBD
Diethylphthalate	1,500	EPA 2015	100	TBD	TBD
Dimethylphthalate	NA	EPA 2015	NA	TBD	TBD
Di-n-butylphthalate	90	EPA 2015	17	TBD	TBD
Di-n-octylphthalate	20	EPA 2015	17	TBD	TBD
Fluoranthene	80	EPA 2015	17	TBD	TBD
Fluorene	29	EPA 2015	17	TBD	TBD
Hexachlorobenzene	0.049	EPA 2015	0.049	TBD	TBD
Hexachlorobutadiene	0.3	EPA 2015	0.3	TBD	TBD
Hexachlorocyclopentadiene	3.1	EPA 2015	3.1	TBD	TBD
Hexachloroethane	0.69	EPA 2015	0.69	TBD	TBD
Indeno(1,2,3-cd) pyrene	0.034	EPA 2015	0.034	TBD	TBD
Isophorone	78	EPA 2015	78	TBD	TBD
Naphthalene	0.17	EPA 2015	0.17	TBD	TBD
Nitrobenzene	0.14	EPA 2015	0.14	TBD	TBD
N-Nitroso-di-n-propylamine	0.011	EPA 2015	0.011	TBD	TBD
N-Nitrosodiphenylamine	12	EPA 2015	12	TBD	TBD
Pentachlorophenol	0.04	EPA 2015	0.04	TBD	TBD
Phenanthrene	NA	EPA 2015	NA	TBD	TBD
Phenol	580	EPA 2015	100	TBD	TBD
Pyrene	12	EPA 2015	10	TBD	TBD

QAPP Worksheet #15k

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL PCBs – EPA 8082A
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
Aroclor-1016	0.4	EPA 2015	0.033	TBD	TBD
Aroclor-1221	0.15	EPA 2015	0.033	TBD	TBD
Aroclor-1232	0.15	EPA 2015	0.033	TBD	TBD
Aroclor-1242	0.24	EPA 2015	0.033	TBD	TBD
Aroclor-1248	0.24	EPA 2015	0.033	TBD	TBD
Aroclor-1254	0.11	EPA 2015	0.033	TBD	TBD
Aroclor-1260	0.24	EPA 2015	0.033	TBD	TBD
Aroclor-1262	NA	EPA 2015	NA	TBD	TBD
Aroclor-1268	NA	EPA 2015	NA	TBD	TBD

QAPP Worksheet #15l

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL PCBs – EPA 8082A
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
Aroclor-1016	0.14	EPA 2015	0.14	TBD	TBD
Aroclor-1221	0.0046	EPA 2015	0.0046	TBD	TBD
Aroclor-1232	0.0046	EPA 2015	0.0046	TBD	TBD
Aroclor-1242	0.039	EPA 2015	0.039	TBD	TBD
Aroclor-1248	0.039	EPA 2015	0.039	TBD	TBD
Aroclor-1254	0.039	EPA 2015	0.039	TBD	TBD
Aroclor-1260	0.039	EPA 2015	0.039	TBD	TBD
Aroclor-1262	NA	EPA 2015	NA	TBD	TBD
Aroclor-1268	NA	EPA 2015	NA	TBD	TBD

QAPP Worksheet #15m

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TCL Pesticides – EPA 8081B
Concentration Level: Trace (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
4,4'-DDD	2.2	EPA 2015	1	TBD	TBD
4,4'-DDE	1.6	EPA 2015	1	TBD	TBD
4,4'-DDT	1.9	EPA 2015	1	TBD	TBD
Aldrin	0.031	EPA 2015	0.01	TBD	TBD
alpha-BHC	0.085	EPA 2015	0.01	TBD	TBD
alpha-Chlordane[1]	1.8	EPA 2015	1	TBD	TBD
beta-BHC	0.3	EPA 2015	0.1	TBD	TBD
delta-BHC	NA	EPA 2015	NA	TBD	TBD
Dieldrin	0.033	EPA 2015	0.01	TBD	TBD
Endosulfan I[2]	37	EPA 2015	10	TBD	TBD
Endosulfan II[2]	37	EPA 2015	10	TBD	TBD
Endosulfan sulfate[2]	37	EPA 2015	10	TBD	TBD
Endrin	1.8	EPA 2015	1	TBD	TBD
Endrin aldehyde[3]	1.8	EPA 2015	1	TBD	TBD
Endrin ketone[3]	1.8	EPA 2015	1	TBD	TBD
gamma-BHC (Lindane)	0.56	EPA 2015	0.1	TBD	TBD
gamma-Chlordane[1]	1.8	EPA 2015	1	TBD	TBD
Heptachlor	0.12	EPA 2015	0.1	TBD	TBD
Heptachlor epoxide	0.059	EPA 2015	0.01	TBD	TBD
Methoxychlor	31	EPA 2015	10	TBD	TBD
Toxaphene	0.48	EPA 2015	0.1	TBD	TBD

[1]The PALs for alpha-chlordane and gamma-chlordane are the EPA RSL for chlordane as there are no RSLs for these compounds individually.
[2]The PALs for endosulfan I, endosulfan II, and endosulfan sulfate are the EPA RSL for endosulfan as there are no RSLs for these compounds individually.
[3]The PALs for endrin aldehyde and endrin ketone are the EPA RSL for endrin as there are no RSLs for these compounds individually.

QAPP Worksheet #15n

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TCL Pesticides – EPA 8081B
Concentration Level: Trace (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
4,4'-DDD	0.031	EPA 2015	0.031	TBD	TBD
4,4'-DDE	0.23	EPA 2015	0.1	TBD	TBD
4,4'-DDT	0.23	EPA 2015	0.1	TBD	TBD
Aldrin	0.0046	EPA 2015	0.0046	TBD	TBD
alpha-BHC	0.0071	EPA 2015	0.0071	TBD	TBD
alpha-Chlordane[1]	0.22	EPA 2015	0.1	TBD	TBD
beta-BHC	0.025	EPA 2015	0.025	TBD	TBD
delta-BHC	NA	EPA 2015	NA	TBD	TBD
Dieldrin	0.0017	EPA 2015	0.0017	TBD	TBD
Endosulfan I[2]	10	EPA 2015	1	TBD	TBD
Endosulfan II[2]	10	EPA 2015	1	TBD	TBD
Endosulfan sulfate[2]	10	EPA 2015	1	TBD	TBD
Endrin	0.23	EPA 2015	0.1	TBD	TBD
Endrin aldehyde[3]	0.23	EPA 2015	0.1	TBD	TBD
Endrin ketone[3]	0.23	EPA 2015	0.1	TBD	TBD
gamma-BHC (Lindane)	0.041	EPA 2015	0.041	TBD	TBD
gamma-Chlordane[1]	0.22	EPA 2015	0.1	TBD	TBD
Heptachlor	0.002	EPA 2015	0.002	TBD	TBD
Heptachlor epoxide	0.0038	EPA 2015	0.0038	TBD	TBD
Methoxychlor	3.7	EPA 2015	1	TBD	TBD
Toxaphene	0.015	EPA 2015	0.015	TBD	TBD

[1]The PALs for alpha-chlordane and gamma-chlordane are the EPA RSL for chlordane as there are no RSLs for these compounds individually.
[2]The PALs for endosulfan I, endosulfan II, and endosulfan sulfate are the EPA RSL for endosulfan as there are no RSLs for these compounds individually.
[3]The PALs for endrin aldehyde and endrin ketone are the EPA RSL for endrin as there are no RSLs for these compounds individually.

QAPP Worksheet #15o

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Solid
Analytical Method: TAL Metals – EPA 6010C
Concentration Level: Low (mg/kg)

Analyte	PAL (mg/kg)	PAL Reference	PQLG (mg/kg)	Laboratory-Specific QL	Laboratory-Specific DL
Aluminum	7,700	EPA 2015	1,000	TBD	TBD
Antimony	3.1	EPA 2015	1	TBD	TBD
Arsenic	0.67	EPA 2015	0.67	TBD	TBD
Barium	1,500	EPA 2015	100	TBD	TBD
Beryllium	16	EPA 2015	1	TBD	TBD
Cadmium	7	EPA 2015	1	TBD	TBD
Calcium	NA	EPA 2015	NA	TBD	TBD
Chromium[1]	180,000	EPA 2015	18,000	TBD	TBD
Cobalt	2.3	EPA 2015	1	TBD	TBD
Copper	310	EPA 2015	100	TBD	TBD
Iron	5,500	EPA 2015	1,000	TBD	TBD
Lead	400	EPA 2015	10	TBD	TBD
Magnesium	NA	EPA 2015	NA	TBD	TBD
Manganese	180	EPA 2015	10	TBD	TBD
Nickel	150	EPA 2015	10	TBD	TBD
Potassium	NA	EPA 2015	NA	TBD	TBD
Selenium	39	EPA 2015	10	TBD	TBD
Silver	39	EPA 2015	10	TBD	TBD
Sodium	NA	EPA 2015	NA	TBD	TBD
Thallium	0.078	EPA 2015	0.078	TBD	TBD
Vanadium	39	EPA 2015	10	TBD	TBD
Zinc	2,300	EPA 2015	100	TBD	TBD

[1]The PAL for chromium is the MCL-based RSL for protection of groundwater as there is no human health-based RSL for chromium.

QAPP Worksheet #15p

Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Aqueous
Analytical Method: TAL Metals – EPA 6010C
Concentration Level: Trace/Low (µg/L)

Analyte	PAL (µg/L)	PAL Reference	PQLG (µg/L)	Laboratory-Specific QL	Laboratory-Specific DL
Aluminum	2,000	EPA 2015	100	TBD	TBD
Antimony	0.78	EPA 2015	0.78	TBD	TBD
Arsenic	0.052	EPA 2015	0.052	TBD	TBD
Barium	380	EPA 2015	100	TBD	TBD
Beryllium	2.5	EPA 2015	1	TBD	TBD
Cadmium	0.92	EPA 2015	0.92	TBD	TBD
Calcium	NA	EPA 2015	NA	TBD	TBD
Chromium[1]	100	EPA 2015	10	TBD	TBD
Cobalt	0.6	EPA 2015	0.6	TBD	TBD
Copper	80	EPA 2015	10	TBD	TBD
Iron	1,400	EPA 2015	100	TBD	TBD
Lead	15	EPA 2015	1	TBD	TBD
Magnesium	NA	EPA 2015	NA	TBD	TBD
Manganese	43	EPA 2015	10	TBD	TBD
Nickel	39	EPA 2015	10	TBD	TBD
Potassium	NA	EPA 2015	NA	TBD	TBD
Selenium	10	EPA 2015	1	TBD	TBD
Silver	9.4	EPA 2015	1	TBD	TBD
Sodium	NA	EPA 2015	NA	TBD	TBD
Thallium	0.02	EPA 2015	0.02	TBD	TBD
Vanadium	8.6	EPA 2015	1	TBD	TBD
Zinc	600	EPA 2015	100	TBD	TBD

[1]The PAL for chromium is the EPA MCL as there is no tap water RSL for chromium.

QAPP Worksheet #16
Project Schedule Timeline Table

Refer to **Figure 3** for project tasks and schedule.

QAPP Worksheet #17
Sampling Design and Rationale

The design and rationale of the field approach are described in detail in the following worksheets:

- Mobilization/Demobilization – Worksheet #17a
- Decontamination Procedures – Worksheet #17b
- Hydrogeological Investigation – Worksheet #17c
- Radiological Background Measurements – Worksheet #17d
- Soil Boring Investigation – Worksheet #17e
- Radiological Building Materials Survey – Worksheet #17f
- Sewer Investigation – Worksheet #17g
- Gamma Exposure Rate Confirmation Readings – Worksheet #17h
- School and Daycare Investigation – Worksheet #17i
- Hazardous Building Materials Inspection – Worksheet #17j
- Groundwater Sampling – Worksheet #17k
- Creek Sediment Sampling – Worksheet #17l
- Gamma Walkover Surveys – Worksheet #17m

QAPP Worksheet #17a
Sampling Design and Rationale – Mobilization/Demobilization

Site Reconnaissance

Site reconnaissance activities will be performed to support mobilization and to prepare for field activities. CDM Smith will procure a New York-licensed surveyor to conduct site surveys covering property boundary, utility right-of-way, and topographic information. These surveys will include the following:

- Topographic survey
- Site civil, boundary, and building survey including all WACC buildings, adjacent structures, shielding areas, and property boundaries
- Subsurface utility and fiberscope survey including storm/sanitary sewer delineation
- Geophysical underground storage tank (UST) survey to determine presence of historical USTs
- Monitoring well survey

Soil boring and monitoring well locations will be identified and marked via Global Positioning System (GPS); property boundaries and utility rights-of-way will be located; overhead utilities and fire hydrants will be documented; and photographs will be taken. The field team will assess potential logistical issues and physical access constraints for drilling. The field team will coordinate with local residents regarding access issues and assess the extent of clearing needed. Potential problem locations will be documented and photographed. If any of the well or boring locations need to be adjusted, the FTL will contact the Task Leader and SM prior to relocation. CDM Smith will also perform site reconnaissance at the two Newtown Creek sampling areas as well as the creek sediment background sampling area.

Reconnaissance of Facility Interiors

CDM Smith will visit each facility where internal surveys or borings are expected to be conducted in order to locate soil borings inside the facility; areas where hazardous building material samples are needed; and locations where surface contamination, radon, and dose rate measurements need to be performed. CDM Smith will coordinate with facility personnel to determine the logistics of performing a drilling operation inside the facility, including any limitations on drilling operations such as facility safety requirements, dust and emissions controls, and work hours. Following this phase of the reconnaissance, CDM Smith will finalize the drilling technology to be used to advance borings inside the auto shop and adjacent storage units. It is assumed that direct-push technology (DPT) will be used to advance the borings inside the buildings.

QAPP Worksheet #17a
Sampling Design and Rationale – Mobilization/Demobilization

Reconnaissance of Wolff-Alport Exterior Grounds and Surrounding Project Areas

CDM Smith will visit the site and surrounding areas in order to locate borings, sewer system entry points, and the daycare and elementary school facilities. The principal purpose of the reconnaissance will be to mark sampling/drilling locations, identify work barriers or safety hazards, establish liaison with local officials and property owners/managers, and identify any city permits needed for the work. It is anticipated that close coordination will be required with property owners and local authorities regarding access and safety issues.

Site Preparation and Restoration

The drilling subcontractor will be responsible for contacting an appropriate utility location service to locate and mark out underground utilities. CDM Smith plans to use existing roadway rights-of-way, open space, and clearings to the maximum extent possible to access well and boring locations. However, it may be necessary to clear areas of vegetation in order to access the well locations. The drilling subcontractor will be responsible for clearing vegetation. CDM Smith will direct and oversee any necessary clearing activities conducted by the drilling subcontractor. In the event that properties are impacted by field activities, the properties will be restored as near as practicable to pre-construction conditions.

For sewer work, appropriate permits and scheduling will be coordinated with the city. CDM Smith will procure a subcontractor for the sewer system assessment and will oversee the work. It is expected that portions of the street will need to be blocked and traffic control instituted to allow safe access into the sewer system.

CDM Smith will work with EPA and NYSDOH to schedule visits to the daycare center and elementary school. The work is principally non-destructive, so the impact on occupants will be minimal except for occasional access to place and retrieve sampling equipment.

CDM Smith will maintain photographic documentation of site conditions prior to and after completion of field activities. H&S work zones, including personnel decontamination areas, will be established in accordance with the site-specific HASP (CDM Smith 2015b). Local authorities, including the police and fire departments, will be notified prior to the start of field activities. Equipment will be demobilized at the completion of each field event, as necessary. Demobilized equipment will include sampling equipment, drilling subcontractor equipment, H&S equipment, and decontamination equipment.

QAPP Worksheet #17a
Sampling Design and Rationale – Mobilization/Demobilization

Access Support

EPA will be responsible for obtaining all required access to public and private properties as needed to execute the field activities, and CDM Smith will provide logistical support. CDM Smith will provide a list of property owners (public and private) to be contacted for access during the field activities. The list will include the mailing addresses of the property owners. When EPA has established that access has been granted, field work can begin. CDM Smith will contact and coordinate with property owners and local officials (for work in public areas) to schedule sampling activities. Per EPA direction, CDM Smith will give 1 week (7 days) advance verbal notice to the facility/property owners before field activities on their properties are initiated.

Radiological Awareness Training

All project personnel with the potential for contact with radioactive materials or exposure to higher than background levels of external radiation will receive radiological awareness training. This training, in addition to explaining the hazards of working with or around radioactive materials, will ensure each field person knows the means of monitoring for radiation and radioactivity and the action levels associated with that monitoring.

Field Planning Meetings

Prior to field activities, each field team member will review all project plans and participate in a field planning meeting, conducted by the CDM Smith FTL, to become familiar with the history of the site, H&S requirements, field procedures, and related QC requirements. The required field data EDDs will be identified and responsibility for preparation will be assigned. The analytical method codes being used in Scribe will be reviewed to ensure that they are consistent with the EQuIS™ database. CDM Smith and GED field personnel will also attend an onsite tailgate kick-off meeting immediately prior to the commencement of each stage of field activities. All new field personnel will receive a comparable briefing if they do not attend the initial field planning meeting and/or the tailgate kick-off meeting. Supplemental meetings may be conducted as required due to changes in site conditions.

Field Equipment and Supplies

Radiological field equipment and supplies will be provided and mobilized by GED as part of their subcontract. Equipment to be procured by CDM Smith includes photoionization detectors (PIDs), dust monitors, and groundwater sampling equipment. Mobilization of this equipment, and all other field supplies not provided by GED, is governed by CDM Smith's QP 2.1, *Procuring Measurement and Test Equipment*, and QP 5.3, *Inspection of Items*. This includes ordering, renting, and/or purchasing all equipment and supplies not provided by GED. This will also include staging and transferring these equipment and supplies to and from the site. Measurement and Test Equipment forms will be

QAPP Worksheet #17a
Sampling Design and Rationale – Mobilization/Demobilization

completed for rental of the field equipment not provided by GED. The field equipment will be inspected for acceptability, and instruments will be calibrated as required prior to use. This task also involves the construction of a decontamination area for sampling equipment and personnel. A separate decontamination pad will be constructed by the drilling subcontractor for drilling equipment.

Photographic Documentation

CDM Smith personnel will take representative photographs to document the reconnaissance activities and significant events or observations during the RI field program. A caption and the date and time the photograph was taken will be included on each photograph.

Investigation-Derived Waste

CDM Smith will procure a subcontractor to be responsible for the removal and proper disposal of purge water, waste soil, drill cuttings, PPE, and other IDW in accordance with all federal, state, and local regulations and in accordance with subcontract requirements and this QAPP. Drill cuttings, waste soil/sediment, and water from drilling operations will be containerized at the drilling location and transported by the drilling subcontractor. Liquid wastes will be transferred to 55-gallon drums. IDW will be contained in secured containers, labeled, monitored, and segregated from personnel gathering or work areas if the senior health physician determines the container external dose rates will result in unnecessary exposure by project or site personnel.

Representative waste samples will be collected and analyzed by a laboratory to characterize the IDW. Waste will be characterized for both hazardous and radiological parameters. IDW will be disposed of as radiologically contaminated material, hazardous material, or non-hazardous material, depending on the waste characterization results. A technical statement of work will be prepared for the waste hauling and disposal subcontractor and will include quality requirements. CDM Smith will conduct field oversight and H&S monitoring during all waste disposal field activities. All IDW will be disposed of properly at facilities approved by EPA under the Off-Site Disposal Rule. In accordance with the RAC2 Contract, CDM Smith will review and sign the required waste transportation documents on behalf of EPA.

Field Changes

If any deviation from this QAPP, approved SOPs, or other project work plans is required, it will be documented using an FCN form, discussed with EPA, and approved by EPA before the change is implemented. Any associated impact on the project's quality objectives will be documented on the form. Deviations from this QAPP also will be discussed in any applicable technical report(s).

QAPP Worksheet #17a
Sampling Design and Rationale – Mobilization/Demobilization

For minor changes, an FCN form will be prepared and sent to EPA. For major changes, CDM Smith will obtain written concurrence from EPA in the form of a work variance notification before proceeding and will hold a teleconference to discuss the change. It is the responsibility of the FTL to determine whether changes to the UFP-QAPP are required and, if so, to communicate these changes to the CDM Smith SM, who will initiate the appropriate communications with EPA.

Field procedures for these activities are detailed in:

TSOP 2-2	Guide to Handling Investigation-Derived Waste
TSOP 4-1	Field Logbook Content and Control (See Worksheet #21 for modifications)
TSOP 4-2	Photographic Documentation of Field Activities
TSOP 5-1	Control of Measurement and Test Equipment
Appendix C	GED Survey Procedures Manual
	Procedure 2.1 – Instrumentation: Calibration & Quality Control
	Procedure 2.7 – Monitoring Personnel and Equipment for Radioactive Contamination
	Procedure 2.10 – Operation of the Global Positioning System Satellite Backpack
	Procedure 3.1 – Survey Procedure Training

QAPP Worksheet #17b
Sampling Design and Rationale – Decontamination Procedures

Decontamination procedures are described in detail in the site-specific HASP (CDM Smith 2015b). Due to the potential presence of radionuclides, all personnel and equipment that enter an exclusion zone (EZ) will be scanned for radiological surface contamination (alpha/beta) prior to being released from the work zone. For this project, EZs are small work areas where the task is performed. The size of the EZ and location of associated buffer and decontamination zones are determined by the FTL. The required scans, and actions to be taken if contamination is detected above the PALs, are described in SOP R-1, Radiological Contamination Control, included in Appendix H of the HASP (CDM Smith 2015b).

Personnel decontamination procedures will be implemented to prevent worker exposure to site contaminants. Equipment decontamination procedures will be implemented to prevent cross-contamination of environmental samples and prevent offsite migration of contaminants as a result of site investigation activities. In some cases it may be necessary to transport equipment to another location for decontamination. In such situations, the equipment will be contained or covered to prevent the spread of radiological contaminants during transport.

Disposable PPE will not be decontaminated, but will be considered IDW and containerized accordingly. In general, equipment and materials to be reused will be decontaminated by first scanning to determine whether radiological contaminants are present. If present, radiological contaminants will be removed using paper/cloth wipes and a solution of simple green. All decontaminated materials and equipment will either be scanned or wipe tested prior to release for unrestricted use outside the work zone. Direct radiological scans and surface wipes will be performed to ensure that total surface contamination and removable surface contamination are less than 500 disintegrations per minute per hundred square centimeters (dpm/100 cm^2) alpha and 100 dpm/100 cm^2 alpha, respectively. Wipe samples will be counted on a planchet using the benchtop alpha-beta scintillation counting system (either a Ludlum 2929 or 3030).

Reusable PPE Decontamination

The required decontamination procedure for all reusable PPE is:

- Non-residual detergent (e.g. Alconox) and tap water rinse
- Respirator sanitizer (for respirator or self-contained breathing apparatus face piece, if needed)
- Thorough rinse with potable water
- Air dry

QAPP Worksheet #17b
Sampling Design and Rationale – Decontamination Procedures

Field Monitoring Equipment Decontamination

Instruments

Radiological monitoring instruments will be decontaminated per the manufacturer's instructions. The electronic water level indicators, geophysical logging equipment, and water quality parameter probes cannot be rinsed with solvents or acids. The electronic water level indicators will be decontaminated with a non-phosphate detergent, tap water rinse, and a final distilled/deionized water rinse prior to use at each well. The water quality parameter probes are rinsed prior to and after each use with deionized/distilled water only.

Well Components

Well components are delivered to the site in manufacturer's packaging. If the well components are not in their original packaging, they will be scanned for radiological surface contamination as described above and then steam cleaned prior to installation to ensure that all oils, greases, and waxes have been removed. The components will be stored using clean polyethylene sheeting to keep the possibility of contamination to a minimum.

Heavy Equipment

Exterior surfaces of all drilling equipment and down-hole equipment that comes in contact with the soil and/or groundwater will be scanned for radiological surface contamination as described above and scraped or brushed prior to removal from the work site. This equipment will be scanned and steamed-cleaned before use and after drilling each borehole. This includes drill rods, bits and augers, DPT samplers and rods, and any other large piece of equipment. Sampling devices such as split-spoons will be decontaminated after each use in accordance with the procedures listed below.

Sampling Apparatus, General Considerations

All sampling apparatus must be properly decontaminated prior to its use in the field to prevent cross-contamination. Equipment should be decontaminated after usage (once a day or on an as needed basis). Decontamination will be performed in an area outside the contamination zone. Enough equipment will be available to be dedicated to the sampling points planned each day.

QAPP Worksheet #17b
Sampling Design and Rationale – Decontamination Procedures

Decontamination Process

The required decontamination procedure for all sampling equipment is:

- Wash and scrub[a] with low phosphate detergent
- Potable tap water rinse[b]
- Rinse with 10% nitric acid, ultrapure (1% for carbon steel implements) when sampling for inorganics
- Deionized water rinse
- Isopropyl alcohol rinse (pesticide-grade or better) when sampling for organics
- Thorough rinse with deionized, demonstrated analyte-free water (at least five times the amount of solvent used)
- Air dry
- Wrap in aluminum foil, shiny side out, for transport

Decontamination Equipment

- Steam cleaner
- Distilled/deionized water
- Potable water
- Deep basins
- Brush
- Acetone or isopropanol (pesticide-grade)
- PPE
- 10% nitric acid (1% when needed), ultrapure grade
- Power source (e.g. generator), if required
- Demonstrated analyte-free water
- Polyethylene sheeting

[a] While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

[b] Tap water must be from a municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute.

QAPP Worksheet #17b
Sampling Design and Rationale – Decontamination Procedures

- Utility knife
- Non-phosphate detergent (e.g. Alconox)
- Aluminum foil
- Air monitoring equipment and calibration gas

Field procedures for these activities are detailed in:

TSOP 4-5	Field Equipment Decontamination at Nonradioactive Sites
Appendix C	GED Survey Procedures Manual
	Procedure 2.7 – Monitoring Personnel and Equipment for Radioactive Contamination
	Procedure 3.6 – Removable Activity Sampling
HASP Appendix H	SOP R-1, Radiological Contamination Control

QAPP Worksheet #17c
Sampling Design and Rationale – Hydrogeological Investigation

In order to investigate contamination in site groundwater, CDM Smith, with the support of a subcontract drilling firm, will direct the installation, development, slug testing, and down-hole geophysical survey of five shallow monitoring wells. Monitoring well locations will be selected following the completion of the initial soil boring program (Worksheet #17e). Proposed locations are shown on **Figure 4**. Final locations will be confirmed with EPA prior to installation.

Soil Sampling

Soils encountered during well drilling will be scanned and sampled as described on Worksheet #17e and **Table 1**. Both hollow-stem auger (HSA) and sonic drilling will be considered as potential drilling methods during the subcontractor procurement process. If HSA drilling is selected, 4-inch inside diameter (I.D.) augers will be used to allow installation of 2-inch I.D. Schedule 40 polyvinyl chloride (PVC) monitoring wells. The sonic drilling method will be considered based on its ability to improve sample quality and volume. Continuous soil samples (using sonic core barrel or split-spoon soil samples) will be collected from the surface to total depth in each well. The lithology will be logged by the onsite geologist. Soil cores will be scanned using a 2x2-inch sodium iodide (NaI) detector and sampled in accordance with Worksheet #17e.

Down-Hole Geophysical Testing

Prior to monitoring well installation, boreholes will be logged by the subcontract driller with an array of gamma and resistivity probes. CDM Smith's drilling subcontractor will perform borehole geophysical logging in the five boreholes prior to completion as monitoring wells. Geophysical logging instruments will be used to provide data to define the lithology and water bearing zones of each borehole. The following suite of borehole logs will be run for the purposes indicated.

- Gamma logs record the amount of gamma radiation emitted by the soils surrounding the borehole
- Normal-resistivity logs record the electrical resistivity of the borehole environment and surrounding soil and water as measured by variably spaced potential electrodes on the logging probe

The subcontractor will supply the necessary equipment and personnel to perform the logging. CDM Smith will direct and oversee the subcontractor. The geophysical data will be collected in electronic format and will be analyzed and evaluated by the CDM Smith Hydrogeologist. If necessary, selected geophysical logs will be exported from WellCAD and imported into gINT for use in boring logs and cross sections. CDM Smith will provide EPA with copies of the well logs in both hard copy and electronic formats.

QAPP Worksheet #17c
Sampling Design and Rationale – Hydrogeological Investigation

Monitoring Well Installation

Monitoring wells will be installed to screen the shallow aquifer just below the water table, which is anticipated at approximately 65 feet below ground surface (bgs). Wells are expected to be screened from 65 to 75 feet bgs. The drilling subcontractor will advance 4.25-inch HSAs to 10 feet below the water table. The wells will be installed through the HSAs (or sonic casing) as they are retrieved to prevent borehole collapse and to ensure proper placement of annular materials. Monitoring wells will be constructed of 2-inch diameter PVC well riser casing and a 10-slot (0.010 inch), 10-foot length well screen connected via flush-threaded joints. FilPro #1 sand pack (or equivalent) will be placed from the bottom to 2 feet above the well screen. A 4-foot bentonite chip seal will be allowed to hydrate before the borehole is grouted to surface. A flush-mount protective casing will be installed at the surface of each well, along with a cement pad around the protective casing.

Monitoring Well Development

Monitoring well development will be performed to remove silt and other fine materials from the well screen and sand pack and to provide a good hydraulic connection between the well and the aquifer materials. Monitoring well installation will not be considered complete until the wells have been fully developed. At least 48 hours following installation, the drilling subcontractor will develop the monitoring wells with a submersible pump using the pump and surge method. Turbidity, pH, temperature, conductivity, and dissolved oxygen (DO) will be monitored and recorded during development. Development will continue until all parameters have stabilized (within 10% for successive measurements) and the water is clear as specified in TSOP 4-3 and on the groundwater purging sheet.

Slug Testing

Monitoring wells will be slug-tested to provide a range of aquifer characteristics as described in CDM Smith TSOP 4-6. Falling- and rising-head slug tests will be performed on each well. Pressure transducers will be used to monitor the water levels during each test.

Field procedures for these activities are detailed in:

Table 1	Sampling Locations and Methods/SOP Requirements
TSOP 3-4	Geophysical Logging, Calibration, and Quality Control (Includes Potential Radioactive Sites)
TSOP 3-5	Lithologic Logging
TSOP 4-1	Field Logbook Content and Control
TSOP 4-2	Photographic Documentation of Field Activities

QAPP Worksheet #17c
Sampling Design and Rationale – Hydrogeological Investigation

TSOP 4-3	Well Development and Purging
TSOP 4-4	Design and Installation of Monitoring Wells in Aquifers
TSOP 4-6	Hydraulic Conductivity Testing
Appendix C	GED Survey Procedures Manual
	Procedure 2.6 – Subsurface Scanning (Borehole Logging)

QAPP Worksheet #17d
Sampling Design and Rationale – Radiological Background Measurements

Initial surveys to establish radiological background measurements for various media will be performed prior to measurements in impacted or suspect areas. These background surveys will be performed in un-impacted areas near but not directly adjacent to the site. For all background datasets collected, a distribution, mean, standard deviation, and 95% UCL will be determined.

The objectives of obtaining background measurements are to:

- Provide a comparison value for use in identification of areas suspected of an impact from historical Wolff-Alport operations.
- Establish the baseline values to be used in performing a radiological risk assessment.

Background Soil Measurements

Background surface and subsurface soil samples will be collected, analyzed, and used with historical background sample data to complete the risk assessments. As shown in **Figure 5**, eight unimpacted locations were selected for collection of soil background measurements and samples. Prior to collection of soil borings, the surface of each location will be scanned using a 2x2-inch NaI detector to determine the gross gamma count rate background. Scanning will be performed at approximately 10 centimeters (cm) from the ground surface and at a scan rate of 0.5 meter per second (m/s). If the scan survey shows relatively homogeneous gross gamma count rates, then soil boring and sample collection will proceed. If gross gamma count rates vary by more than 50% across the entire surface scanned, then the FTL will be notified and a determination will be made about the acceptability of the location for use as a background soil measurement point.

At each soil boring location, 20 one-minute counts using a collimated 2x2-inch NaI detector will be taken at evenly spaced intervals. Count rate data will also be collected and analyzed in a similar manner for concrete, asphalt, and gravel surfaces, since background levels for these surfaces will differ from those in grass-covered areas. The data points will be collected at a distance of approximately 10 cm from surface to detector. Down-hole logging will be performed at each location using either a 1x1-inch or 2x2-inch NaI detector to provide a baseline gross gamma count rate for logging at borings inside the impacted study area. For areas in which background exposure rate measurements cannot be collected due to the geometrical/media complexity, the range of 6 to 10 microroentgen per hour (µR/h) established from previous surveys will be assigned as the background.

It is expected that four deep borings (as deep as 30 feet bgs) and four additional surface sampling locations (0 to 2 ft bgs) will be advanced. Refer to **Table 1** for the sampling intervals and total number of samples to be collected. The lithology will be logged by the onsite geologist. Soil cores will be scanned using a 2x2-inch NaI detector and sampled in accordance with Worksheet #17e. Samples will be analyzed on site by GED using CANBERRA's ISOCS™ gamma spectroscopy system as described in Worksheet #17e.

QAPP Worksheet #17d
Sampling Design and Rationale – Radiological Background Measurements

Background Sewer Measurements

Background count rate and exposure rate data will be collected from four unimpacted sewer systems as shown on **Figure 5**. Gross gamma count rates and dose rates will be measured at approximately 1-foot intervals from the top of the entry point to the bottom of the sewer. Gross gamma count rates for the lateral cross section are also planned, where room is available. Gross gamma count rate measurements will be performed using 2x2-inch NaI detectors, and dose rate measurements will be performed using a pressurized ion chamber (PIC). No statistical analysis will be performed for these values.

Background Air Measurements

No radon/thoron background data will be collected as the previous surveys have established the range of values likely to be observed.

Field procedures for these activities are detailed in:

Table 1	Sampling Locations and Methods/SOP Requirements
TSOP 1-3	Surface Soil Sampling
TSOP 1-4	Subsurface Soil Sampling
TSOP 3-5	Lithologic Logging
TSOP 4-1	Field Logbook Content and Control
TSOP 4-2	Photographic Documentation of Field Activities
Appendix C	GED Survey Procedures Manual
	Procedure 2.2 – Surface Scanning
	Procedure 2.3 – Direct Radiation Measurement
	Procedure 2.4 – Gamma Radiation (Exposure Rate) Measurement
	Procedure 2.5 – Pressurized Ion Chamber Correlation
	Procedure 2.6 – Subsurface Scanning (Borehole Logging)
	Procedure 2.8 – Preparing Samples for Transportation
	Procedure 3.3 – Soil Sampling

QAPP Worksheet #17e
Sampling Design and Rationale – Soil Boring Investigation

Soil Borings

Prior to finalizing soil boring locations, a 2x2-inch NaI scan of approximately two square meters (m^2) around each proposed drilling location will be performed. Boring locations will be moved if, in the opinion of the project team, the lateral contamination extends beyond the initial boring location selected. Prior to advancing soil borings, the field team will visit proposed locations to identify and mark exact drilling locations and assess potential logistical issues and physical access constraints for the drill rig, as described in Worksheet #17a. Potential problem locations will be documented and photographed and locations may be adjusted to facilitate access. Most of the soil borings are located on private property, requiring coordination with property owners and local authorities.

Thirty-five 10-foot (shallow) soil borings (**Figure 6**) will be advanced via DPT on the WACC property, at the periphery and surrounding area of the site, and along Moffat Street with the principal purpose of delineating the lateral extent of the contamination, and to confirm previously identified shallow contamination depth. Eight 30-foot (deep) soil borings (**Figure 6**) will be advanced via DPT inside the WACC property and adjacent to the property to verify the vertical extent of the contamination. Upon retrieval from the sampler, each 4-foot sample will be screened for VOCs using a PID and for gamma radiation as described below. The lithology of each sample will be characterized and logged by the field geologist.

Soil Sample Radiological Screening and Analysis

Gamma scans of continuous soil cores will be performed as the cores are removed from the auger and prior to sample collection. All soil cores will be scanned in the field using a 2x2 NaI probe to verify the depth at which count rates reduce to background rates, suggesting the limit of contamination has been reached. In addition, where refusal occurs, a 1x1-inch or 2x2-inch NaI detector will be used to log the vertical gross gamma count rate and verify the contamination does not extend beyond the depth of refusal. Samples will be collected at the intervals and frequencies listed in **Table 1** and analyzed in the field using CANBERRA's ISOCS™. Additional borings (lateral extent) or deeper cores (vertical extent) will be collected where analysis indicates the Th-232 concentrations exceed the 95% UCL for background.

CDM Smith's subcontractor, GED, will analyze all soil samples in an onsite counting lab trailer using CANBERRA's ISOCS™ spectroscopy system to quantify Th-232 and Ra-226 in sample borings. The ISOCS™ is a field deployable HPGe gamma spectroscopy system, capable of identifying gamma emitting radionuclides at a detection level comparable to HPGe laboratory analysis systems. The Ra-226 values will be quantified from the 186 kiloelectron-volt (keV) peak as well as several peaks (295.2 keV, 351.9 keV, and 609.3 keV) from the radioactive progeny of Ra-226. The Th-232 will be quantitatively assessed using the actinium-228 peaks (911.1 keV and 969.1 keV) and other peaks (338.32 keV and 72.17 keV) from the thorium decay chain progeny.

QAPP Worksheet #17e
Sampling Design and Rationale – Soil Boring Investigation

Ten percent of the soil samples analyzed in the field (randomly selected) will be shipped to an offsite subcontract laboratory for confirmation of the field analyses. The subcontract laboratory analysis consists of a gamma spectroscopy analysis in accordance with EPA Standard Method 901.1. Ten percent of the samples sent to the offsite subcontract laboratory will also be analyzed for isotopic thorium via alpha spectroscopy and isotopic uranium via ICP-MS or HASL 300.

Soil Sampling Chemical Analysis

At each shallow and deep soil boring, analytical soil samples will be collected and analyzed for TCL VOCs, TCL SVOCs, TCL PCBs, TCL pesticides, and TAL metals as shown in **Table 1**. Sample depths may be modified based on results of the field screening with the PID and ISOCS™. Each soil sample will be analyzed for the parameters listed in **Table 1** by a subcontract laboratory. Once a sampling interval has been determined, the soil will be transferred to volatile organic analysis (VOA) vials using Lock N' Load™ samplers. Remaining soil will be homogenized and sampled for the remaining analyses.

Borehole Abandonment

Borehole abandonment will be similar to the methodology outlined in TSOP 4-10. Any soil borings advanced through the installed shielding will be backfilled with a cement bentonite grout, which will be allowed to settle prior to restoration of the lead shielding and concrete floor.

Field procedures for these activities are detailed in:

Table 1	Sampling Locations and Methods/SOP Requirements
Worksheet #17b	Decontamination Procedures
TSOP 1-2	Sample Custody
TSOP 1-3	Surface Soil Sampling
TSOP 1-4	Subsurface Soil Sampling, Section 5.2 Direct Push Rig Sampling, Section 5.2.3 Split-Barrel (or Split-Spoon) Sampling
TSOP 1-10	Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
TSOP 2-1	Packaging and Shipping Environmental Samples
TSOP 2-2	Guide to Handling Investigation-Derived Waste
TSOP 3-1	Geoprobe Sampling
TSOP 3-5	Lithologic Logging
TSOP 4-1	Field Logbook Content and Control, with modifications shown on Worksheet #21
TSOP 4-10	Borehole and Well Decommissioning, except Sections 5.3 (Well Overdrilling) and 5.4 (Borehole or Well Plugging)

QAPP Worksheet #17e
Sampling Design and Rationale – Soil Boring Investigation

Appendix C	GED Survey Procedures Manual *Procedure 2.2 – Surface Scanning* *Procedure 2.3 – Direct Radiation Measurement* *Procedure 2.4 – Gamma Radiation (Exposure Rate) Measurement* *Procedure 2.6 – Subsurface Scanning (Borehole Logging)* *Procedure 2.8 – Preparing Samples for Transportation* *Procedure 3.3 – Soil Sampling* *Procedure 4.6 – Routine Operations for ISOCS™ Measurements of Surface Soil*

QAPP Worksheet #17f
Sampling Design and Rationale – Radiological Building Materials Survey

A radiological survey of the building materials will be performed to determine if any process or effluent radioactive materials have become embedded in the building materials. The characterization survey of the buildings and building materials will follow the guidance provided in MARSSIM, Sections 5.2 and 5.3 (EPA et al. 2000). Note that these types of surveys do not typically involve a statistical approach as used in the Final Status Survey guidelines within MARSSIM. An initial wall will be scanned for alpha and beta radiation using gas proportional detectors and/or dual phosphorous scintillation detectors with the objective of identifying locations with elevated surface/near-surface count rates. This survey will be problematic in some areas of the buildings due to the higher levels of radioactivity that exist below the concrete surfaces. For those locations, professional judgment will be used to select media to sample. In locations where new flooring has been installed, no floor scans will be performed.

The exterior walls up to 6 feet above the ground surface will first be scanned. If contamination is observed to 6 feet above the ground surface, the walls will also be scanned above this level. The rooftops will also be scanned and special targeted surveys will be performed for any air intake units, including the filter media. Suspect areas are any areas where total surface contamination levels exceed 1,000 dpm/100 cm^2 alpha. Wipe samples of those areas will also be collected and analyzed in the onsite counting trailer using the benchtop alpha-beta scintillation counting system (either a Ludlum 2929 or 3030). Levels greater than 200 dpm/100 cm^2 alpha will be considered as a marker for areas with potential inhalation and ingestion risks for personnel working in the building.

Where suspect locations are identified, a 5-cm core or chip sample of the media will be collected. Repairs to these sample locations will be made after collection of the sample. Where multiple suspect areas are identified within the same 10 m^2 area on a wall, floor, or roof surface, the location with the highest count rate will be selected as the sample location. Bulk samples collected will be analyzed with the onsite CANBERRA ISOCS™ gamma spectroscopy system. As with the soils samples, 10% of the bulk samples collected will be sent for analysis at an offsite subcontract laboratory to verify the accuracy of the ISOCS™ results. Refer to Worksheet #11 for acceptance criteria and the types of decisions to be made based on these analyses, and to **Table 1** for the total number of samples to be collected for each analysis. The following buildings and sub-areas will be surveyed:

- The basement of the Jarabacoa Deli at 1125 Irving Street (Lot 46)
- The Primo Auto Body Repair Shops at 1127 Irving Street and 1129 Irving Street (Lot 44 and part of Lot 42)
- The Terra Nova – Construction Contractor Shop at 1129 Irving Street (part of Lot 42)
- The Arctic Glacier Losquadro, Inc. Warehouse at 1133-1139 Irving Street (Lot 33)

QAPP Worksheet #17f
Sampling Design and Rationale – Radiological Building Materials Survey

Field procedures for these activities are detailed in:	
Table 1	Sampling Locations and Methods/SOP Requirements
TSOP 1-2	Sample Custody
TSOP 2-1	Packaging and Shipping Environmental Samples
TSOP 4-1	Field Logbook Content and Control, with modifications shown on Worksheet #21
Appendix C	GED Survey Procedures Manual
	Procedure 2.2 – Surface Scanning
	Procedure 2.3 – Direct Radiation Measurement
	Procedure 2.8 – Preparing Samples for Transportation
	Procedure 3.6 – Removable Activity Sampling (wipe sampling procedure)

QAPP Worksheet #17g
Sampling Design and Rationale – Sewer Investigation

The sewer investigation will be performed within and adjacent to the combined sewer system in the area around WACC that may have been impacted by the historic discharge of radiological material. The objectives of the sewer investigation are to:

- Identify locations inside the sewers where contaminants may be lodged as sediment or embedded in the sewer walls/floors.
- Quantify the level of contamination within the sewer.
- Identify potential external sources of contamination surrounding the sewer mains.
- Quantify the concentration and determine the extent of contamination surrounding the sewer mains.

This investigation will involve the following processes:

- Fiberscope mapping
- In-sewer dose rate measurements
- Sewer building materials sampling
- Soil borings

Fiberscope Mapping
An initial mapping of the sewer system will be performed by a subcontractor using a fiberscope and camera to identify locations where significant cracks and leaks may exist. **Figure 7** shows the lines to be examined. The intent is to map the lines on Irving Avenue, Cooper Street, Moffat Street and Halsey Street (in the direction of sewer flow); the adjoining streets will also be scoped to limits of the second manhole on each road.

Sewer Dose Rate Measurements
One of the more significant concerns with existing data is the existence of substantial "in-sewer" gamma dose rates with no corresponding high activity soil/debris in or adjacent to the sewer. To confirm the previous survey exposure rate data, in-sewer gamma dose rates will be performed at access points along the highlighted sewer systems and the survey exposure rates observed will be compared to the previous survey data (refer to **Figure 7**; manhole locations are estimated on the figure and will be finalized following completion of the survey task). Similar to the fiberscope survey, the intent is to scan the manholes on Irving Avenue, Cooper Street, and Moffat Street. In addition, manholes on the adjoining streets will be scanned, likely limited to the first or second manhole on each road based on the survey exposure rate data. If elevated readings continue past the first two manholes, additional sewer scans will be performed.

QAPP Worksheet #17g
Sampling Design and Rationale – Sewer Investigation

Sewer Soil Borings

If the fiberscope mapping and in-sewer dose rate measurements indicate contamination likely exists outside of the sewer system, further investigatory work around and in the sewers will be performed. Soil borings will be performed laterally as close as possible and to a depth of at least 3 feet below the sewer line. Sewer soil boring locations will be determined as field investigation results are evaluated. In addition, these borings will determine if material from the site may have been used as backfill during sewer installation. It is assumed that 10 sewer soil borings will be advanced to a depth of 15 feet bgs. Sewer soil borings and sampling will be completed in a manner similar to the soil borings described in Worksheet #17e. Refer to **Table 1** for sampling depths and the total number of samples to be collected.

Sewer Materials

Samples of potentially impacted sewer construction materials (concrete, mortar, or bricks) will be collected from manholes in an attempt to verify the source of gamma exposure. Samples will be analyzed in the field using ISOCS™. It is assumed that up to five samples will be collected.

Field procedures for these activities are detailed in:

Table 1	Sampling Locations and Methods/SOP Requirements
TSOP 1-2	Sample Custody
TSOP 1-4	Subsurface Soil Sampling
TSOP 2-1	Packaging and Shipping Environmental Samples
TSOP 3-5	Lithologic Logging
TSOP 4-1	Field Logbook Content and Control
TSOP 4-2	Photographic Documentation of Field Activities
Appendix C	GED Survey Procedures Manual
	Procedure 2.2 – Surface Scanning
	Procedure 2.3 – Direct Radiation Measurement
	Procedure 2.4 – Gamma Radiation (Exposure Rate) Measurement
	Procedure 2.5 – Pressurized Ion Chamber Correlation
	Procedure 2.6 – Subsurface Scanning (Borehole Logging)

QAPP Worksheet #17g
Sampling Design and Rationale – Sewer Investigation

	Procedure 2.8 – Preparing Samples for Transportation
	Procedure 3.3 – Soil Sampling
	Procedure 3.6 – Removable Activity Sampling
HASP Appendix J	Sewer Investigation Confined Space Entry Plan (to be provided in Final HASP)

QAPP Worksheet #17h
Sampling Design and Rationale – Gamma Exposure Rate Confirmation Readings

Locations will be selected for further surveying to aid in the final dose/risk assessment. It is believed that the current gamma dataset is sufficient for data analysis, but the myriad of existing dose rate values should be filtered so that the most accurate data are used in the risk assessment evaluation. In addition, if, as suspected, the extent of contamination is laterally greater than previously determined, additional data points will aid in the final risk assessment. It is assumed that approximately 50 gamma exposure rate measurements will be collected from the following locations (refer to **Figure 2**):

- Previously identified hotspots
- Auto body shop areas at 0.5 feet and 3 feet from the floor
- Office areas at 3 feet from the floor
- Deli at 3 feet from the floor
- Warehouse areas at 3 feet from the floor
- Irving Avenue, both south and north sides, at 3 feet from the surface
- Backyard/rail spur at 3 feet from the surface
- Manholes at 1.5 feet from the surface

Dose rate measurements will be made using a National Institute of Standards and Technology (NIST)-traceable, calibrated PIC. Except as noted above, all measurements will be made at waist height or approximately 3 feet above ground surface.

Field procedures for these activities are detailed in:

TSOP 4-1	Field Logbook Content and Control
TSOP 4-2	Photographic Documentation of Field Activities
Appendix C	GED Survey Procedures Manual
	Procedure 2.2 – Surface Scanning
	Procedure 2.3 – Direct Radiation Measurement
	Procedure 2.4 – Gamma Radiation (Exposure Rate) Measurement
	Procedure 2.5 – Pressurized Ion Chamber Correlation

QAPP Worksheet #17i
Sampling Design and Rationale – School and Daycare Investigation

Supplemental radon and dose rate surveys will be performed at the P.S./I.S. 384 Frances E. Carter School and Daycare Center for the purpose of validating and augmenting previously collected survey data. The samples to be collected and surveys to be performed include the following.

Radon Evaluations

A visual inspection of the basements and crawl spaces will be performed for the purpose of identifying locations where radon/thoron gas may be entering the buildings. Suspect locations will then be monitored by GED using electrometers such as the RAD7 Portable Radiation Monitor or equivalent device to verify if these locations are radon/thoron gas entry points to the respective buildings. This information will be used to identify radon/thoron entry points only and will not generate reportable data.

A short-term radon test will be performed at the school and daycare facilities in all frequently occupied rooms in contact with the ground using charcoal canisters. If the initial radon test result is 4 pCi/L or greater, a follow-up short-term test using charcoal canisters and long-term radon/thoron tests using ATDs will be performed to ensure that the two short-term results are comparable and to evaluate the average radon/thoron concentrations. Four ATDs (2 standard and 2 thoron filtered) will be placed at each location and retrieved after 6 months and 1 year. It is assumed that radon measurements will be performed at 5 locations in the school and 2 locations in the daycare. All radon measurements will be performed in accordance with the EPA Radon Measurement in Schools guidance document, dated July 1993 (EPA 1993), by a subcontractor certified by the American Association of Radon Scientists and Technologists (AARST), National Radon Safety Board (NRSB), State of New Jersey, or State of Pennsylvania, and analyzed by a NYSDOH Environmental Laboratory Accreditation Program (ELAP)-certified laboratory.

Dose Rate Evaluations

Dose rate mapping using a PIC will be performed in the basement areas and the outside grounds areas of the school and daycare. The mapping will be performed in 10-m intervals at a height of 3 feet above ground surface.

Soil Borings

It is assumed that six shallow soil borings will be installed to 10 feet bgs adjacent to the buildings to evaluate the presence of any tailings or radiologically contaminated soil (**Figure 8**). Soil borings will be completed and soil cores will be scanned and samples collected and analyzed for Th-232 and Ra-226 using the ISOCS™ as described in the soil boring investigation activity section. Soil borings will be advanced and collected as outlined in Worksheet #17e. Refer to **Table 1** for sampling depths and the total number of samples to be collected.

QAPP Worksheet #17i
Sampling Design and Rationale – School and Daycare Investigation

Field procedures for these activities are detailed in:	
Table 1	Sampling Locations and Methods/SOP Requirements
TSOP 1-2	Sample Custody
TSOP 2-1	Packaging and Shipping Environmental Samples
TSOP 4-1	Field Logbook Content and Control
TSOP 4-2	Photographic Documentation of Field Activities
Appendix C	GED Survey Procedures Manual
	Procedure 2.2 – Surface Scanning
	Procedure 2.3 – Direct Radiation Measurement
	Procedure 2.4 – Gamma Radiation (Exposure Rate) Measurement
	Procedure 2.5 – Pressurized Ion Chamber Correlation
	Procedure 2.8 – Preparing Samples for Transportation
	Procedure 3.9 – Air Sampling for Radioactivity

QAPP Worksheet #17j
Sampling Design and Rationale – Hazardous Building Materials Inspection

CDM Smith will procure a subcontractor to perform a hazardous building materials inspection for site properties. The subcontractor will prepare a hazardous building materials inspection work plan for CDM Smith's review and approval. A copy of the work plan will be submitted to EPA as an FCN. The inspection will include an initial inspection to determine the likely presence of hazardous building materials including asbestos-containing material (ACM), lead paints, mercury, and PCBs. Following the initial inspection, the subcontractor will collect samples as indicated by the initial survey to help determine disposal costs of the building materials if necessary.

Field procedures for these activities are detailed in:

TSOP 4-1	Field Logbook Content and Control
TSOP 4-2	Photographic Documentation of Field Activities

QAPP Worksheet #17k
Sampling Design and Rationale – Groundwater Sampling

Groundwater Sampling

Two rounds of groundwater samples will be collected from the five new monitoring wells (**Table 1** and **Figure 4**). Wells will be purged with a submersible pump and sampled according to TSOP 1-12. The following parameters will be measured in every well in the field during sampling: DO, pH, oxidation-reduction potential (ORP) (as Eh), turbidity, temperature, conductivity, and depth to water. All groundwater samples will be analyzed for TCL VOCs, SVOCs, PCBs, pesticides, TAL metals (both filtered and unfiltered), and gamma spectroscopy.

Synoptic Water Level Measurement

Two rounds of synoptic water level measurements will be collected from the newly installed wells to provide data to evaluate groundwater flow in the vicinity of the site. Water level measurements will be collected from conventional monitoring wells using an electronic water level indicator, at the surveyors mark on the inner casing. The water levels will be collected during both the dry (fall) and wet (spring) seasons to help define the seasonal range of groundwater elevations.

During monitoring well sampling and synoptic water level activities, air will be monitored for VOCs in the breathing zone using a PID in accordance with the site-specific HASP (CDM Smith 2015b).

Field procedures for these activities are detailed in:

TSOP 1-2	Sample Custody
TSOP 1-6	Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators (and manufacturer's instructions)
TSOP 1-10	Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
TSOP 1-12	Low-Stress (Low-Flow) Groundwater Sampling
TSOP 2-1	Packaging and Shipping Environmental Samples
TSOP 2-2	Guide to Handling Investigation-Derived Waste
TSOP 4-1	Field Logbook Content and Control
Worksheet 17b	Decontamination Procedures
Table 1	Sampling Locations and Methods/SOP Requirements
Appendix C	GED Survey Procedures Manual
	Procedure 2.8 – Preparing Samples for Transportation
	Procedure 3.5 – Water Sampling

QAPP Worksheet #17l
Sampling Design and Rationale – Creek Sediment Sampling

CDM Smith will procure a vibracore subcontractor to collect sediment samples from the two potential Newtown Creek discharge areas as well as a background locations in Coney Island Creek to investigate the presence of site-related contaminants in the creek sediments. Sampling will include:

- Background sampling, comprising collection of two 10-foot sediment cores and eight shallow grab samples via barge-mounted vibracore drilling from Coney Island Creek, the proposed background location, approximately 9 miles from the site (see **Figure 9**)
- Newtown Creek sampling, comprising collection of five 10-foot sediment cores via barge-mounted vibracore drilling from each of the two most upstream branches of Newtown Creek (English Kills and East Branch tributaries; see **Figures 10** and **11**, respectively)

All core/grab samples will be analyzed for gamma spectroscopy, isotopic uranium, and isotopic thorium. Refer to **Table 1** for sampling intervals and the total number of samples to be collected for each analysis.

Field procedures for these activities are detailed in:

Table 1	Sampling Locations and Methods/SOP Requirements
Worksheet #17b	Decontamination Procedures
TSOP 1-2	Sample Custody
TSOP 1-10	Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
TSOP 1-11	Sediment/ Sludge Sampling
TSOP 2-1	Packaging and Shipping Environmental Samples
TSOP 2-2	Guide to Handling Investigation Derived Waste
TSOP 3-5	Lithologic Logging
TSOP 4-1	Field Logbook Content and Control, with modification shown on Worksheet #21
TSOP 4-2	Photographic Documentation of Field Activities
TSOP 4-10	Borehole and Well Decommissioning, except Sections 5.3 (Well Overdrilling) and 5.4 (Borehole or Well Plugging)
Appendix C	GED Survey Procedures Manual
	Procedure 2.8 – Preparing Samples for Transportation
	Procedure 3.2 – Sediment Sampling

QAPP Worksheet #17m
Sampling Design and Rationale – Gamma Walkover Surveys

CDM Smith will perform gamma walkover surveys at locations not previously surveyed in the studies performed between 2009 and 2014. Gamma walkover surveys will include the use of a shielded 2x2-inch NaI detector connected to a GPS-enabled data logger for exterior surveys. Interior building surveys will not require the use of a GPS mapping system.

The walkover surveys will be performed with the detector at approximately 10 cm above the ground surface and at a speed of 0.5 m/s. Count rate and GPS data will be downloaded and assessed by the project RSO. The assessment will identify areas that require further survey and/or sampling.

Field procedures for these activities are detailed in:

TSOP 4-1	Field Logbook Content and Control, with modification shown on Worksheet #21
TSOP 4-2	Photographic Documentation of Field Activities
Appendix C	GED Survey Procedures Manual
	Procedure 2.2 – Surface Scanning
	Procedure 2.3 – Direct Radiation Measurement

QAPP Worksheet #18
Sampling Locations and Methods

Refer to **Table 1** for sampling locations and methods and to **Worksheet #17** for sampling rationale.

QAPP Worksheet #19 and 30
Sample Containers, Preservation, and Hold Times

Laboratory: Subcontract laboratory TBD
Required accreditations/certifications: National Environmental Laboratory Accreditation Program (NELAP) or equivalent
Back-up laboratory: TBD
Sample delivery method: FedEx Priority Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
TCL VOCs	Soil	EPA 8260	TBD	(3) 40-milliliter (mL) VOA vials with polytetrafluoroethylene (PTFE) septum caps	Cool 0 to 6 degrees Celsius (°C); freeze <-7°C	48 hours if cooled only; 14 days if frozen or preserved	14 days	21 days for analysis and 21 days for validation
% Moisture (include with VOC vials)		SM2540G (to record dry weight results)		(1) 4-ounce (oz) jar w/Teflon lined cap. No headspace	None - No headspace	Technical – 48 hours		
TCL SVOCs		EPA 8270		(1) 8-oz glass jar	Cool 0 to 6°C; store in dark	14 days	40 days	
TCL PCBs		EPA 8082		(1) 8-oz wide mouth amber glass jar	Cool 0 to 6°C; store in dark	14 days	40 days	
TCL Pesticides		EPA 8081		(1) 8-oz wide mouth amber glass jar	Cool 0 to 6°C; store in dark	14 days	40 days	
TAL Metals		EPA 6010		(1) 8-oz glass jar	Cool 0 to 6°C	6 months		

Notes:
1. Soil VOC vials must be shipped on the day of collection.
2. Soil VOC vial sample weights are recorded; a log of the vial and vial plus sample and spin bar weights will accompany the cooler.
3. For soil PCBs and pesticides, no additional volume is required for MS/MSD analyses. The sampler will designate a sample for the laboratory to perform the MS/MSD analysis at a frequency of 1 per 20 samples.
4. See Worksheet #21 for further VOC sampling procedure information.
5. If PCBs and pesticides are analyzed by the same laboratory, only one sample needs to be taken for both fractions.

QAPP Worksheet #19 and 30
Sample Containers, Preservation, and Hold Times

Laboratory: Subcontract laboratory TBD
Required accreditations/certifications: NELAP or equivalent
Back-up laboratory: TBD
Sample delivery method: FedEx Priority Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
TCL VOCs	Aqueous	EPA 8260	TBD	(3) 40-mL glass vials with PTFE-lined caps; no headspace	Cool 0 to 6°C; preserve with 1:1 HCl, $NaHSO_4$, or H_2SO_4	7 days (no preservative) 14 days (with preservative)		21 days for analysis and 21 days for validation
TCL SVOCs		EPA 8270		(1) 1-liter (L) amber glass	Cool 0 to 6°C; store in dark	Extract within 7 days	Analyze within 40 days of extraction	
TCL PCBs		EPA 8082		(1) 1-L amber glass w/PTFE lined cap	Cool 0 to 6°C; store in dark	7 days		
TCL Pesticides		EPA 8081		(1) 1-L amber glass w/PTFE lined cap	Cool 0 to 6°C; store in dark	7 days		
TAL Metals		EPA 6010		(1) 1-L high-density polyethylene (HDPE)	HNO_3 to pH < 2; Cool 0 to 6°C	6 months		

QAPP Worksheet #19 and 30
Sample Containers, Preservation, and Hold Times

Laboratory: Subcontract laboratory TBD[1]
Required accreditations/certifications: NELAP or equivalent
Back-up laboratory: TBD
Sample delivery method: FedEx Priority Overnight

Analyte/ Analyte Group	Matrix[2]	Analytical and Preparation Method/SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)[2]	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
ISOCS™[3]	Soil	GED Procedure 4.6	TBD	(1) plastic zip-top bag, transferred to Marinelli beaker for analysis	None	NA		NA
Gamma spectroscopy		EPA 901.1M		(1) 16-oz plastic jar; minimum 350 grams of sample	None	6 months		30 calendar days
Isotopic uranium		SW846 6020A or HASL 300		(1) 2-oz glass or plastic jar; minimum 350 grams of sample	None	6 months		30 calendar days
Isotopic thorium		HASL-300 A-01-R		(1) 2-oz glass or plastic jar; minimum 350 grams of sample	None	6 months		30 calendar days
Gamma spectroscopy	Aqueous	EPA 901.1		(1) 1-L plastic bottle	1 Normal (N) nitric acid (HNO_3) to pH < 2	6 months		30 calendar days
Radon/thoron	Air	Track Etch/ Charcoal Canister		(1) ATD or charcoal canister	None	TBD	TBD	TBD

Notes:
[1]Information labeled "TBD" will be provided upon procurement of a subcontract laboratory.
[2]Soil samples collected for gamma spectroscopy, isotopic uranium, and isotopic thorium analysis can be prepared and analyzed from one 32-oz container or zip-top bag.
[3]Samples collected for ISOCS™ analysis will be analyzed in the field and will not be shipped to the subcontract laboratory.

QAPP Worksheet #20
Field QC Sample Summary Table

Matrix	Event	Analytical Group	No. of Field Samples	No. of Field Duplicates	No. of MS/MSDs	No. of Rinsate Blanks[1]	No. of Trip Blanks	Total No. of Samples[2,3]
Soil	Radiological background measurements	ISOCS™	24	2	0	0	0	26
		Gamma spectroscopy	3	1	0	0	0	4
		TCL VOCs	24	2	2	0	2	28
		TCL SVOCs	24	2	2	0	0	26
		TCL PCBs	24	2	2	0	0	26
		PCL pesticides	24	2	2	0	0	26
		TAL metals	24	2	2	0	0	26
		Isotopic uranium	1	1	0	0	0	2
		Isotopic thorium	1	1	0	0	0	2
	Soil boring investigation	ISOCS™	295	15	0	0	0	310
		Gamma spectroscopy	30	2	0	0	0	32
		TCL VOCs	40	2	2	0	2	44
		TCL SVOCs	40	2	2	0	0	42
		TCL PCBs	40	2	2	0	0	42
		TCL pesticides	40	2	2	0	0	42
		TAL metals	40	2	2	0	0	42
		Isotopic uranium	4	1	0	0	0	5
		Isotopic thorium	4	1	0	0	0	5

[1]Rinsate blanks will not be required if dedicated sampling equipment is used.
[2]Total number of samples does not include MS/MSDs, which are sent to the laboratory as extra sample volume.
[3]Total number and types of QC samples subject to change based on subcontract laboratory requirements.

QAPP Worksheet #20
Field QC Sample Summary Table

Matrix	Event	Analytical Group	No. of Field Samples	No. of Field Duplicates	No. of MS/MSDs	No. of Rinsate Blanks[1]	No. of Trip Blanks	Total No. of Samples[2,3]
Soil	Sewer investigation	ISOCS™	75	4	0	0	0	79
		Gamma spectroscopy	8	1	0	0	0	9
		Isotopic uranium	1	1	0	0	0	2
		Isotopic thorium	1	1	0	0	0	2
	School and daycare survey	ISOCS™	50	3	0	0	0	53
		Gamma spectroscopy	5	1	0	0	0	6
		Isotopic uranium	1	1	0	0	0	2
		Isotopic thorium	1	1	0	0	0	2
Building/ construction materials	Radiological building materials survey	ISOCS™	20	1	0	0	0	21
		Gamma spectroscopy	2	1	0	0	0	3
	Sewer investigation	ISOCS™	5	1	0	0	0	6
		Gamma spectroscopy	1	1	0	0	0	2
Air	School and daycare survey	Radon/thoron	42	3	0	0	0	45

[1]Rinsate blanks will not be required if dedicated sampling equipment is used.
[2]Total number of samples does not include MS/MSDs, which are sent to the laboratory as extra sample volume.
[3]Total number and types of QC samples subject to change based on subcontract laboratory requirements.

QAPP Worksheet #20
Field QC Sample Summary Table

Matrix	Event	Analytical Group	No. of Field Samples	No. of Field Duplicates	No. of MS/MSDs	No. of Rinsate Blanks[1]	No. of Trip Blanks	Total No. of Samples[2,3]
Groundwater	Groundwater sampling	Gamma spectroscopy	10	2	0	0	0	12
		TCL VOCs	10	2	2	0	2	16
		TCL SVOCs	10	2	2	0	0	12
		TCL PCBs	10	2	2	0	0	12
		TCL pesticides	10	2	2	0	0	12
		TAL metals – filtered	10	2	2	0	0	12
		TAL metals – unfiltered	10	2	2	0	0	12
Sediment	Creek sediment sampling	Gamma spectroscopy	140	7	0	0	0	147
		Isotopic uranium	140	7	0	0	0	147
		Isotopic thorium	140	7	0	0	0	147

[1]Rinsate blanks will not be required if dedicated sampling equipment is used.
[2]Total number of samples does not include MS/MSDs, which are sent to the laboratory as extra sample volume.
[3]Total number and types of QC samples subject to change based on subcontract laboratory requirements.

QAPP Worksheet #21
Project Sampling SOP References Table

Refer to Worksheet #21 in CDM Smith's Generic QAPP (CDM Smith 2013) and the GED Survey Procedures Manual (**Appendix C**). An SOP for vibracore sediment sampling will be provided upon procurement of a vibracore subcontractor.

QAPP Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Refer to Worksheet #22 in CDM Smith's Generic QAPP (CDM Smith 2013) and the GED Survey Procedures Manual (**Appendix C**).

QAPP Worksheet #23
Analytical SOPs

Refer to Worksheet #23 in CDM Smith's Generic QAPP (CDM Smith 2013) for chemical analyses and the table below for radiological analyses. Information labeled "TBD" will be provided upon procurement of a subcontract laboratory.

SOP #	Title	Definitive or Screening Data	Analytical Group	SOP Option or Equipment Type	Organization Performing Analysis	Modified for Project Work? (Y/N)
GED Procedure 4.6 (**Appendix C**)	Routine Operations for ISOCS™ Measurements of Surface Soil	Screening	ISOCS™	Gamma Spectroscopy	CDM Smith through subcontractor GED	N
GED Procedure 3.6 (**Appendix C**)	Removable Activity Sampling	Screening	Wipe Samples	Ludlum 2929 or 3030	CDM Smith through subcontractor GED	N
TBD	TBD	Definitive	Soil and Aqueous/Gamma Spectroscopy	Gamma Spectroscopy	TBD	TBD
TBD	TBD	Definitive	Radon/thoron	Charcoal Canister/ATD/ E-PERM®	TBD	TBD
TBD	TBD	Definitive	Soil/Isotopic Uranium	ICP-MS or HASL 300	TBD	TBD
TBD	TBD	Definitive	Soil/Isotopic Thorium	Alpha Spectroscopy	TBD	TBD

QAPP Worksheet #24
Analytical Instrument Calibration Table

Refer to Worksheet #24 in CDM Smith's Generic QAPP (CDM Smith 2013) for chemical analyses and the table below for radiological analyses. Information labeled "TBD" will be provided upon procurement of a subcontract laboratory.

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
ICP-MS	Linear dynamic range (LDR) or high-level check standard	At initial setup and checked every 6 months with a high standard at the upper limit of the range	Within +10% of true value	Dilute samples within the calibration range, or reestablish/verify the LDR	Subcontract laboratory analyst	TBD
	Tuning	Prior to initial calibration (ICAL)	Mass calibration ≤ 0.1 atomic mass unit (amu) from the true value; resolution < 0.9 amu full width at 10% peak height	Retune instrument and verify		
	ICAL – minimum one high standard and a calibration blank	Daily ICAL prior to sample analysis	3 standards and a blank. Correlation Coefficient of ≥ 0.998	Recalibrate		
	Second source initial calibration verification (ICV)	Once after each ICAL, prior to sample analysis	Value of second source for all analyte(s) within ± 10% of expected value	Recalibrate		
	Continuing calibration verification (CCV)	After every 10 samples and at the end of the analysis sequence	All analytes within ± 10% of expected value	Recalibrate – rerun 10 samples previous to failed CCV		
	Low-level calibration check standard (low-level ICV)	Daily	All analytes within + 20% of expected value	Correct problem and repeat ICAL		
	Interference check solution (ICS)	After ICAL and prior to sample analysis	ICS-A: Absolute value of concentration for all non-spiked project analytes < limit of detection (LOD) (unless they are a verified trace impurity from one of the spike analytes) ICS-AB: within + 20% of true value	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples		

QAPP Worksheet #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
Gamma spectrometer	Energy calibration	Annual	• Within 0.5% or 0.1 keV for all calibration points • Within 8% for all calibration points • Verify with second source that always contains at least Americium-241 (Am-241), cobalt-60 (Co-60), and cesium-137 (Cs-137) • Must be ± 10% difference for each nuclide	• Recalibrate • Instrument maintenance • Consult with Technical Director	Subcontract laboratory analyst	TBD
	Full width at half maximum (FWHM) calibration	Annual				
	Background	Monthly	12 hours			
Alpha spectrometer	Energy calibration	Monthly	Three isotopes in 3-6 million electron-volt (MeV) range all within ± 40 keV of expected value	• Recalibrate • Instrument maintenance • Consult with Technical Director • If background check is > 20 counts per minute (CPM), then detector requires maintenance		
	Efficiency calibration and background check	Monthly	>20%			
	Subtraction spectrum	Monthly	Ultra Low Level: < 2 CPM Low Level: < 2-4 CPM Routine Level: < 4-10 CPM High Level: < 10-20 CPM			
	Pulser check and background check	Daily	Pulser energy, peak centroid, peak resolution, peak area, calibration, and background must pass statistical "boundary" out-of-range test			

QAPP Worksheet #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
ISOCS™	Initial efficiency calibration	Daily	± 1 keV	Readjust gain and voltage	GED Field Manager	GED Survey Procedures Manual (**Appendix C**), Procedure 4.6 – Routine Operations for ISOCS™ Measurements of Surface Soil
	Calibration check count	At the start of each counting shift	No flagged results	Repeat procedure. If results are still flagged, discontinue counting until the cause has been determined and corrected.	GED Field Manager	
	Background check count				GED Field Manager	
Track Etch analyzer/ charcoal canister	Calibration in a radon calibration chamber	Every 12 months	TBD	TBD	Subcontract laboratory analyst	TBD

QAPP Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Refer to Worksheet #25 in CDM Smith's Generic QAPP (CDM Smith 2013) for chemical analyses and the table below for radiological analyses. Information labeled "TBD" will be provided upon procurement of a subcontract laboratory.

Instrument/ Equipment	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	Reference
ICP-MS	Parameter setup	Physical check	Initially	Predetermined optimum parameter settings	Reset if incorrect	Subcontract laboratory analyst	TBD
	ICS	Instrument performance	Prior to sample analysis	Within + 20% of expected value	Terminate analysis, reanalyze ICS to rule out standard degradation or inaccurate injection. If problem persists, perform instrument maintenance, repeat calibrations, and reanalyze all associated samples.		
	Initial calibration blank (ICB)/ continuing calibration blank (CCB)	Instrument performance	After every calibration verification	ICB: No analytes detected > RL CCB: no analyte detected > 3X method detection limit (MDL)	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank and all associated samples.		

QAPP Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	Reference
Gamma spectrometer	Clean cave; fill dewar with nitrogen gas (N_2)	Physical check	Weekly	Acceptable background	• Recalibrate • Instrument maintenance • Consult with Technical Director	Subcontract laboratory analyst	TBD
	QA check	Background and source check	Daily	Within 3 sigma of measured population			
Alpha spectrometer	Clean planchette holders	Physical check	Monthly	Acceptable background and calibration efficiencies	• Recalibrate • Instrument maintenance • Consult with Technical Director		
ISOCS™	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Track Etch analyzer/ charcoal canister	Count instrument check source	Routine instrument check	Daily	Response constant within established limits	TBD	Subcontract laboratory analyst	TBD

QAPP Worksheet #26
Sample Handling, Custody, and Disposal

Refer to Worksheet #26 in CDM Smith's Generic QAPP (CDM Smith 2013) and the GED Survey Procedures Manual (**Appendix C**).

QAPP Worksheet #27
Sample Custody Requirements

This worksheet has been combined with Worksheet #26.

QAPP Worksheet #28
Analytical Quality Control and Corrective Action

PROCEDURE FOR COLLECTION OF FIELD QC SAMPLES

Duplicates: Field duplicate samples are collected and analyzed to assess the overall precision of the field sampling technique. Duplicate samples, of the same matrix, will be collected at a rate of 5% (1 per 20 samples) or one every 14 days, or one if less than 20 samples are collected. These duplicates will be submitted "blind" to the laboratory by using sample numbers that differ from their associated environmental samples. For groundwater samples collected during the sampling event, duplicate samples will be collected on a per event basis. Duplicate samples will be collected by alternately filling bottles for the same analysis.

Trip Blanks: A trip blank will be prepared at the start of each day on which aqueous samples will be collected for analysis of VOCs. Trip blanks are used to determine whether onsite atmospheric contaminants are seeping into the sample vials, or if any cross-contamination of samples is occurring during shipment or storage of sample containers. A trip blank consists of demonstrated analyte-free water sealed in 40-mL Teflon septum vials with no headspace (including bubbles) in the vials. Trip blank water will be considered analyte-free when analysis results for VOC analysis are below QLs. Certification of blank water quality will be kept on site and will be filed in the project files once field work is completed. A sample of the blank water lot used in the field will be submitted for confirmatory analysis.

Trip blanks are to be kept in close proximity to the samples being collected and will be maintained at 4 °C and handled in the same manner as the other VOC aqueous samples. Preservation of trip blanks is presented on Worksheet #19. One trip blank will be included with each cooler that contains aqueous samples collected for VOCs.

Rinsate Blanks (Field Blanks): One field blank will be collected for each equipment type per decontamination event and will be analyzed for the same constituents as the environmental samples. Field blanks, also known as "rinsate blanks" or "equipment blanks," are used to assess the effectiveness of equipment decontamination. Field blanks will be collected before the use of the decontaminated equipment for sampling. The frequency for field blanks is one per decontamination event, not to exceed one per day, for each equipment type and for each sample matrix. Field blanks are generated by pouring demonstrated analyte-free water over or through the decontaminated sampling tool.

QAPP Worksheet #28
Analytical Quality Control and Corrective Action

The definition of demonstrated analyte-free water is discussed in the previous section. Field blanks will be collected in a way that will minimize potential contamination from the ambient air. The use of the same aliquot of water on all equipment associated with a particular matrix for the required analyses is permissible. However, a separate rinsate blank may be collected for each piece of equipment associated with a particular sample matrix that will be analyzed for VOCs. Preservation of field blanks is specified on Worksheet #19. Field blanks will accompany the set of samples collected by the decontaminated sampling equipment and will be kept between 0 and 6°C.

Field blanks may be minimized by decreasing the frequency of decontamination and using additional equipment. In this case the samples associated with the field blank will be noted in the field logbooks and sample trip report. Field equipment blank samples should be analyzed prior to environmental samples.

Cooler Temperature Indicators

One cooler temperature indicator or "temperature blank" will be placed in each cooler containing samples (solid and aqueous) being sent to the laboratory for analysis. The temperature blank will consist of a sample container filled with non-preserved water (potable or distilled). The container will be labeled "COOLER TEMPERATURE INDICATOR" and dated.

Matrix Spikes

MS samples are laboratory QC samples drawn from excess volumes of existing samples to demonstrate the accuracy of laboratory analysis. In accordance with EPA Region 2, MS samples will be designated on environmental samples at a rate of one per sample delivery group (SDG). This designation will be noted on the sample container labels and the sample paperwork. An SDG is defined as one of the following:

1. All samples of an analytical case if the sample number is less than 20 (including environmental duplicates and QC blanks) and if sampling is completed within 7 calendar days.
2. Each group of 20 samples within an analytical case (including environmental duplicates, but excluding QC blanks) if the number is greater than 20.
3. Each 7-day calendar day period during which samples within an analytical case are received. This period begins with the receipt of the first sample in the SDG.

Triple volume may be required for aqueous VOC matrix MS/MSD since a subcontract laboratory is being used. The water quality parameters may require extra volume as identified on Worksheet #19 and confirmed with the subcontract laboratory.

QAPP Worksheet #28
Analytical Quality Control and Corrective Action

The following worksheets from CDM Smith's Generic QAPP (CDM Smith 2013) are applicable to this project:

- Worksheet #12ao – TCL VOCs in solid samples by EPA 8260
- Worksheet #28f – TCL VOCs in aqueous samples by EPA 8260
- Worksheet #28ar – TCL SVOCs in solid samples by EPA 8270
- Worksheet #28i – TCL SVOCs in aqueous samples by EPA 8270
- Worksheet #28aw – TCL pesticides/PCBs in solid samples by EPA 8081/8082
- Worksheet #28n – TCL pesticides/PCBs in aqueous samples by EPA 8081/8082
- Worksheet #28bc – TAL metals in solid samples by EPA 6010
- Worksheet #28u – TAL metals in aqueous samples by EPA 6010

In addition, the following worksheets are included in this QAPP:

- Worksheet #28-1 – Field analysis of solid samples for Th-232 and Ra-226 using ISOCS™
- Worksheet #28-2 – Gamma spectroscopy for solid samples by EPA 901.1M
- Worksheet #28-3 – Gamma spectroscopy for aqueous samples by EPA 901.1
- Worksheet #28-4 – Radon/thoron in air samples using alpha ATDs and charcoal canisters
- Worksheet #28-5 – Isotopic uranium in solid samples by ICP-MS (SW846 6020A) or HASL 300
- Worksheet #28-6 – Isotopic thorium in solid samples by alpha spectroscopy (HASL 300 A-01-R)

Note: Information labeled "TBD" in the following worksheets will be provided upon procurement of a subcontract laboratory. Due to the presence of radioactive contamination, all samples to be collected under the RI/FS will be analyzed by a subcontract laboratory.

QAPP Worksheet #28-1
Analytical Quality Control and Corrective Action

Matrix: Solid
Analytical Group: ISOCS™
Analytical Method/SOP Reference: GED Survey Procedures Manual (**Appendix C**), Procedure 4.6 – Routine Operations for ISOCS™ Measurements of Surface Soil

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
QC replicate count	10% of field measurement locations	| Normalized Difference | < 1.96	TBD	GED Field Manager	Accuracy	| Normalized Difference | < 1.96

QAPP Worksheet #28-2
Analytical Quality Control and Corrective Action

Matrix: Solid
Analytical Group: Gamma spectroscopy/EPA 901.1M
Analytical Method/SOP Reference: TBD

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	Target nuclides < target MDC	Correct problem, then reanalyze method blank and all samples processed with the contaminated blank	Subcontract laboratory analyst	Accuracy	Target nuclides < target MDC
LCS		Recovery Limits: Cs-137: 87-120% Co-60: 87-115% Am-241: 87-116%	Identify problem; if not related to matrix interference, reanalyze LCS and all associated batch samples	Subcontract laboratory analyst	Accuracy	Within in-house limits
Laboratory Sample Duplicate		| Normalized Difference | < 1.96	Correct problem, then reanalyze all samples processed with the duplicate	Subcontract laboratory analyst	Precision	Within in-house limits

QAPP Worksheet #28-3
Analytical Quality Control and Corrective Action

Matrix: Aqueous
Analytical Group: Gamma spectroscopy/EPA 901.1
Analytical Method/SOP Reference: TBD

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	Target nuclides < target MDC	Correct problem, then reanalyze method blank and all samples processed with the contaminated blank	Subcontract laboratory analyst	Accuracy/Bias	Target nuclides < target MDC
LCS		Recovery Limits: Cs-137: 90-111% Co-60: 89-110% Am-241: 90-111%	Identify problem; if not related to matrix interference, reanalyze LCS and all associated batch samples	Subcontract laboratory analyst	Accuracy	Within in-house limits
Laboratory Sample Duplicate		| Normalized Difference | < 1.96	Correct problem, then reanalyze all samples processed with the duplicate	Subcontract laboratory analyst	Precision	Within in-house limits

QAPP Worksheet #28-4
Analytical Quality Control and Corrective Action

Matrix: Air
Analytical Group: Radon/thoron – ATDs and charcoal canisters
Analytical Method/SOP Reference: TBD

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Duplicate (collocated) detectors	10% of the number of ATDs/canisters deployed	RPD ≤ 25%	TBD	CDM Smith FTL	Precision	RPD ≤ 25%
Known exposure measurements (spiked samples)	3 per 100 measurements; minimum of 3 per year and maximum of 6 per month	Recovery within 75-125%	TBD	CDM Smith FTL	Precision/ Accuracy	Recovery within 75-125%
Laboratory control detectors	TBD	Recovery within 80-120%	TBD	Subcontract laboratory analyst	Accuracy	Recovery within 80-120%

QAPP Worksheet #28-5
Analytical Quality Control and Corrective Action

Matrix: Solid
Analytical Group: Isotopic uranium/ICP-MS – SW846 6020A or HASL 300
Analytical Method/SOP Reference: TBD

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	No radionuclides detected above the target MDC	Correct problem, then reanalyze method blank and all samples processed with the contaminated blank	Lab Manager/Analyst	Accuracy/ Bias	No radionuclides detected above the target MDC
LCS		Recovery limits: 80-120%	Correct problem, then re-prep and reanalyze the LCS and all associated batch samples for failed analytes, if sufficient sample volume is available and samples are within 2x the hold time. Qualify data accordingly if re-prep & reanalysis cannot be performed or if re-prep & reanalysis also has failed analytes.	Lab Manager/Analyst	Accuracy	Acceptable % recoveries
MS/MSD	One MS/MSD pair per batch of 20 samples per matrix	Recovery limits: 75-125% RPD: 30%	Identify problem; if not related to matrix interference, reanalyze MS/MSD and all associated batch samples	Lab Manager/Analyst	Precision/ Accuracy	Acceptable % recoveries and RPD
Serial dilution	Each new sample matrix	1:5 dilution must agree within ±10% of original determination.	Perform post-digestion spike if serial dilution does not meet criteria	Lab Manager/Analyst	Accuracy	1:5 dilution must agree within ±10% of original determination.
Post-digestion spike	When serial dilution or MS fails	Recovery within 80-120%	Reanalyze post-digestion spike	Lab Manager/Analyst	Accuracy	Recovery within 80-120%

QAPP Worksheet #28-6
Analytical Quality Control and Corrective Action

Matrix: Aqueous
Analytical Group: Isotopic thorium/alpha spectroscopy – HASL 300 A-01-R
Analytical Method/SOP Reference: TBD

QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	Once per batch of 20 samples or fewer if total number of samples sent to lab is < 20	No radionuclides detected above the target MDC	Correct problem, then reanalyze method blank and all samples processed with the contaminated blank	Lab Manager/Analyst	Accuracy/ Bias	No radionuclides detected above the target MDC
LCS		% Recovery: Th-230: 81–118%	Identify problem; if not related to matrix interference, reanalyze LCS and all associated batch samples	Lab Manager/Analyst	Accuracy	Within in-house limits
Laboratory Sample Duplicate		| Normalized Difference | < 1.96	Correct problem, then reanalyze all samples processed with the duplicate	Lab Manager/Analyst	Precision	Within in-house limits
Tracer	Per sample, blank, LCS, MS, MSD	Th-229 tracer: ≥ 30% and ≤ 110%	Truncate carriers/tracers above 100% recovery to eliminate low biased results. Re-prep and reanalyze sample if carrier is low (indicating high biased results) if there is activity in the sample above the RL. No reanalysis if matrix interference is nonconformance during sample preparation.	Lab Manager/Analyst	Accuracy	Within in-house limits

QAPP Worksheet #29
Project Documents and Records

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage Location/Archive**
Field Logbook or Data Collection Sheets	Field Sampler or FTL or Designee	RI Task Manager	Project File
Scribe COC Forms	Sample Manager or Designee	FTL or Designee	Project File
Air Bills	Sample Manager or Designee	FTL or Designee	Project File
Sample Tracking Forms	Sample Manager or Designee	FTL or Designee	Project File
Daily QC Reports	FTL or Designee	RI Task Manager or Designee	Project File
Deviations – FCN Forms	FTL or Designee	RI Task Manager or Designee	Project File
Correspondence	CDM Smith SM	CDM Smith SM or Designee	Project File
Analytical Services Tracking System (ANSETS) Forms	Sample Manager or Designee	ASC	Project File
Soil Boring/Groundwater Logs	FTL or Designee	Field Geologist or Designee	Project File
Water Quality Data Logs	FTL or Designee	Field Geologist or Designee	Project File
Equipment Calibration and Maintenance Log	FTL or Designee	Field Scientist or Designee	Project File
Photographs	FTL or Designee	Field Scientist or Designee	Project File
Inspection and Maintenance Records	FTL or Designee	Field Geologist or Designee	Project File
Well Construction Diagrams	FTL or Designee	Field Geologist or Designee	Project File
Sample Disposal and Waste Manifests	FTL or Designee	Field Scientist or Designee	Project File
Final Assessment Report[1]	FTL or Designee	CDM Smith SM or Designee	Project File

[1]The Final Assessment Report will include analytical reports generated by the ISOCS™ system and hard copies of field surveys as appendices. The ISOCS™ data will also be presented in tabular summary form within the report to identify location, sample type, and radium and thorium results.

QAPP Worksheet #29
Project Documents and Records

Project Assessments			
Record	**Generation**	**Verification**	**Storage Location/Archive**
Corrective Action Report	QA Manager	CDM Smith SM	Project File
Self-Assessment Checklist	CDM Smith SM or Designee	QA Specialist	Project File
Data Verification Checklists	FTL or Designee	ASC	Project File
Data Validation Report	Data Validator	Chemist	Project File
Laboratory Records			
Record	**Generation**	**Verification**	**Storage Location/Archive**
Bid Sheets, Scopes of Work	RI Task Manager or Designee	Technical Reviewer and Procurement Specialist	Procurement File
Subcontract Laboratory Certifications	Laboratory QA Officer	Chemist or QA Specialist	Procurement File
Subcontract Laboratory QA Plans	Laboratory QA Officer	Chemist or QA Specialist	Procurement File
SOPs	Laboratory QA Officer	Chemist or QA Specialist	Procurement File

QAPP Worksheet #29
Project Documents and Records

Laboratory Data Deliverables			
Record	**Organics**	**Metals**	**Radiological**
Narrative	X	X	X
COC	X	X	X
Summary Results	X	X	X
Analytical sample results	X	X	X
QC Results	X	X	X
Chromatograms	X	NA	NA
Sample Preparation Log	X	X	X
Sample Run Log	X	X	X
Tentatively Identified Compounds (TICs)	X	NA	NA
Raw Data	X	X	X

QAPP Worksheet #30
Analytical Services Table

This worksheet has been combined with Worksheet #19.

QAPP Worksheet #31
Assessments and Corrective Action

Refer to Worksheet #31 in CDM Smith's Generic QAPP (CDM Smith 2013).

QAPP Worksheet #32
Assessment Findings and Corrective Action Responses

This worksheet has been combined with Worksheet #31.

QAPP Worksheet #33
QA Management Reports Table

This worksheet has been combined with Worksheet #31.

QAPP Worksheet #34
Data Verification and Validation Inputs

Refer to Worksheet #34 in CDM Smith's Generic QAPP (CDM Smith 2013) for chemical data. Data validation SOPs for radiological data (both ISOCS™ data and subcontract laboratory data) are provided in **Appendix D**.

QAPP Worksheet #35
Data Verification Procedures

Refer to Worksheet #35 in CDM Smith's Generic QAPP (CDM Smith 2013) for chemical data. Data validation SOPs for radiological data (both ISOCS™ data and subcontract laboratory data) are provided in **Appendix D**.

QAPP Worksheet #36
Data Validation Procedures

Refer to Worksheet #36 in CDM Smith's Generic QAPP (CDM Smith 2013) for chemical data. Data validation SOPs for radiological data (both ISOCS™ data and subcontract laboratory data) are provided in **Appendix D**.

QAPP Worksheet #37
Data Usability Assessment

Personnel responsible for participating in the data usability assessment: CDM Smith PM, RQAS, and ASC

The usability assessment will be completed as follows:
The Data Usability Assessment will be performed by a team of personnel at CDM Smith. The SM, Muzaffar Rahmani, will be responsible for information in the assessment and will also be responsible for assigning task work to the individual task members who will be supporting the work. Note that the Data Usability Assessment will be conducted on validated or reviewed data. After the Data Usability Assessment has been performed, data deemed appropriate for use will then be used in the subsequent project evaluation.

The Data Usability Assessment will be summarized in the DER. The following items will be assessed:

Precision – Results of laboratory duplicates will be assessed during data validation and data will be qualified according to the data validation procedures cited on Worksheet #36. Field duplicates will be assessed by matrix using the RPD for each pair of results reported above the QL for organic and inorganic analyses respectively. RPD acceptance criteria, presented in Worksheet #12, will be used to access field sampling precision. Absolute difference will be used for low results as described in Worksheets #12 and #28.

Field Duplicates – The SM will review the extent of exceedance of the field duplicate criteria. For groundwater, the sample results will be flagged according to the data validation protocol. For soils/sediment, the exceedances will be compared with the field lithological logs and grain size results, if available. Based on this review, the SM will determine whether the exceedance is due to inherent soil heterogeneity or the result of sample handling in the field or laboratory. This information will be included in the DER. As an added measure, the FTL will be asked to inspect the soil coning and quartering procedures and re-train staff if needed. The data assessor will review the data validation report. If the field duplicate comparison is not included, it will be performed by the assessor.

Accuracy/Bias Contamination – Laboratory blank results will be assessed as part of data validation. During the data validation process, the validator will qualify the data following the procedures listed on Worksheet #36. A discussion summarizing the results of laboratory accuracy and bias based on contamination will be presented and limitations on the use of the data will be described.

QAPP Worksheet #37
Data Usability Assessment

Overall Accuracy/Bias – The results of instrument calibration and MS recoveries will be reviewed and data will be qualified according to the data validation procedures cited on Worksheet #36. A discussion summarizing the results of laboratory accuracy and any limitations on the use of the data will be described.

Sensitivity – Data will be compared to criteria provided on Worksheet #15. A discussion summarizing any conclusions about sensitivity of the analyses will be presented and any limitations on the use of the data will be described. Refer to Worksheet #37 in CDM Smith's Generic QAPP (CDM Smith 2013).

Representativeness – A review of adherence to the sampling plan, field procedures, and of project QA audits will be performed in order to assess the representativeness of the sampling program. Data validation narratives will also be reviewed and any conclusions about the representativeness of the data set will be discussed.

Comparability – Study results will be used in conjunction with existing data to make qualitative and quantitative assessments of the data to be used to produce the site reports.

Reconciliation – The DQIs presented in Worksheet #12 will be examined to determine if the MPCs were met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of major impacts observed from data validation, DQIs, and MPC assessments. Based on the results of these assessments, the quality of the data will be determined. As a result of the quality determined, the usability of the data for each analysis will be established. After the combined usability of the data from all analyses for an objective is determined, it will be concluded if the DQIs were met and whether project goals were achieved. As part of the reconciliation of each objective, conclusions will be drawn and any limitations on the usability of any of the data will be described.

Completeness – The environmental database will be queried to summarize the number of sample results in each analytical fraction that are rejected versus the total data set. These data will be used along with the planned samples indicated in the QAPP to calculate the completeness of the obtained data set.

QAPP Worksheet #37
Data Usability Assessment

Data validation reports will be reviewed to determine the quality of the data and potential impacts on data usability. Field duplicates will be evaluated against the MPCs outlined in Worksheet #12. Non-compliant data will be discussed in the DER. The following equations will be used:

1. To calculate field duplicate precision:

   RPD = 100 x 2 |X1 - X2 | / (X1 + X2)

   where X1 and X2 are the reported concentrations for each duplicate or replicate.

2. To calculate completeness:

   % Completeness = V/n * 100

   where V= number of measurements judged valid and n = total number of measurements made

   % Completeness = C/X * 100

   where C= number of samples collected and X = total number of measurements planned

The results will be evaluated using temporal and spatial relationships of the data. This activity will be performed during the data usability evaluation. Not all "J" qualified data is usable, so all lines of evidence to support data use will be evaluated. Although "J" data are reasonable for use, CDM Smith will also document the evaluation of all qualified results against the values, data quality, and bias of surrounding data. If needed, qualified results at plume edges will be mapped and evaluated. Validated results will be further examined during data evaluation and re-coded in accordance with EPA Region 2 directives.

For qualified results that are outliers or at the edge of contaminated areas:

a) Discuss how data outliers will be addressed
b) Evaluate against all issues such as geology, hydrogeology, depth, past history
c) Consider whether qualified data are reasonable based on surrounding data (e.g., data qualified due to missed holding time may be lower than expected)
d) Address data quality bias and reason for qualification
e) Evaluate effect of data qualification on the data

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Tables

Table 1
Sampling Locations and Methods/SOP Requirements
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

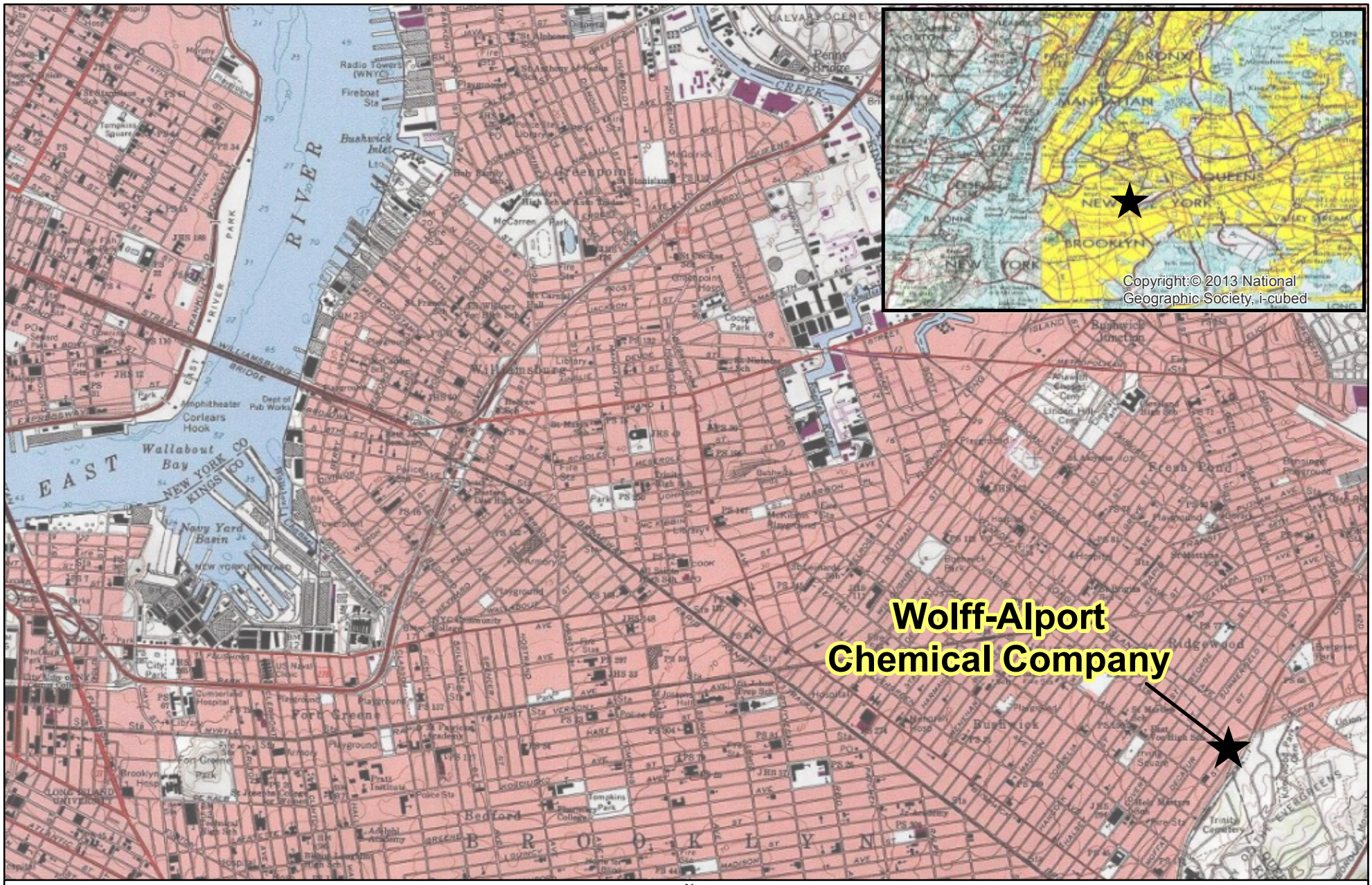
Activity/Sample Type	Matrix	Depth (feet bgs)	Analytical Group	Concentration Level	Number of Samples[1]	Sample Naming Scheme	Sampling SOP Reference	Rationale for Sampling Location
Radiological background measurements - soil borings; 8 samples collected from each zone	Soil	0-2 2-10 10-30	ISOCS™ [2]	Low	24	BKSB-(boring ##)-(top depth - bottom depth)	TSOP 1-3 TSOP 1-4 GED Procedure 3.3	Refer to Worksheet #17d
			Gamma Spectroscopy[3]	Low	3			
			TCL/TAL[4]	Trace/Low	24			
			Isotopic Uranium/Thorium[5]	Low	1			
Soil boring investigation - 35 shallow soil borings	Soil	Every 2 feet from 0-10 feet bgs	ISOCS™ [2]	Low	175	SB-(boring ##)-(top depth - bottom depth)	TSOP 1-3 TSOP 1-4 GED Procedure 3.3	Refer to Worksheet #17e
			Gamma Spectroscopy[3]	Low	18			
			TCL/TAL[4]	Trace/Low	24			
			Isotopic Uranium/Thorium[5]	Low	2			
Soil boring investigation - 8 deep soil borings	Soil	Every 2 feet from 0-30 feet bgs	ISOCS™ [2]	Low	120	SB-(boring ##)-(top depth - bottom depth)	TSOP 1-3 TSOP 1-4 GED Procedure 3.3	Refer to Worksheet #17e
			Gamma Spectroscopy[3]	Low	12			
			TCL/TAL[4]	Trace/Low	16			
			Isotopic Uranium/Thorium[5]	Low	2			
Radiological building materials survey - core samples	Building materials	NA	ISOCS™ [2]	Low	20	(material type)-##	GED Procedure 3.6	Refer to Worksheet #17f
			Gamma Spectroscopy[3]	Low	2			
Sewer investigation - soil borings	Soil	15	ISOCS™ [2]	Low	75	SWSB-(boring ##)-(top depth - bottom depth)	TSOP 1-3 TSOP 1-4 GED Procedure 3.3	Refer to Worksheet #17g
			Gamma Spectroscopy[3]	Low	8			
			Isotopic Uranium/Thorium[5]	Low	1			
Sewer investigation - construction materials samples	Construction materials	NA	ISOCS™ [2]	Low	5	(material type)-##	GED Procedure 3.6	Refer to Worksheet #17g
			Gamma Spectroscopy[3]	Low	1			
School and daycare survey - soil borings	Soil	10	ISOCS™ [2]	Low	50	SCSB-(boring ##)-(top depth - bottom depth)	TSOP 1-3 TSOP 1-4 GED Procedure 3.3	Refer to Worksheet #17i
			Gamma Spectroscopy[3]	Low	5			
			Isotopic Uranium/Thorium[5]	Low	1			
School and daycare survey - radon survey	Air	NA	Radon/Thoron	Low	42	SCRA-(sample ##)-date	GED Procedure 3.9	Refer to Worksheet #17i
Groundwater sampling and synoptic water levels	Groundwater	65-75	Gamma Spectroscopy[3]	Low	10	MW-##-(R1 or R2)	TSOP 1-12 GED Procedure 3.5	Refer to Worksheet #17k
			TCL/TAL[4]	Trace/Low	10			
Creek sediment sampling	Sediment	0-0.5, 0.5-1.0, and every 1-foot interval thereafter to 10 feet	Gamma Spectroscopy[3]	Low	140	SED-(boring ##)-(top depth - bottom depth)	TSOP 1-11 GED Procedure 3.2	Refer to Worksheet #17l
			Isotopic Uranium/Thorium[5]	Low	140			

Notes

1. Number of samples does not include QC samples, which are listed in Worksheet #20.
2. ISOCS™ samples will be analyzed in the field for Th-232 and Ra-226.
3. Samples will be collected for gamma spectroscopy at a rate of 10 percent of the number of ISOCS™ samples. Th-232 and Ra-226 will be reported.
4. TCL/TAL analyses include TCL VOCs, TCL SVOCs, TCL PCBs, TCL pesticides, and TAL metals (filtered and unfiltered).
5. Soil samples will be collected for isotopic uranium and thorium at a rate of 10 percent of the number of gamma spectroscopy samples.

bgs - below ground surface
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
TSOP - Technical Standard Operating Procedure
GED - Greenwich Environmental Designs
QC - quality control
TAL - Target Analyte List
VOC - volatile organic compound
ISOCS™ - In Situ Object Counting System
Ra-226 - radium-226
TCL - Target Compound List
NA - not applicable
SOP - Standard Operating Procedure
Th-232 - thorium-232

Figures



N
W E
S

0 0.25 0.5 1 Miles

Figure 1
Site Location Map
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Combined Storm Sewer (approximate)

Property Lines

N E S W

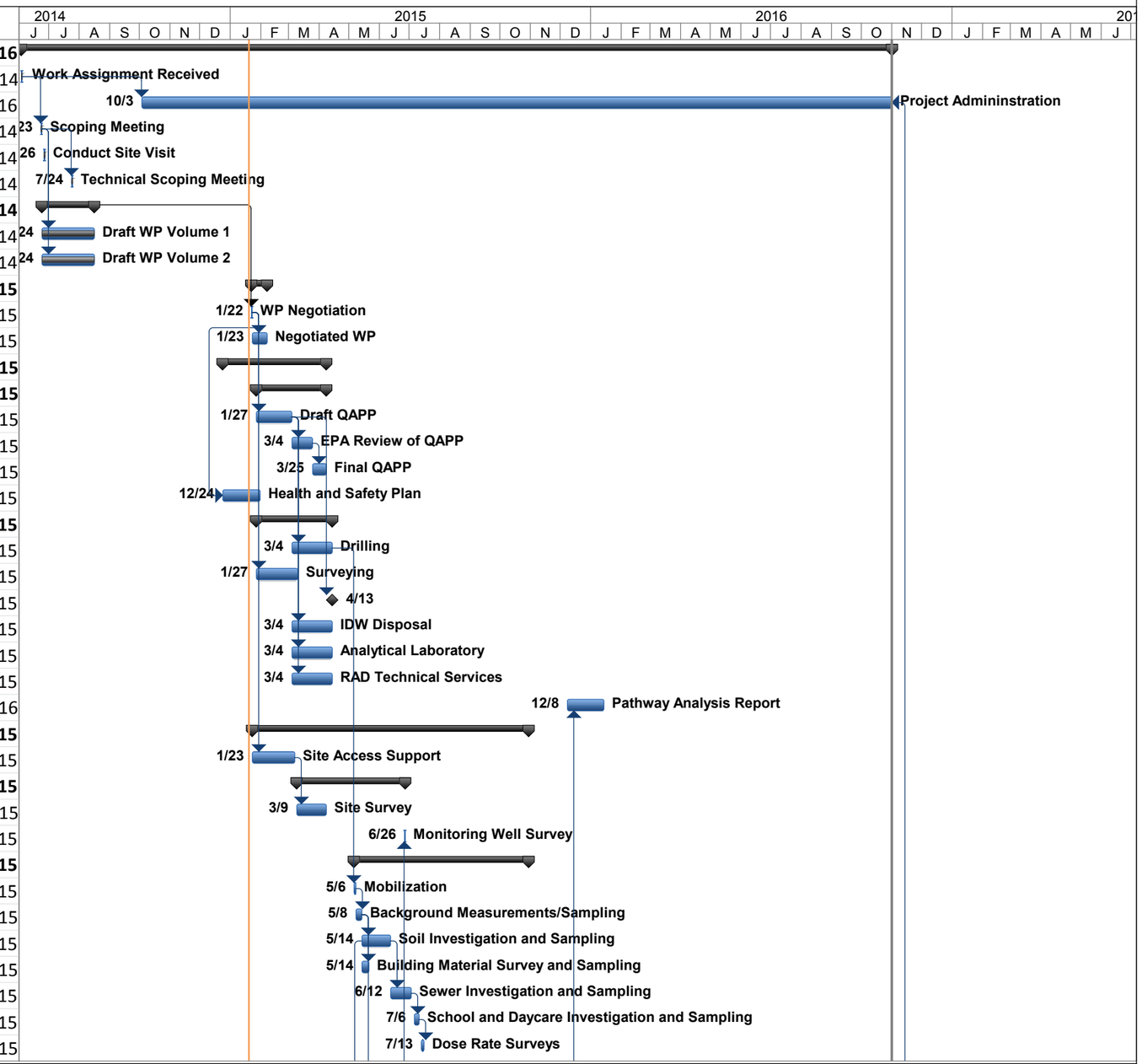
0 20 40 80 Feet

Figure 2
Site Plan
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Figure 3
Proposed Project Schedule
Remedial Investigaiton/Focused Feasibilty Report
Wolff-Alport Chemcial Company Site
Ridgewood, Queens, New York

ID	Task Name	Duration	Start	Finish
1	**Task 1 - Project Planning and Support**	**606 days**	**Tue 6/3/14**	**Mon 10/31/16**
2	Work Assignment Received	1 day	Tue 6/3/14	Tue 6/3/14
3	Project Admininstration	520 days	Fri 10/3/14	Mon 10/31/16
4	Scoping Meeting	1 day	Mon 6/23/14	Mon 6/23/14
5	Conduct Site Visit	1 day	Thu 6/26/14	Thu 6/26/14
6	Technical Scoping Meeting	1 day	Thu 7/24/14	Thu 7/24/14
7	**Prepare Draft WP and Cost Estimate**	**38 days**	**Tue 6/24/14**	**Fri 8/15/14**
8	Draft WP Volume 1	38 days	Tue 6/24/14	Fri 8/15/14
9	Draft WP Volume 2	38 days	Tue 6/24/14	Fri 8/15/14
10	**Negotiate and Revise Draft WP and Budget**	**12 days**	**Thu 1/22/15**	**Fri 2/6/15**
11	WP Negotiation	1 day	Thu 1/22/15	Thu 1/22/15
12	Negotiated WP	11 days	Fri 1/23/15	Fri 2/6/15
13	**Project Plans**	**71 days**	**Wed 12/24/14**	**Tue 4/7/15**
14	**Quality Assurance Project Plan (QAPP)**	**50 days**	**Tue 1/27/15**	**Tue 4/7/15**
15	Draft QAPP	25 days	Tue 1/27/15	Tue 3/3/15
16	EPA Review of QAPP	15 days	Wed 3/4/15	Tue 3/24/15
17	Final QAPP	10 days	Wed 3/25/15	Tue 4/7/15
18	**Health and Safety Plan**	25 days	Wed 12/24/14	Fri 1/30/15
19	**Subcontract Procurement**	**54 days**	**Tue 1/27/15**	**Mon 4/13/15**
20	Drilling	29 days	Wed 3/4/15	Mon 4/13/15
21	Surveying	29 days	Tue 1/27/15	Mon 3/9/15
22	Building Material Inspection	29 days	Wed 3/4/15	Mon 4/13/15
23	IDW Disposal	29 days	Wed 3/4/15	Mon 4/13/15
24	Analytical Laboratory	29 days	Wed 3/4/15	Mon 4/13/15
25	RAD Technical Services	29 days	Wed 3/4/15	Mon 4/13/15
26	**Pathway Analysis Report**	25 days	Tue 12/8/15	Wed 1/13/16
27	**Task 3 - Field Investigation**	**195 days**	**Fri 1/23/15**	**Thu 10/29/15**
28	Site Access Support	30 days	Fri 1/23/15	Fri 3/6/15
29	**Site Reconnaissance**	**79 days**	**Mon 3/9/15**	**Fri 6/26/15**
30	Site Survey	22 days	Mon 3/9/15	Tue 4/7/15
31	Monitoring Well Survey	1 day	Fri 6/26/15	Fri 6/26/15
32	**Remedial Investigation**	**123 days**	**Wed 5/6/15**	**Thu 10/29/15**
33	Mobilization	2 days	Wed 5/6/15	Thu 5/7/15
34	Background Measurements/Sampling	4 days	Fri 5/8/15	Wed 5/13/15
35	Soil Investigation and Sampling	20 days	Thu 5/14/15	Thu 6/11/15
36	Building Material Survey and Sampling	5 days	Thu 5/14/15	Wed 5/20/15
37	Sewer Investigation and Sampling	15 days	Fri 6/12/15	Thu 7/2/15
38	School and Daycare Investigation and Sampling	5 days	Mon 7/6/15	Fri 7/10/15
39	Dose Rate Surveys	3 days	Mon 7/13/15	Wed 7/15/15

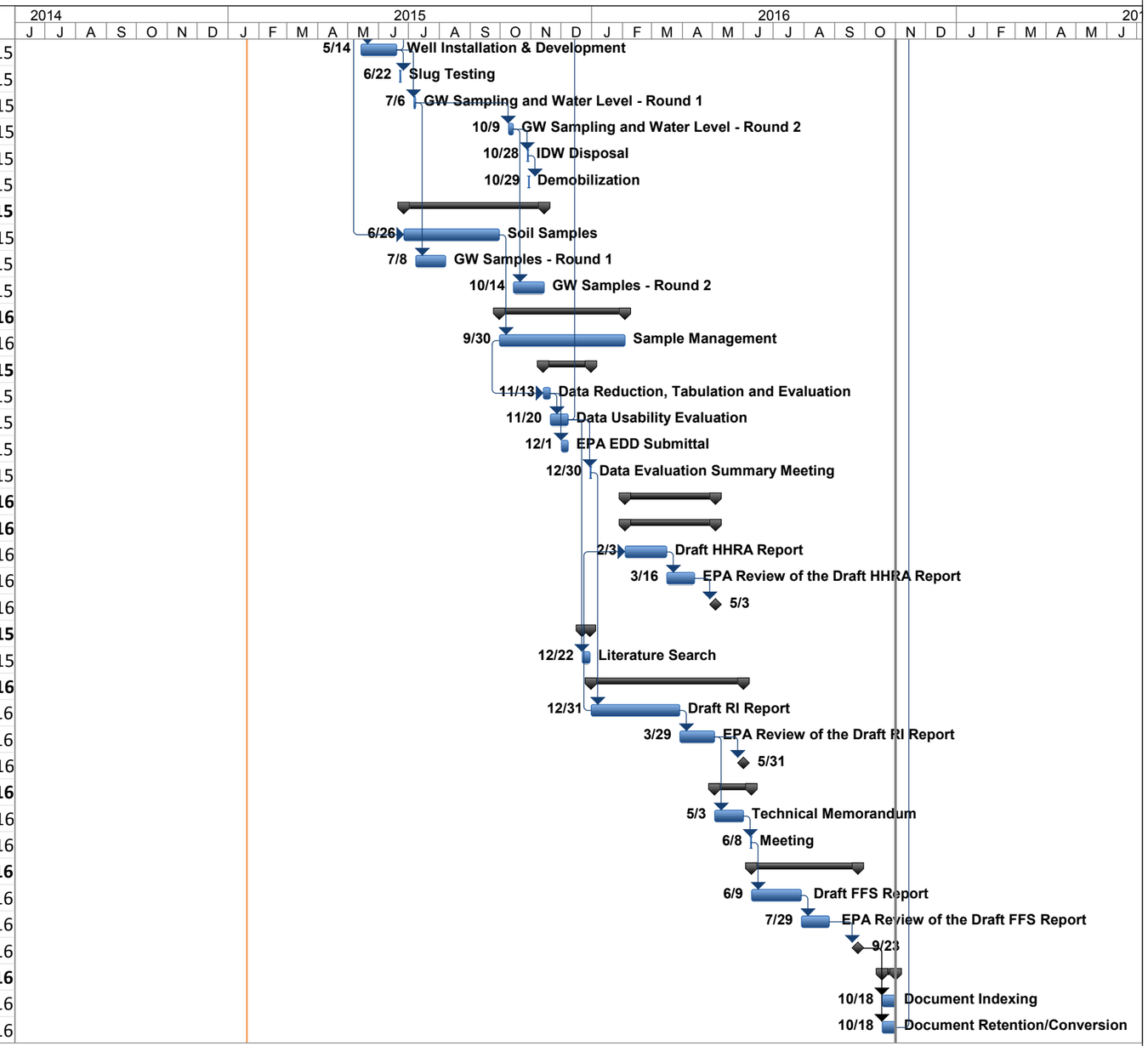


Project: WA 054 Wolff-Alport RI/FFS
Date: Tue 1/20/15

Task | Milestone | Summary | Progress

Figure 3
Proposed Project Schedule
Remedial Investigaiton/Focused Feasibilty Report
Wolff-Alport Chemcial Company Site
Ridgewood, Queens, New York

ID	Task Name	Duration	Start	Finish
40	Well Installation & Development	25 days	Thu 5/14/15	Thu 6/18/15
41	Slug Testing	1 day	Mon 6/22/15	Mon 6/22/15
42	GW Sampling and Water Level - Round 1	2 days	Mon 7/6/15	Tue 7/7/15
43	GW Sampling and Water Level - Round 2	2 days	Fri 10/9/15	Tue 10/13/15
44	IDW Disposal	1 day	Wed 10/28/15	Wed 10/28/15
45	Demobilization	1 day	Thu 10/29/15	Thu 10/29/15
46	**Task 4 - Sample Anaysis**	**97 days**	**Fri 6/26/15**	**Fri 11/13/15**
47	Soil Samples	66 days	Fri 6/26/15	Tue 9/29/15
48	GW Samples - Round 1	22 days	Wed 7/8/15	Thu 8/6/15
49	GW Samples - Round 2	22 days	Wed 10/14/15	Fri 11/13/15
50	**Task 5 - Analytical Support and Data Validation**	**83 days**	**Wed 9/30/15**	**Tue 2/2/16**
51	Sample Management	83 days	Wed 9/30/15	Tue 2/2/16
52	**Task 6 - Data Evaluation**	**31 days**	**Fri 11/13/15**	**Wed 12/30/15**
53	**Data Reduction, Tabulation and Evaluation**	5 days	Fri 11/13/15	Thu 11/19/15
54	**Data Usability Evaluation**	10 days	Fri 11/20/15	Mon 12/7/15
55	**EPA EDD Submittal**	5 days	Tue 12/1/15	Mon 12/7/15
56	**Data Evaluation Summary Meeting**	1 day	Wed 12/30/15	Wed 12/30/15
57	**Task 7 Assessment of Risk**	**64 days**	**Wed 2/3/16**	**Tue 5/3/16**
58	**Human Health Risk Assessment (HHRA)**	**64 days**	**Wed 2/3/16**	**Tue 5/3/16**
59	Draft HHRA Report	29 days	Wed 2/3/16	Tue 3/15/16
60	EPA Review of the Draft HHRA Report	20 days	Wed 3/16/16	Tue 4/12/16
61	Final HHRA Report	15 days	Wed 4/13/16	Tue 5/3/16
62	**Task 8 - Treatability Study and Pilot Testing**	**5 days**	**Tue 12/22/15**	**Tue 12/29/15**
63	Literature Search	5 days	Tue 12/22/15	Tue 12/29/15
64	**Task 9 - Remedial Investigation (RI) Report**	**105 days**	**Thu 12/31/15**	**Tue 5/31/16**
65	Draft RI Report	60 days	Thu 12/31/15	Mon 3/28/16
66	EPA Review of the Draft RI Report	25 days	Tue 3/29/16	Mon 5/2/16
67	Final RI Report	20 days	Tue 5/3/16	Tue 5/31/16
68	**Task 10 - Remedial Alternative Screening**	**26 days**	**Tue 5/3/16**	**Wed 6/8/16**
69	Technical Memorandum	20 days	Tue 5/3/16	Tue 5/31/16
70	Meeting	1 day	Wed 6/8/16	Wed 6/8/16
71	**Task 12 - Focused Feasibility Report (FFS) Report**	**75 days**	**Thu 6/9/16**	**Fri 9/23/16**
72	Draft FFS Report	35 days	Thu 6/9/16	Thu 7/28/16
73	EPA Review of the Draft FFS Report	20 days	Fri 7/29/16	Thu 8/25/16
74	Final FFS Report	20 days	Fri 8/26/16	Fri 9/23/16
75	**Task 13 - Work Assignment Closeout**	**10 days**	**Tue 10/18/16**	**Mon 10/31/16**
76	Document Indexing	10 days	Tue 10/18/16	Mon 10/31/16
77	Document Retention/Conversion	10 days	Tue 10/18/16	Mon 10/31/16



Project: WA 054 Wolff-Alport RI/FFS
Date: Tue 1/20/15

Task Milestone Summary Progress

Proposed Monitoring Wells

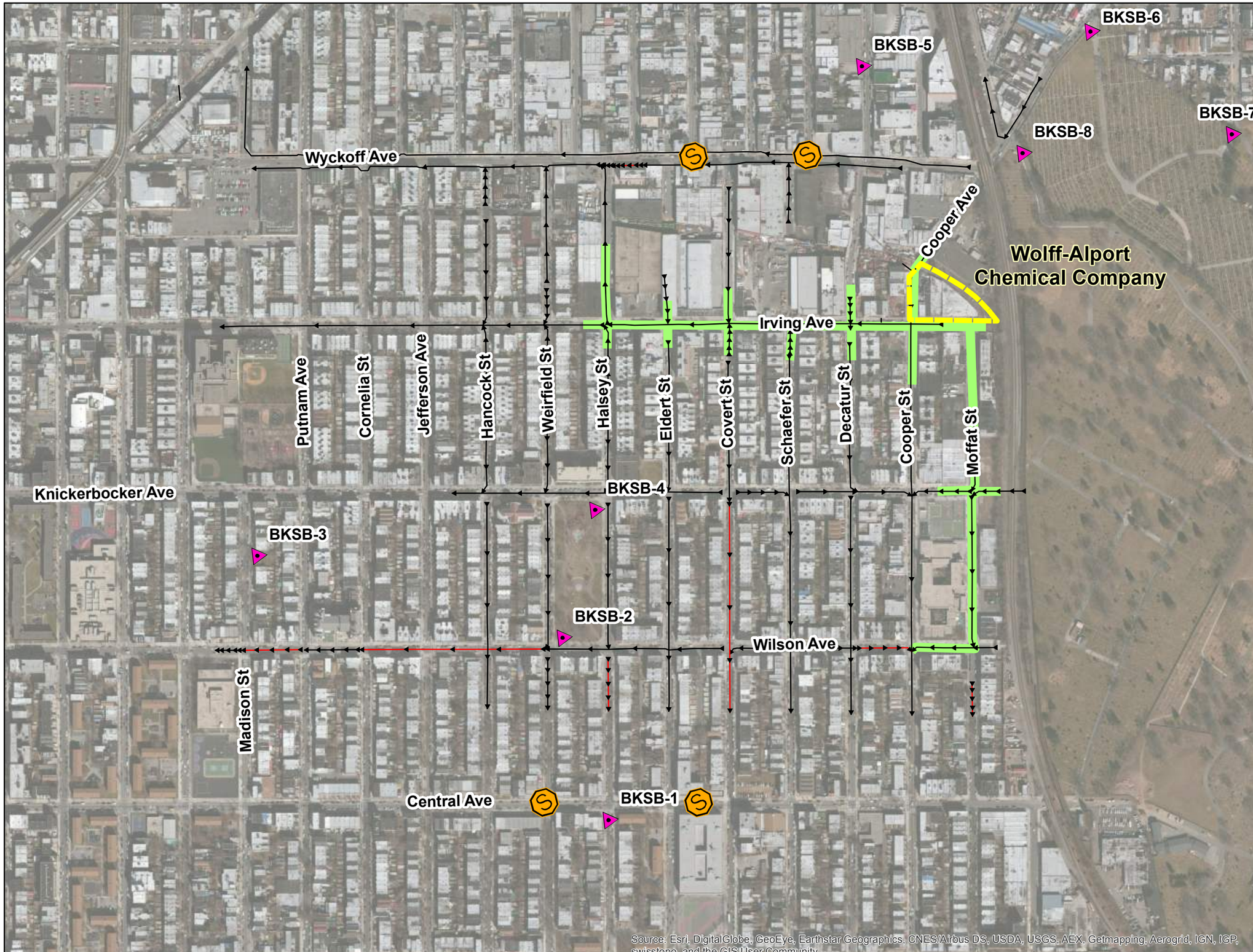
2010 USGS Piezometric Contours

N E S W

0 50 100 200 Feet

Figure 4
Proposed Monitoring Well Locations
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith



Proposed Background Locations

Background Soil Location

Background Sewer Location

Proposed Sewer Survey Area

Combined Storm Sewer (approx.)

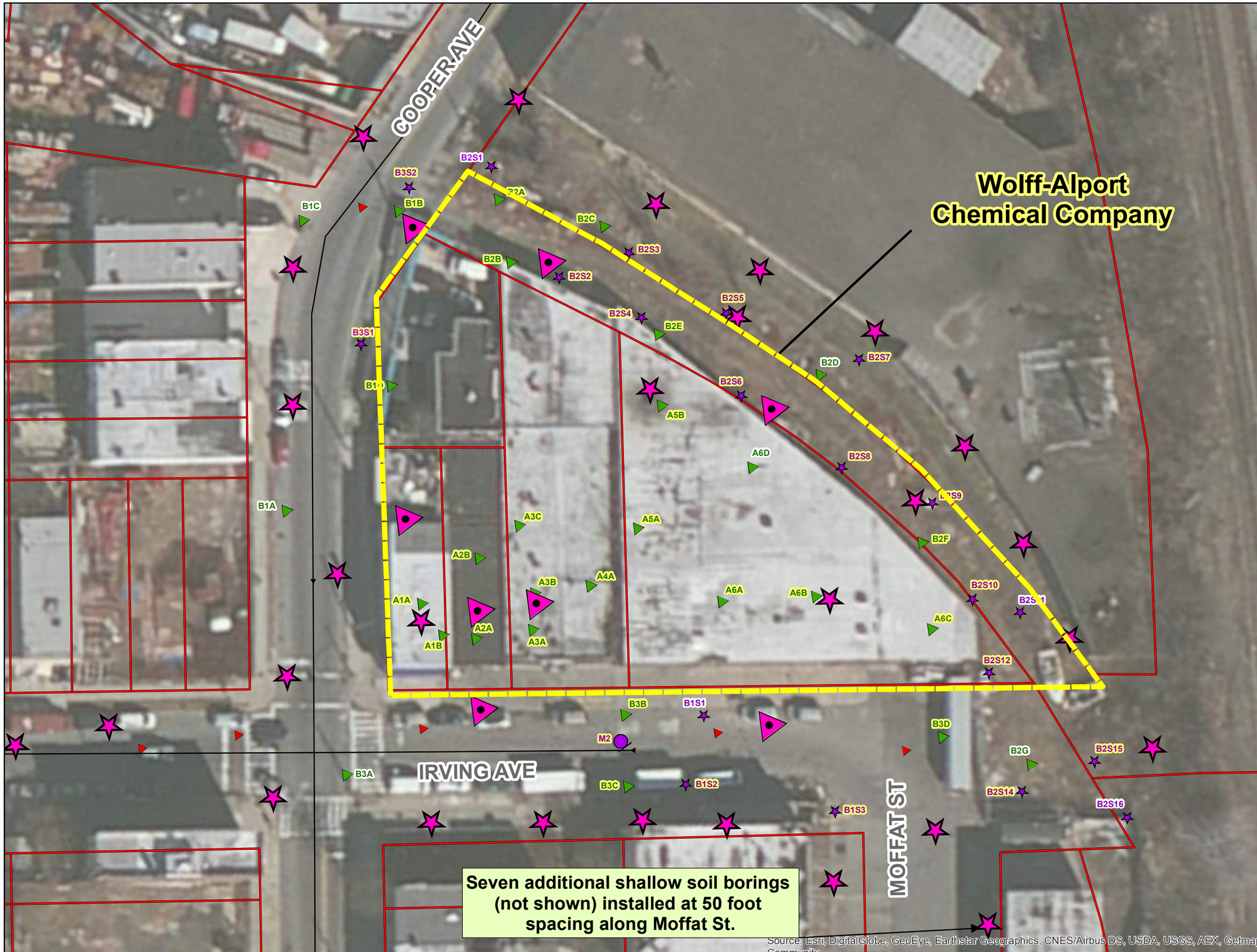
Unknown Sewer (approx.)

N E S W

0 200 400 800 Feet

Figure 5
Proposed Background
Soil and Sewer Sampling Locations
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith



Proposed Soil Borings

- Shallow Soil Boring (35 Locations)
- Deep Soil Boring (8 Locations)

2010 DDC Borings

- 2010 Soil Boring
- 2010 Road Opening
- 2010 Surface Soil

2013 BVNA Borings

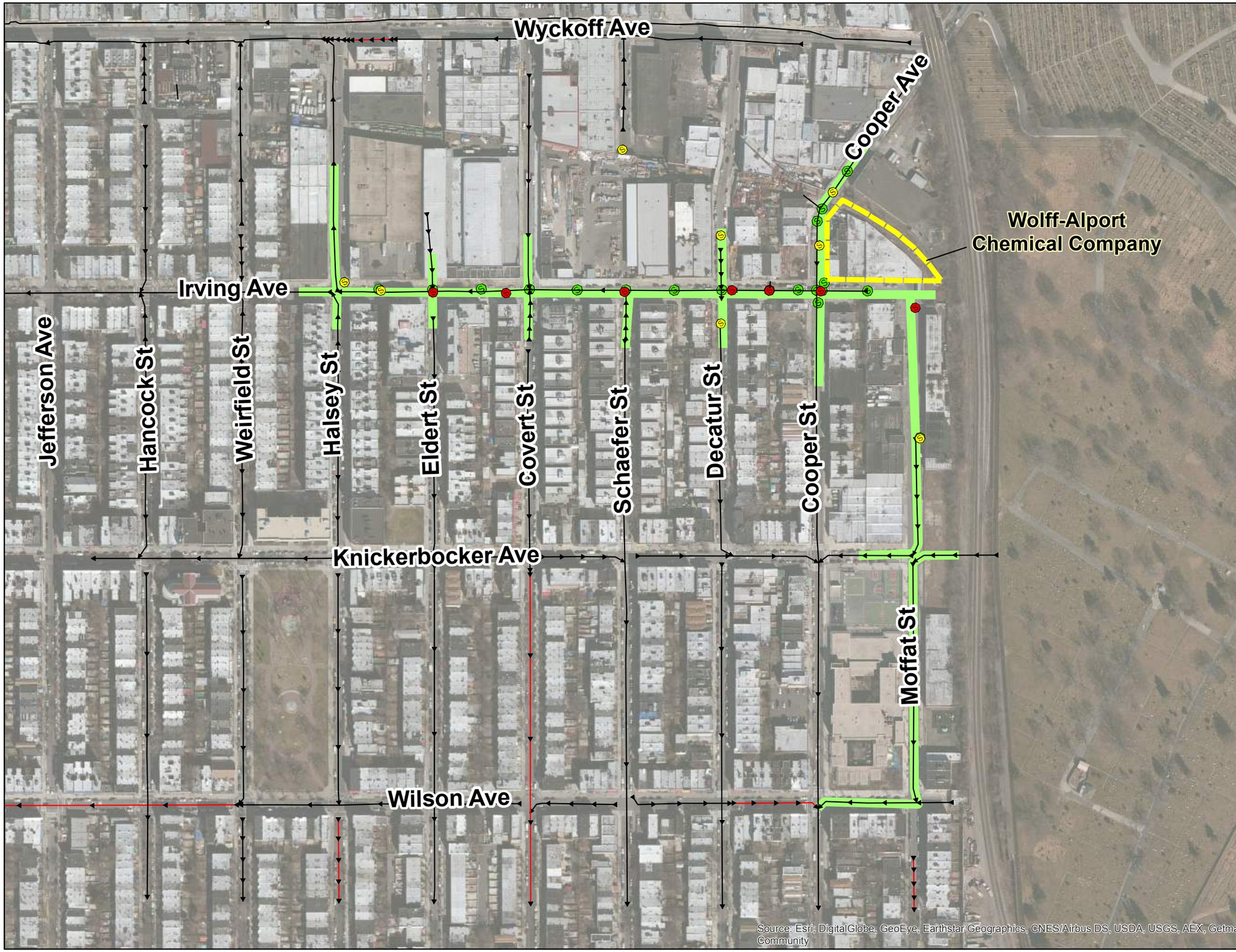
- 2013 Soil Boring
- Combined Storm Sewer (approx.)
- Property Lines

N E S W

0 20 40 80 Feet

Figure 6
Proposed Soil Boring Locations
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith



2013 BVNA Sewer Locations

- 2013 Manhole
- 2013 Manhole + SED

2010 DDC Sewer Locations

- Manhole - not investigated
- 2010 Manhole
- Proposed Sewer Survey Area
- Combined Storm Sewer (approx.)
- Unknown Sewer (approx.)

Note: Up to 10 soil borings may be advanced along the sewer lines based on the results of the sewer survey.

N E S W

0 125 250 500 Feet

Figure 7
Proposed Sewer Survey Locations
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Proposed School and Daycare Soil Borings

Shallow Soil Boring (6 Locations)

Combined Storm Sewer (approx.)

Unknown Sewer (approx.)

N
W E
S

0 37.5 75 150 Feet

Figure 8
Proposed School and Daycare
Soil Boring Locations
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

C:\IMS\GIS\Wolff Alport\MXD\QAPP\Newtown Creek_Background.mxd

Figure 9
Proposed Background Sediment Sampling Locations
Coney Island Creek
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

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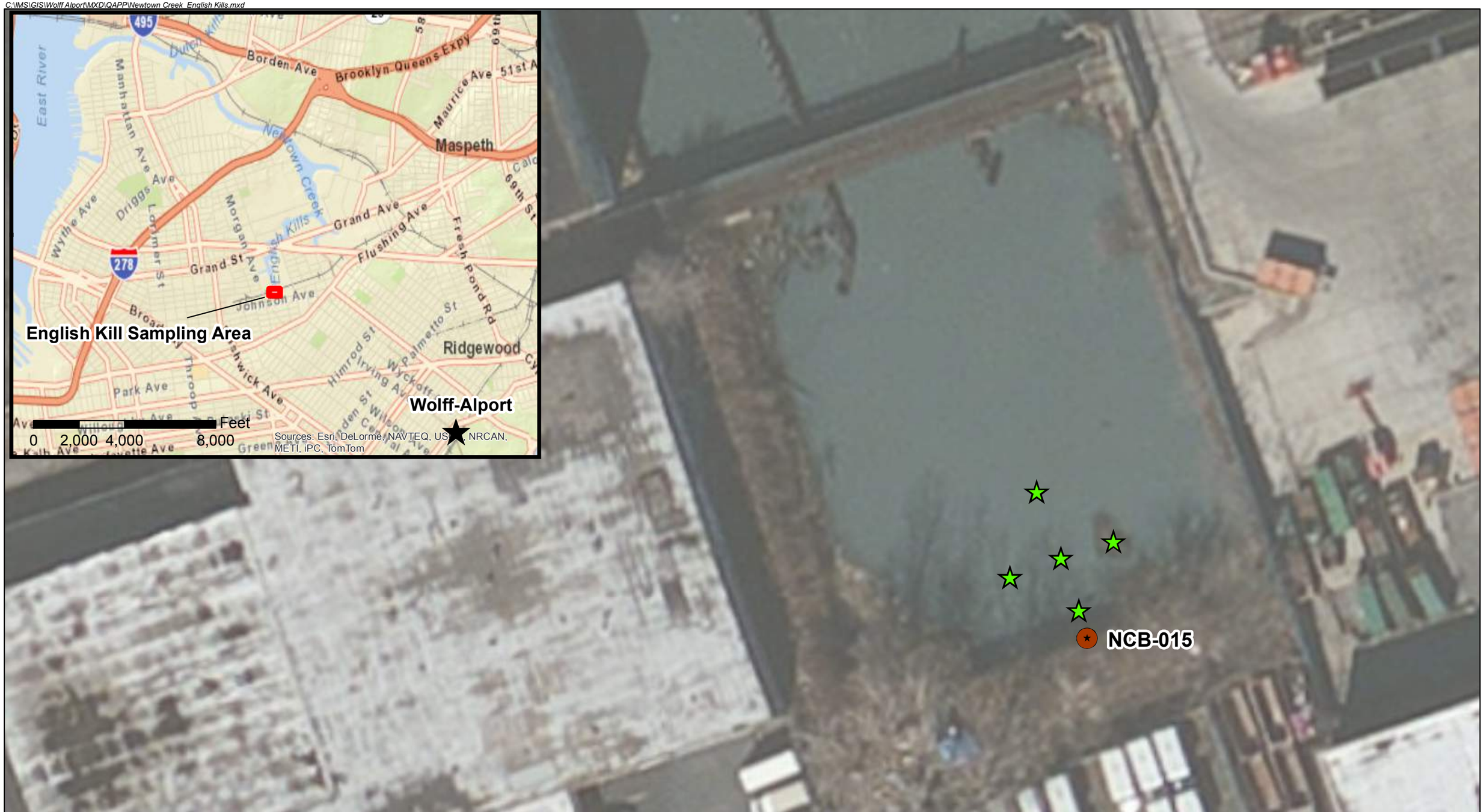

Proposed Sediment Core Location

Approximate Combined Sewer Overflow Discharge Location (Morgan Avenue Interceptor East)

N

Feet
0 15 30 60

Figure 10
Proposed Sediment Sampling Locations
Newtown Creek - English Kill
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

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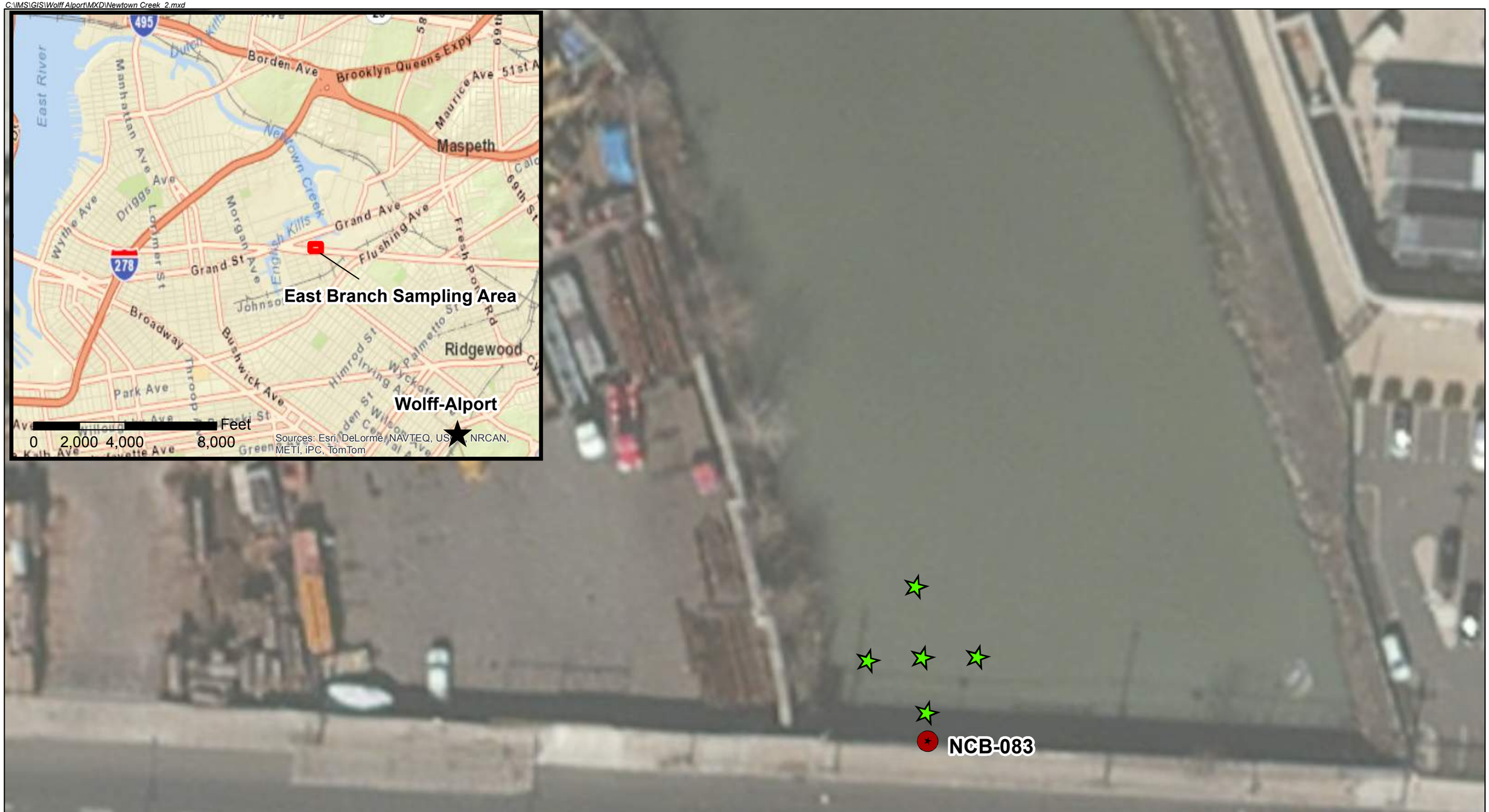


Proposed Sediment Core Location

Approximate Combined Sewer Overflow Discharge Location (Morgan Avenue Interceptor East)

N

Feet
0 15 30 60

Figure 11
Proposed Sediment Sampling Locations
Newtown Creek - East Branch
Wolff-Alport Chemical Company Site
Ridgewood, Queens, New York

CDM Smith

Appendix A

CDM Smith TSOPs

To be provided in field copy of final QAPP

Appendix B

GED Field Forms

Greenwich Environmental designs

MISCELLANEOUS SAMPLE FORM

Project Name:_____ **Date:**_____

Location:_____

Name of Surveyor(s):_____

Recorder:_____

TYPE OF RADIOACTIVITY:_____			TYPE OF RADIOACTIVITY:_____		
METER:	MODEL		METER:	MODEL	
	S/N			S/N	
PROBE:	MODEL		PROBE:	MODEL	
	S/N			S/N	

LOCATION	INSTRUMENT READING		SAMPLE TYPE	SAMPLE #	COMMENTS
	TYPE:	TYPE:			
	c/_____m	c/_____m			

Data Reviewed By (Signature):_____
Date:_____

Greenwich environmental designs

PIC CORRELATION DATA FORM

Project Name:_____ **Date:**_____

Site:_____

Name of Surveyor(s)/Recorder:_____

PIC:	MODEL	RSS 112	10 R/hr	LAST CALIBRATION
	S/N	N-320	N-2313	/ /

MEASUREMENT LOCATION:	

MENU ACCESS: MAIN - CURRENT DATA - DATA STATS

CURRENT DATA	DOSE INTEGRATOR		
		_____	µR
	START DATE:	____/____/____	
	START TIME:	_____	
	TOTAL TIME:	_____	
	AVERAGE:	_____	µR/h

MENU ACCESS: MAIN - DATA - DATA STATS

PLOT STATISTICS				
START DATE:	____/____/____	AVE:	_____	µR/h
START TIME:	_____	MAX:	_____	µR/h
END DATE:	____/____/____	MIN:	_____	µR/h
END TIME:	_____	S D:	_____	µR/h
TOTAL TIME:	_____			
TOTAL PTS:	_____			

PORTABLE SURVEY INSTRUMENTS

METER:	MODEL					
	S/N					
PROBE:	MODEL					
	S/N					
	UNITS					
	READING					

Reviewed By (Signature):_____ **Date:** _____

Greenwich environmental designs

INSTRUMENT QUALITY CONTROL CHECK FORM

METER: (READOUT)	MODEL	
	S/N	
DETECTOR:	MODEL	
	S/N	
	UNITS	
	MODE	
	HEADPHONE CHECK	

METER CALIBRATION DUE DATE	
DETECTOR CALIBRATION DUE DATE	
DATE COMBINATION BASELINE RESPONSE ESTABLISHED	

CHECK SOURCES

RADIONUCLIDE	
ID	

RADIONUCLIDE	
ID	

DATE/TIME OF CHECK	BATTERY RESPONSE	HIGH VOLTAGE	INPUT SENSITIVITY (THRESHOLD)	BACKGROUND READING	INSTRUMENT READING				SURVEY. INITIALS	LOCATION/ COMMENTS
					CHECK SOURCE #1		CHECK SOURCE #2			
					GROSS	NET	GROSS	NET		

heck Source #1: + or - 20% Net Source Response Limits are _____ to _____.

heck Source #2: + or - 20% Net Source Response Limits are _____ to _____.

ata Reviewed By: _____ Date Reviewed: _____

Greenwich Environmental designs

___ m x ___ m GRID FORM

Project Name:_____ **Location:**_____

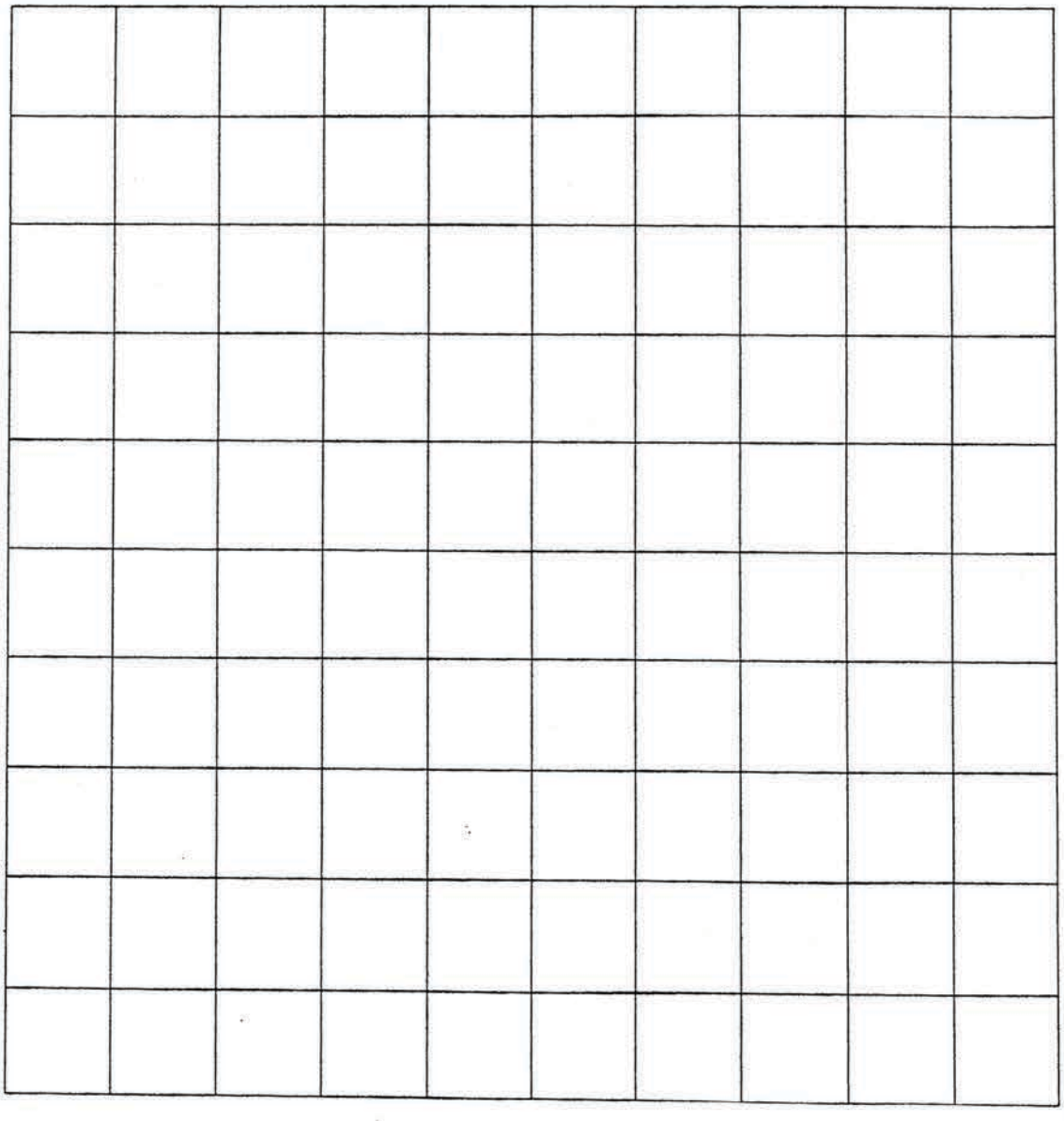
Name of Surveyor(s):_____ **Date:**_____

Recorder:_____

METER:	MODEL		METER:	MODEL	
	S/N			S/N	
PROBE:	MODEL		PROBE:	MODEL	
	S/N			S/N	
	UNITS			UNITS	

Flag#
Coor.
Coor.

Flag#
Coor.
Coor.



Reference Direction

Scale :
1 block=

Flag#
Coor.
Coor.

Flag#
Coor.
Coor.

Readings are written to the left of the point surveyed.

Readings taken at approximately 1 cm above ground surface.

Readings taken at approximately 1 meter above ground surface are circled.

Data Reviewed By (Signature):_____

Date:_____

Greenwich Environmental designs

SURFACE CONTAMINATION GRIDBLOCK FORM

Project Name:_____ **Date:**_____

Location:_____

Name of Surveyor(s):_____

Recorder:_____

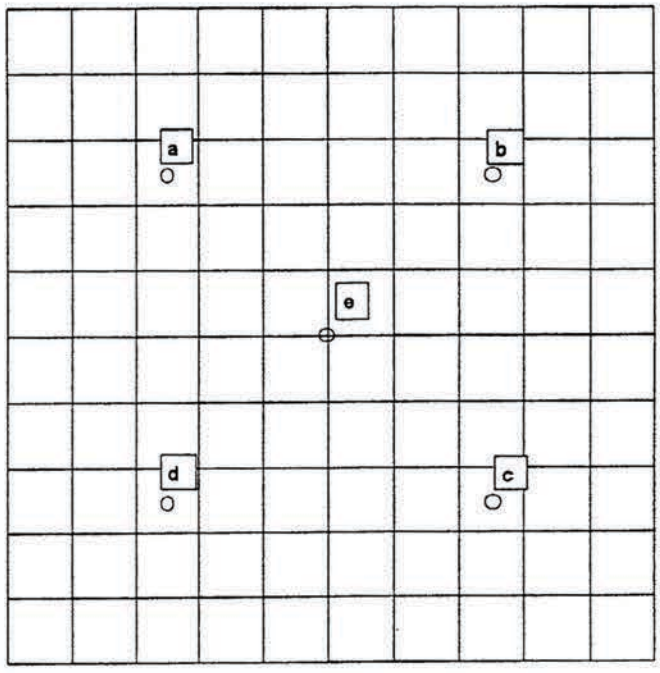
ALPHA		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

BETA		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

GRID PT.

Floor
Lower Wall
Upper Wall
Ceiling
Other:
_____

GRID PT.



GRID PT.

Reference Direction

Scale :
1 block=

GRID PT.

SCAN RANGE: alpha_____beta_____

LOCATION	INSTRUMENT READING ALPHA c/____m	INSTRUMENT READING BETA c/____m	SMEAR #
A			
B			
C			
D			
E			
AVERAGE			
F			
G			

Data Reviewed By (Signature):_____

Date:_____

Greenwich Environmental designs

CHAIN OF CUSTODY FORM

Project Name:_____ Project Manager:_____

Location:_____ Telephone No.:_____

Sample Custodian:_____ Fax No.:_____

SAMPLE IDENTIFICATION	DATE OF COLLECTION	SAMPLE DESCRIPTION	SAMPLE IDENTIFICATION	DATE OF COLLECTION	SAMPLE DESCRIPTION

Relinquished By:	Received In Good Condition By:	Time:	Date:
Method Of Shipment:			
Relinquished By:	Received In Good Condition By:	Time:	Date:
Method Of Shipment:			
Relinquished By:	Received In Good Condition By:	Time:	Date:

Greenwich Environmental designs

AREA SURVEY FORM

Project Name:_____

Location:_____

Date:_____

METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	
	UNITS	

Name of Surveyor(s):_____

Recorder:_____

ELEVATED AREAS		
GRID LOCATION	INSTRUMENT READING	AFFECTED AREA SIZE

Reference Direction

Scale:
1 block=

Data Reviewed By (Signature):_____

Date:_____

Greenwich Environmental designs

SURFACE CONTAMINATION FORM

Project Name:_____ **Date:**_____

Location:_____

Name of Surveyor(s):_____

Recorder:_____

ALPHA		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

BETA		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

LOCATION	INSTRUMENT READING		SMEAR #	COMMENTS
	TYPE:	TYPE:		
	c/_____m	c/_____m		

Data Reviewed By (Signature):_____

Date:_____

Greenwich environmental designs

FIELD SURVEY FORM

Project Name: _____

Location: _____

Date: _____

Name of Surveyor(s): _____

Recorder: _____

METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	
	UNITS	

	INSTRUMENT READING			INSTRUMENT READING	
LOCATION	SURFACE	SURFACE +1m	LOCATION	SURFACE	SURFACE +1m

Data Reviewed By (Signature): _____

Date: _____

Greenwich Environmental designs

COMPLIANCE STATEMENT FOR LIMITED QUANTITY SHIPMENT

NOTICE

CONSIGNOR (Shipper): _____

CONSIGNEE (Recipient): _____

RADIOACTIVE

This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s., UN2910.

Greenwich Environmental designs

PERSONNEL MONITORING FORM

Project Name:_____

Location:_____

MONITOR INSTRUMENT ONE		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

MONITOR INSTRUMENT TWO		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

DATE	PERSONNEL	TIME	MONITOR #	RESULT

Data Reviewed By (Signature):_____

Date:_____

Greenwich Environmental designs

INSTRUMENT MONITORING FORM

Project Name:_____

Location:_____

Recorder:_____

MONITOR INSTRUMENT ONE		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

MONITOR INSTRUMENT TWO		
METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

INSTRUMENT MONITORED	MON. #	DAY1	DAY 2	DAY 3	DAY 4	DAY 5

Data Reviewed By (Signature):_____

Date:_____

Greenwich Environmental designs

SOIL SAMPLING FORM

Project Name:_____

Location:_____

Date:_____

Name of Surveyor(s):_____

_____

Recorder:_____

METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	
	UNITS	

SAMPLE ID	LOCATION	INSTRUMENT READING			
		Surface, Before Sample Collection	Surface, After Sample Collection*	Subsurface**	
				Depth (cm)	Reading

* On area immediately adjacent to sample location

** "Down-hole" measurement after sample collection

Data Reviewed By (Signature):_____

Date:_____

Greenwich Environmental designs

FIELD SUBSURFACE SAMPLING FORM

Project Name:_____

Location:_____

Date:_____

Name of Surveyor(s):_____

Recorder:_____

METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	

LOCATION	DEPTH	INSTRUMENT READING UNITS:_____	SAMPLE #	COMMENTS

Data Reviewed By (Signature):_____

Date:_____

Greenwich environmental designs

FIELD SURFACE SAMPLING FORM

Project Name:_____

Location:_____

Date:_____

Name of Surveyor(s):_____

Recorder:_____

METER:	MODEL	
	S/N	
PROBE:	MODEL	
	S/N	
	UNITS	

LOCATION	INSTRUMENT READING		SAMPLE #	COMMENTS
	SURFACE	SURFACE + 1m		

Data Reviewed By (Signature):_____

Date:_____

Greenwich environmental designs

SAMPLE PACKAGING DATA FORM

Prepared By: _____ Date: _____

Project Site: _____

Package Contents: _____

Radionuclides: _____

Inner Container Type (size, material): _____

Outer Container Type (size, material): _____

Package Destination: _____

Transport Method: _____ Transport #: _____

SURVEY DATA

External Radiation Measurements

Instrument: _____ Background: _____

Maximum Radiation Levels (gross)

Location(side, top, etc): _____

Contact Level: _____ uR/hr

At 30 cm: _____ uR/hr

At 1 m: _____ uR/hr

Removable Surface Contamination

Instrument: _____ Background: _____

Type Radiation: _____

Removable Contamination: _____ c/m (gross) _____ dpm/100cm² (net)

Shipping Category (Refer to Survey Work Plan for Criteria):

_____ Exempt

_____ Limited Quantity

Remarks: _____

_____

Reviewed By (Signature): _____

Date: _____

Greenwich Environmental designs

BASELINE RESPONSE OF DETECTOR/READOUT INSTRUMENT COMBINATIONS

DETECTOR INFORMATION

TYPE:		CALIBRATION DATE:	
MODEL:		RECOMMENDED HIGH VOLTAGE:	
MANUFACTURER:		RECOMMENDED INPUT SENSITIVITY:	
SERIAL NUMBER:			

DATE	READOUT INSTRUMENT			OPERATING PARAMETERS		BACKGROUND	SOURCE	SOURCE RESPONSE		LOCATION/	BY
	MANUFACTURER	MODEL	SERIAL NO.	HV	SENSITIVITY	c/___m	ID	gross c/___m	net c/___m	REMARKS	
									*		

* Response range for accepting calibration: _____ to _____ c/___m

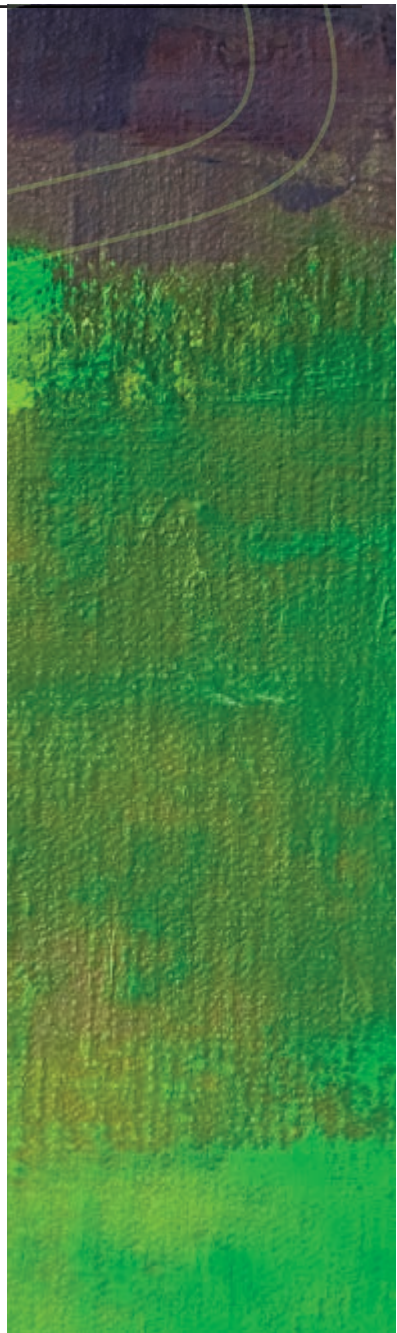
Reviewed by: _____ Date reviewed: _____

Appendix C

GED Survey Procedures Manual

Survey Procedures Manual

Effective Date: 02/01/2014
Revision No: 1



Greenwich Environmental Designs, Inc., New York, New York 10013

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INTRODUCTION

GENERAL

Greenwich Environmental Designs, Inc. (GED) conducts radiological measurements and sampling for a variety of clients. Facilities and sites surveyed are primarily those where radioactive material may remain from previous operations and the potential risk to the environment or to the health and safety of those occupying the site, previously, currently, or in the future, is of interest. Other activities include technical assistance to clients on a variety of matters related to radiation protection and health.

This Manual contains a selection of more commonly used radiological sampling and measurement methods, and survey-related activities. These methods and activities have been adapted from those used by other noted radiological survey organizations for implementation with survey resources (equipment and personnel) of GED. Experience has demonstrated these methods and activities to be accurate and adequate within the limitations of their intended applications. A companion document, "Quality Assurance Plan for Survey Activities", serves as a guide in the establishment and maintenance of quality assurance, related to radiological surveys conducted by GED.

This Manual and the Quality Assurance Plan for Survey Activities provide guidance for performing radiological surveys. However, these documents are not comprehensive for GED projects; optional or modified techniques may be required for specific situations and applications. For field activities not covered by these procedures, consensus or industry-wide procedures, such as those of EPA, DOE/EML, ANSI, ASTM, and other accepted standard organizations, may be used. Planned modifications to or deviations from established procedures and use of procedures, other than those presented in the Survey Procedures Manual, should be documented and a copy of applicable procedures should be readily available to personnel during the performance of survey activities. Also, these procedures do not include step-by-step instructions on operation of equipment and instruments. The user is referred to the operating manuals, provided by the manufacturers or suppliers, for such detailed direction.

This Survey Procedures Manual is a controlled document. Copies are distributed to all GED personnel who might use the information to perform or review work; clients may also receive copies, on request. Controlled copies of documents are uniquely identified, and a listing of assignees is maintained, along with documentation of receipt.

This Manual is reviewed annually and revised, if necessary. Interim revisions may also be performed when significant modifications or additions are required. Permanent revisions are reviewed and approved by the Field Survey Resources Committee (FSRC), prior to implementation and inclusion in this Manual.

PROJECT ORGANIZATION AND RESPONSIBILITIES

Each GED Project Manager (PM) is responsible for determining required project information, selecting methods for obtaining that information, and developing appropriate documentation to support radiological survey activities. The FSRC is available to provide technical support to projects involving radiological surveys. A Project Manager is provided survey resource support in response to a request. At the request of the PM, the FSRC assists in developing a survey work plan (SWP) and in coordinating preparation of the plan with the Health and Safety Committee and the Quality Assurance Committee to assure that requirements of these groups are also adequately addressed. Changes or modifications to plans and procedures may be made, with concurrence of the PM.

The FSRC is also available to assist the PM with selection of the survey team, designation of a member of the team as Site Survey Manager (SSM) for survey-related activities for the project, and selection and preparation of appropriate instruments and other survey equipment. It is the responsibility of each individual conducting surveys to follow established

procedures and to report deviations or abnormal results to the SSM and/or PM. Prior to initiating on-site survey activities, a pre-survey meeting of survey team personnel may be conducted to review responsibilities, specific activities, and special requirements, associated with the survey.

Responsibilities of groups and individuals are described in greater detail in the Quality Assurance Plan for Survey Activities.

FIELD RECORDS

Field survey records provide the direct evidence and support for the technical interpretations, judgments, and decisions regarding a project; they usually contain original data or information, which would be difficult, if not impossible, to replace.

All data, notes, maps, calibrations, and other information pertinent to a survey project should be recorded and maintained. Records must be legible, thorough, and unambiguous; they are to be prepared in indelible ink (black ink is preferable). Sufficient information and data should be collected to enable an independent evaluation of the site status.

Examples of information that should be included with survey data are:

- site/project identification
- measurement or sampling location (grid position and depth/height)
- instrument identification • survey personnel
- date of data collection
- data units
- unusual observations and situations
- signature of recorder

When practical, survey data are recorded on standardized forms. Forms that are generally appropriate for typical survey activities are available; these forms, examples of which are included in the Manual, maybe modified or tailored to meet the needs of a specific project, application, or site. Information that is requested on data record forms may be inappropriate or incorrect for specific applications. If so, handwritten changes should be made on the forms. When certain information on a form is not required, the space or columns should be eliminated, crossed through, or marked "N/A" (not applicable) as an indication that such information was not required, rather than having possibly been overlooked. Other information, for which forms are not a practical means of documentation, is also recorded in project files.

If data corrections are necessary, a single line is drawn through the entry; new data are then recorded and the change is initialed and dated. Data will not be obliterated by overwriting, erasing, or use of whiteout.

The SSM or designee will review records for conformance with the above requirements. Reviews should be preformed as soon after completion of the task is practical; however, it is prudent to complete such a review before on-site activities are terminated to assure that all necessary data have been obtained. The review is documented by signing and dating the record. A project-specific logbook entry may also be used to document review of large quantities of data.

SAMPLE MANAGEMENT

At the time of collection, each sample will be assigned a unique identification in accordance with Procedure 3.7 of this Manual. In addition to the sample identification code, the identity of the collector and the sampling date will be noted on the sample container in the field records.

A chain-of-custody record will be initiated for all samples, in accordance with Procedure 3.8 of the Manual.

Samples to be sent for analysis by a contract analytical laboratory will be screened to assure that radiological content satisfies the regulatory limitations of the laboratory and the transportation regulations. The Health and Safety Committee will provide guidance regarding screening; the site-specific screening procedure should be incorporated into the SWP.

DATA MANAGEMENT

The quality and validity of data should be consistently and thoroughly evaluated and documented to assure that the objectives of the survey project are satisfied and conclusions developed from the data are supported.

Data should be reported in standard units for comparison with applicable guidelines or criteria; the metric system is the system of choice, but English units may be acceptable for some applications. Typically, uncertainties are reported with data, based on counting statistics, only. If known, uncertainties resulting from other aspects of the measuring process may be combined with counting uncertainties, to estimate total uncertainties.

The initiator is responsible for a record until a task is complete. Upon completion of on-site activities, records are transported to the GED offices, either in the possession of the SSM or his/her designee or by a traceable method of shipment. If possible, records should be transported in the possession of GED personnel; if that is not feasible, the most appropriate alternate method may be selected. If items are shipped, documentation of the shipment should be included in the project survey file. Upon completion of a survey project, records will be placed in the project file and are the responsibility of the PM. When not in use, records and/or the site file will be kept in a container or an area that can be sealed or locked.

Procedure 1.1
Effective Date: 02/01/2014
Revision No: 1

PROCEDURE 1.1 REFERENCE GRID SYSTEM

1.0 PURPOSE

1.1 To provide a procedure for establishing a grid system for referencing radiological survey activities.

2.0 RESPONSIBILITIES

2.1 Areas to be surveyed may already be gridded as part of the prior decontamination and survey activities. Where possible, GED surveys will utilize this same grid system.

2.2 The GED survey team will establish indoor grids not already in place.

2.3 Gridding of open land areas will usually be performed by a professional land survey organization under subcontract arrangements. Survey personnel may perform gridding of small land areas or may subdivide grids established by other groups.

2.4 The Site Survey Manager is responsible for determining the gridding requirements and supervising on-site gridding activities to assure compliance with conditions of survey plans and subcontract agreements.

2.5 The Project Manager will prepare or approve the necessary plans, subcontracts, and other documents describing and implementing gridding operations.

3.0 PROCEDURE

3.1 Selection of Baseline

3.1.1 The grid baseline is generally selected to be the longest dimension of the property or structure, or to be coincident with a property boundary.

3.2 Referencing to Other Systems

3.2.1 Open land grids should be referenced to a location on an existing state or local grid system. This will usually require the services of a professional land surveyor and may be performed during or after the grid installation.

3.2.2 Building grids may be referenced to a permanent feature of the structure, such as a specific inside corner.

3.3 Grid Dimensions

3.3.1 GED prefers to use the metric system for gridding. This system is usually used except where an acceptable grid system in English units has already been established.

3.3.2 Grid dimensions may be mandated by the client or regulation or determined based on the potential for contamination in the area. The number of grid blocks may indirectly determine the number of systematic sampling/measurements locations and the grid dimensions may thus have to be chosen to assure that an adequate number of data points are obtained to allow for the project-specific objectives or requirements.

3.4 Open Land Grid System

3.4.1 Equipment

3.4.1.1 Compass
3.4.1.2 Global Positioning System
3.4.1.3 Measuring Tape
3.4.1.4 Grid markers (stakes, flags, flagging tape, etc.)
3.4.1.5 Chaining pins
3.4.1.6 Waterproof marker
3.4.1.7 Fluorescent paint
3.4.1.8 Mallet

3.4.2 The basic GED grid interval is 10 meters; however, this interval maybe decreased or increased, depending on the total property area and the radiological history of the site.

3.4.3 Grid line intersections, also called grid points or nodes are marked using stakes, hubs, spikes, paint, flags, or survey tape. The selection of an appropriate marker depends upon the characteristics and routine uses of the surface.

3.4.4 A specific grid point is identified as the origin for the grid. This point, generally near the center or at a corner of the property (southwest corner is preferred) is typically identified on the grid marker as point 0, 0.

3.4.5 Coordinates of other grid points are referenced to the origin using alphanumeric identifiers. The numeric identifier indicates the distance (meters or feet) and the alphabetic identifier indicates the direction from the origin, i.e. N (north), S (south), B (east), W (west), or L (left of baseline) and R (right of baseline).

3.4.6 Coordinates are identified on or adjacent to the grid point markers.

3.4.7 Any location within a grid system may be designated by measuring the distance and direction from the point of interest to a grid point marker.

3.4.8 Grid blocks can be identified by the southwest coordinate or by an assigned grid block number.

3.5 Building Grid System

3.5.1 Equipment

3.5.1.1 Measuring tape
3.5.1.2 Grid markers (masking tape, markers, paint, chalk)

3.5.2 The basic GED building grid interval is 1 meter. If a grid system has been previously established, GED may use that system.

3.5.3 Grid blocks are marked on the floor and lower wall (up to 2 meters) using a chalk line or other

appropriate marking system. The starting point for referencing the grid is usually selected as the southwest corner of the room. Grid blocks can be identified by the southwest coor dinate for floors and the lower left coordinate for walls, or by an assigned grid block number (also see step 3.5.9, below).

3.5.4 Grid points (grid line intersections) are marked using paint, tape, grease pencil, chalk or equivalent. The owner's permission is required before using paint or other markers that may deface the surface.

3.5.5 Grid points are identified using an alphanumeric system. Lines perpendicular to the baseline are identified alphabetically; lines parallel to the baseline are identified by a number indicating the distance from the baseline. Grid points are labeled with their identifiers.

3.5.6 Any location within a grid system may be designated by measuring the distance from the point of interest to a grid marker.

3.5.7 Where buildings contain multiple rooms, it may be convenient to individually grid each room, rather than attempting to include all areas on the same system. This is at the discretion of the Project Manager.

3.5.8 Small rooms (less than 10 m2) do not require gridding, but grids may be installed for consistency.

3.5.9 Upper walls and ceiling areas are usually gridded only if there is a likelihood that contamination is present on these surfaces. If not gridded, measurements on these surfaces are referenced to prominent building features or to locations corresponding to the floor and lower wall grid.

3.5.10 Portions of building external surfaces that will be surveyed are also gridded at 1meter intervals.

3.5.11 Large items of equipment that are to be surveyed are individually gridded at 1meter intervals; these grids are referenced to the building surface grid, where appropriate.

3.6 Site Drawings

3.6.1 Following establishment of the grid system, a drawing is prepared by the survey team or the land surveyor, indicating the grid, site boundaries, and other pertinent site features. A legend should be included on the drawing indicating the following information: site name, surveyor, date, distance scale and reference compass direction. Drawings used to record data should first be made permanent by tracing in ink or producing a photocopy prior to the addition of data to the page.

Procedure 1.2
Effective Date: 02/01/2014
Revision No: 1

PROCEDURE 1.2 BACKGROUND MEASUREMENTS AND SAMPLING

1.0 PURPOSE

1.1 To describe the considerations for performing measurements of background direct radiation levels and for collecting samples of media to analyze for background radionuclide concentrations.

2.0 RESPONSIBILITY

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 The Project Manager or his/her designee is responsible for selecting locations for background determinations.

2.3 Survey team personnel are responsible for following this procedure while collecting background samples and measuring background radiation levels.

3.0 PROCEDURE

3.1 Guidelines for residual radioactivity are expressed in terms of radiation or activity levels above ambient background for a specific site of interest. It is therefore necessary to establish background levels in order to eventually determine net residual radiation levels or concentrations for comparison with guidelines.

Background, as related to radiological survey operations, is of two general categories. One of these is the concentration of material, naturally occurring in environmental media (air, soil, water, vegetation) and incorporated into construction materials. Examples of such radionuclides are carbon-14, potassium-40, uranium and thorium and their associated daughter products, and cesium-137 from worldwide fallout. The second category of background radiation is the direct radiation level, produced by the materials from the first category, plus the direct radiation from extraterrestrial sources.

Concentrations of naturally- occurring radioactive materials vary, as do direct radiation levels from those materials and cosmic sources. Background radiation will therefore be a distribution of values, rather than a single value. The range may vary from location to location on a particular site; the degree of variation may be small or significant enough that more than one background value must be determined for application at the site.

3.2 Locations for Background Measurements and Samples

3.2.1 Outdoor

3.2.1.1 Locations for measurement and sampling are selected from within a 0.5 to 10 kilometer radius of the site.

3.2.1.2 Locations should be undisturbed by radioactivity from the candidate site or other anthropogenic sources (e.g., fertilizers containing elevated concentrations of uranium and potassium and building materials with high natural levels of uranium and thorium).

3.2.1.3 If the radionuclides of interest are from the naturally occurring series, efforts should be made to obtain background concentrations from geologic formations similar to that at the site.

3.2.2 Indoor

3.2.2.1 Locations should not be potentially impacted by contamination, but may include influences determined to be naturally occurring in building materials. Preferable locations are within on-site buildings of similar construction, but having no history of radioactive materials operations.

3.2.2.2 If the background determined at the time of calibration is not representative of site conditions, or different areas on-site have influences causing backgrounds to vary, then site/area specific backgrounds should be determined. See Procedure 2.1.

3.3 Background Measurements

3.3.1 Measure the external gamma exposure rate at 1 meter above the ground surface using a pressurized ion chamber (PIC) (see Procedure 2.4).

3.3.2 If appropriate for the specific site, measure the alpha dpm/l00 cm2 and the beta dpm/l00 cm2 (see Procedure 2.3).

3.4 Background Sampling

3.4.1 Collect a sample of soil. Soil sampling procedures are described in Procedure 3.3.

3.4.2 When potential contamination of water is of concern to the survey objectives, a water sample should be collected from surface sources upstream from the site of concern. Water sampling procedures are described in Procedure 3.5. Sediment samples should also be collected at locations where surface water is obtained (see Procedure 3.2).

3.4.3 Collect samples of other environmental media (e.g., air and vegetation) that are appropriate based on the types of samples to be collected on-site.

3.4.4 Collect samples of building materials, if necessary, to determine the extent of naturally occurring radioactivity present.

3.5 Number of Background Measurements/Samples

3.5.1 The degree to which the average background of a particular radiological parameter (concen tration or direct radiation level), determined for a specific site, is representative of the true background value is a factor in determining the number of measurements required for that determination. Many radionuclides are not present in the environment at levels that are sufficient to be either quantifiable using reasonable, standard measurement techniques or which are significant, relative to guidelines for unrestricted site use. On the other hand, levels of direct radiation (exposure rates) and some naturally occurring (uranium and thorium decay series) or manmade (cesium-137) radionuclides are typically present in the environment at levels which are easily quantifiable and may have background levels which are significant, relative to guideline values.

For practical purposes, it is recommended that 21 measurements for each parameter of concern are performed initially and the average and distribution be determined.

Guidance on identifying additional background data needs is available from several sources (e.g., draft NUREG/CR-5849, MARSSIM, and NUREG-1501). If the PM anticipates that the selection of appropriate background values will be a critical factor in the evaluation and interpretation of the survey findings, determining project specific background needs should be addressed in accordance with procedure 4.1. Large variations in background levels within a site may require that the site be subdivided and separate backgrounds determined for the individual portions to establish.

Procedure 2.1
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.1 INSTRUMENTATION: CALIBRATION & QUALITY CONTROL

1.0 PURPOSE

1.1 To describe the general approach to calibration and quality control checks of survey instruments.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Calibration

3.1.1 Instruments to be used for quantitative measurements are source calibrated a minimum of every twelve months; more frequent calibration may be necessary for some projects or applications to satisfy requirements of the responsible regulatory agency or following repair of the instrument. Exception: A properly calibrated Pressurized Ionization Chamber may be used as a secondary standard to calibrate response of a gamma detector, relative to true exposure rate (refer to Procedure 2.5).

3.1.2 Calibration is to be performed with standards traceable to the National Institute of Standards and Technology (NIST) or other industry recognized standards organizations.

3.1.3 Records will be maintained for each detector and readout instrument, detailing the calibration and maintenance history. Originals of calibration records are to be maintained at the GED New York main office facility; however, copies should accompany instruments to the field measurement location.

3.1.4 Calibration will be performed by the instrument manufacturer or other outside organization. GED will provide directions/specifications for calibration by outside agencies. An exception to manufacturer calibration is calibration of gamma detectors, using a pressurized ionization chamber (see Procedure 2.5). Calibration for response of surface contamination monitors to radionuclides or radionuclide mixtures for which commercial calibration services are not available or practical may necessitate in-house determination of source response or theoretical calculation of response, based on estimated parameters, e.g., from draft NUREG-1507. If in-house calibration is performed, detailed procedures will be developed, approved by the Field Survey Resources Committee, and placed in the appropriate project file.

3.1.5 Instruments, such as a pressurized ionization chamber, may be calibrated as a detector/read out combination; if calibrated in this manner, quantitative measurements are made only with the components and parameters for which the combination was calibrated.

3.1.6 Detectors and readouts, which are individual pieces of equipment, are usually calibrated separately; however, a calibrated detector may be used with various calibrated readout in struments, even if a specific source calibration of the combination has not been performed. To enable such use, the baseline response of the calibrated detector to a designated check source is determined immediately after return of the detector from calibration, using a readout instrument (for which the calibration is also current) with the operating parameters, e.g., high voltage and threshold (input), set according to those parameters at which the de tector was calibrated. Where possible, for an analog readout instrument, select a scale on which the source will provide a reading of between half-and full-scale; for an integrating digital readout instrument select a count time which will result in accumulation of at least 10,000 counts. Each detector/readout combination, which satisfies the acceptance criterion for the designated baseline check source may be assumed to be responding with the efficiency established for the detector. This record is filed with other detector response, calibration, and maintenance information. (see procedure 4.1)

3.2 Quality Control Check

3.2.1 Equipment

3.2.1.1 Instrument (detector and/or readout)

3.2.1.2 Cables

3.2.1.3 Check source

3.2.1.4 Pulse generator (Ludlum Measurements, Inc. Model 500 or equivalent)

3.2.1.5 Calibration documents

3.2.1.6 Forms for Baseline Detector Response and Instrument QC Check

3.2.2 Procedure

3.2.2.1 This procedure is applicable to all field survey instruments.

3.2.2.2 Quality control checks are performed prior to sending instruments to the field, at the beginning and end of each day of data acquisition, upon return of the instrument from a field assignment, at any time instrument factors (batteries, cables, operating parameters,etc.) which could effect the instrument response are altered, and whenever the performance of an instrument is in question.

3.2.2.3 Assure that the baseline response has been established, that the response to the check source has been determined, and that the response was satisfactory (refer to Step 3.1.6).

3.2.2.4 All equipment associated with instrument operation (e.g., tubing, flow meters, collimators, headphones, etc.) should be in place when testing response to assure proper operation of the complete system.

3.2.2.5 Turn the instrument on and check batteries. Record result on Instrument QC check form; replace batteries and repeat test, if necessary.

3.2.2.6 Check high voltage, threshold, and other operating parameters; record values and, if necessary, adjust parameters to predetermined values and repeat checks. For some instruments it will be necessary to use the Ludlum Pulse Generator to determine and adjust the operating parameters.

3.2.2.7 Determine and record the background response. The site-specific background will be determined at each site at a location selected by the Site Survey Manager to have low and consistent background levels. Typical background instrument responses are as follows:

Instrument	Background Response
Ludlum Model 19	5 to 15 μR/h
Bicron microrem	3 to 10 μrem/h
Ludlum 44-2	1,000 to 4,000 counts/min
Ludlum 44-9	1 to 60 counts/min
Ludlum 44-10	3,000 to 6,000 counts/min

3.2.2.8 Place the baseline check source in contact with the detector and determine and record the analog or integrated digital response, as appropriate. Calculate the net response compare with the previously established acceptable baseline response range. (see procedure 4.1) If the source falls within that range, the instrument may be considered to be operating properly. If the response does not fall within the acceptable range, the instrument should not be used for quantitative measurements unless a thorough evaluation justifies otherwise.

3.2.2.9 If the instrument response to the baseline source is acceptable, select a QC check source and place the appropriate surface in contact with the designated location on the detector or instrument. Turn on the audible output to confirm its operation.

3.2.2.10 Where possible, for an analog readout instrument, select a scale on which the QC check source will provide a reading of half- and full-scale; for an integrating digital readout instrument select a count time which will result in accumulation of at least 10,000 counts. Determine and record the gross and net instrument response on the appropriate form. For instruments that will be operated in the scaler mode, re peat the determination ten times and calculate the average; one reading is recorded for instrument to be operated in the rate-meter mode. Calculate and enter the range of acceptable instrument response as the average ±20%.

3.2.2.11 To check response of the instrument, relative to the predetermined acceptable QC response range, place the source at the designated source test position and determine and record the analog or integrated digital response, as appropriate. Calculate the net response and compare with the previously established acceptable response range. If the source falls with that range, the instrument may be considered to be operating properly. If the response does not fall within the acceptable range, data recorded since the previous acceptable test should be considered questionable, and not used for quantitative purposes, unless a thorough evaluation justifies otherwise.

Procedure 2.2
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.2 SURFACE SCANNING

1.0 PURPOSE

1.1 To provide a method for identifying areas of elevated direct radiation

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented. Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Surfaces are scanned to determine the level of gross activity present. Action levels are determined based on guidelines established for each site and serve as indicators that further investigation is necessary. Scans are conducted for all radionuclides potentially present based on the site history. Monitoring for the unexpected is also recommended.

3.2 Surface Scanning

3.2.1 Equipment

3.2.1.1 Ratemeter-scaler: Model 3 or Model 2221, Ludlum Measurements, Inc. or equivalent, equipped with audible speaker

3.2.1.2 Detector: Selected detectors are indicated below. Equivalent detectors are also acceptable

Activity	Detector Type	Model
alpha	ZnS scintillator gas proportional	Ludlum 43-1,Eberline AC3-7 or AC3-8 Ludlum 43-68, Ludlum 239-1
beta	gas proportional	Ludlum 43-68, Ludlum 239-1
alpha-beta	gas proportional	Ludlum 43-68, Ludlum 239-1
beta-gamma	Geiger-Mueller	Ludlum 44-9, Eberline HP-260
gamma	NaI(Tl)scintillator	Ludlum 44-2 or 44-10,Eberline SPA-3

3.2.1.3 Cables

3.2.1.4 Check sources

3.2.1.5 Record forms

3.2.2 Quality Control Check

3.2.2.1 Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and check source responses. Follow procedures described in Procedure 2.1.

3.2.3 Scanning

3.2.3.1 Set the instrument for 'FAST' response, where possible. Headphone use is recom mended for scanning.

3.2.3.2 Pass the detector slowly over the surface. The detector should be kept as close to the surface as conditions allow. Gamma scanning is usually performed by moving the detector from side to side in front of the body while progressing at the speed of a slow walk. The speed of detector movement over the surface and rate at which sur veyor advances across the surface will vary depending upon the radionuclide of concern and the experience of the surveyor; the typical advancing speed is 0.5 to 1.0 meter per second. When scanning for alpha or beta activity, the detector is typically moved about one detector width per second.

3.2.3.3 Note increases in count rate as indicated by the audible meter output. Compare count rates to the established site action level (see Procedure 2.3, Part 3.3.1).

3.2.3.4 Mark areas that meet or exceed action levels using survey flags for open land areas and grease pencil, paint, chalk or other appropriate method for other surfaces. Further in vestigation may be necessary at these locations.

3.2.3.5 Continue traversing the area at intervals appropriate for the percent coverage specified. This will vary depending upon the site's radiological history, contamination potential, and findings as the survey progresses.

3.2.3.6 After a specific area (usually a grid block or grid line) has been scanned, map the dimensions of any areas of concern; record locations and levels of ambient gamma radiation and elevated gamma radiation on the appropriate record form.

Procedure 2.3.
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.3 DIRECT RADIATION MEASUREMENT

1.0 PURPOSE

1.1 To describe the method for measuring total alpha and beta radiation levels on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Ratemeter-scaler: Model 3, Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent

3.1.2 Detector: Selected detectors are listed below: Equivalent detectors are also acceptable

Activity	Detector Type	Model
alpha	ZnS scintillator gas proportional	Ludlum 43-1 or 43-5 Ludlum 43-68
beta	Geiger-Mueller gas proportional	Ludlum 44-9, Eberline HP-260 Ludlum 43-68

3.1.3 Cables

3.1.4 Check source

3.1.5 Record forms

3.2 Quality Control Check

3.2.1 Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and check source responses. Follow the procedures described in Procedure 2.1.

3.3 Direct Measurement

3.3.1 When applicable, team members performing instrument checks will calculate the average and maximum "field action levels" for instrument combination based on the specific site criteria and background.

Action level(cpm) = [site criteria (dpm/l00 cm')x E x G x T] + B

T = count time (minutes)

E = operating efficiency (counts/disintegration)

G = geometry (total detector area (cm2)/100)

B = background (cpm)

Detector	Total Area	Active Area
43-5 detector area =	80 cm2	60 cm2
43-1 detector area =	80 cm2	50 cm2
3-68 detector area =	126 cm2	100 cm2
44-9 detector area =	20 cm2	15.5 cm2
HP-260 detector area =	20 cm2	15.5 cm2

A field count at or above this value indicates that further investigation in this location is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3.2 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable activity (see Procedure 4.2) value less than 50% of the applicable criteria. For most radionuclides a 1-minute count, using the instruments listed above, is adequate to achieve this sensitivity. For radionuclides having guidelines of 5000 dpm/l00 cm2, average and 15,000 dpm/l00 cm2, maximum, 0.5 minute counting times may be acceptable.

3.3.3 Place the detector face in contact with the surface to be surveyed. The detector face is typically constructed of a very thin and fragile material, so care must be exercised to avoid damage by rough surfaces or sharp objects. (Scans should have been performed, prior to this point, to identify representative locations and locations of elevated direct surface radiation for measurement.)

3.3.4 Set the meter timer switch, press the count-reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.5 Record the count and time on the appropriate record form.

3.3.6 If the location has a surface activity level above background, the area around the measurement locations should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the appropriate record form.

3.3.7 The surface activity may be calculated according to Procedure 4.3.

Procedure 2.4
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.4 GAMMA RADIATION (EXPOSURE RATE) MEASUREMENT

1.0 PURPOSE

1.1 To describe the method for measuring external gamma radiation levels in buildings and over ground surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Pressurized Ion Chamber (PIC)

3.1.1 Equipment

3.1.1.1 Pressurized Ion Chamber: Model RSS-11, Model RSS112, or Model RSS-1011, Reuter Stokes Co., or equivalent

3.1.1.2 Gamma-sensitive survey instrument (refer to Section 3.2 of this procedure

3.1.1.3 Tripod

3.1.1.4 Check sources

3.1.1.5 Record forms

3.1.2 Quality Control Check

3.1.2.1 Assemble instrument, turn on, check batteries, and allow to stabilize approximately 10 minutes. Check background level and response to the gamma check source. Follow procedures described in Procedure 2.1.

3.1.2.2 An action level may be established by the SSM, based on the exposure rate guidelines that have been established for the site. For a particular site the action level may be established as any activity exceeding background. A field measurement at or above this value indicates that further investigation at this location is necessary.

3.1.3 Measurements

3.1.3.1 Adjust the tripod to place the center of the detector chamber approximately 1 meter above the surface.

3.1.3.2 Place the readout unit several meters from the detector to minimize shielding by the readout housing and maintain a distance of several meters from the detector to prevent effects on the exposure rate, due to shielding and/or natural body activity. Allow the PIC to stabilize approximately 5 minutes after moving.

3.1.3.3 Following the instructions provided in the manufacturer's operating manual, obtain a series of 10 consecutive rate readings or integrate the exposure over a predetermined time. The method to be used will be established by the PM.

3.2 Scintillator

3.2.1 Equipment

3.2.1.1 Ratemeter: Model 3, Ludlum Measurements, Inc.; or equivalent

3.2.1.2 Sodium iodide detector: Model 44-2, Ludlum Measurements, Inc.; Model SPA-3 or PG-2, Eberline Instrument Corporation; or equivalent

3.2.1.3 Micro R Meter: Model 19, Ludlum Measurements, Inc.; Micro Rem Meter, Harshaw Bicron Radiation Measurement Products, or equivalent

3.2.1.4 Cables

3.2.1.5 Check sources

3.2.1.6 Record forms

3.2.2 Quality Control Check

3.2.2.1 Assemble instrument, turn on, check batteries, and adjust high voltage, if necessary. Check background and check source count rates. Follow procedures described in Procedure 2.1.

3.2.3 Measurements

3.2.3.1 Place the detector at the position where the measurement is desired.

3.2.3.2 Allow the meter to stabilize and observe the meter response; if necessary, switch the range selector to obtain the maximum fraction of full-scale meter deflection possible.

3.2.3.3 Record the average response rate on the appropriate record form.

3.2.3.4 The observed response may be converted to exposure rate (uR/h) using factors determined by correlation with the Ion Chamber (see Procedure 2.5).

Procedure 2.5
Effective Date: 03/02/98
Revision No: 1

PROCEDURE 2.5 PRESSURIZED ION CHAMBER CORRELATION

1.0 PURPOSE

1.1 To describe the procedure for correlation of instruments in units of exposure rate.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Ratemeter-scaler: Model 3, Ludlum Measurements, Inc.; or equivalent

3.1.2 Sodium iodide detector: Model 44-2, Ludlum Measurements, Inc.; Model SPA-3 or PG-2, Eberline Instrument Corporation; or equivalent

3.1.3 Micro R Meter: Model 19, Ludlum Measurements, Inc.; Micro Rem Meter, Harshaw Bicron Radiation Measurement Products

3.1.4 Pressurized Ion Chamber (PIC): Model RSS-111, Model RSS-112, or Model RSS-1011, Reuter Stokes Co., or equivalent

3.1.5 Record forms

3.2 Quality control check

3.2.1 Assemble instruments, turn on, check batteries, and adjust high voltage and threshold, if necessary. Allow PIC to stabilize approximately 5 minutes. Check background and check source responses. Follow procedures described in Procedure 2.1

3.3 Procedure

3.3.1 Place the PIC at the measurement location. Adjust the tripod to position the center of the PIC at 1 meter above the surface. If possible, obtain correlation points throughout the entire range of radiation levels identified on the site. If no areas of elevated direct gamma radiation are present, perform the correlation at 6 to 10 locations on the site.

3.3.2 Determine the exposure rate (see Procedure 2.4).
Record on the appropriate record form.

3.3.3 Remove the PIC and measure the response of the instrument to be correlated at the same location.

3.3.4 Repeat steps 3.3.1 to 3.3.3 at locations of different intensities.

3.3.5 Prepare a correlation curve of detector response versus exposure rate as described in Procedure 4.4.

Procedure 2.6
Effective Date: 2/01/2014
Revision No: 2

PROCEDURE 2.6 SUBSURFACE SCANNING (BOREHOLE LOGGING)

1.0 PURPOSE

1.1 To describe the method for performing subsurface sampling and vertical scanning.

1.2 Subsurface scanning indicates locations and relative levels of radioactivity.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 MATERIALS

3.1 Instrumentation

3.1.1 Bicron microrem meter or comparable tissue equivalent dose meter.

3.1.2 Portable ratemeter-scaler: Model 3, Model 12, Model 2241 or Model 2221 Ludlum Measurements, Inc.; or equivalent.

3.1.3 Sodium iodide detector: Model 44-2, Ludlum Measurements, Inc.; Model SPA-3 or PG-2, Eberline Instrument Corporation; or equivalent.

3.1.4 Cables of sufficient length to reach the bottom of the deepest borehole.

3.2 Supplemental Equipment

3.2.1 Light rope or cable of sufficient strength and length to lower detector to the bottom of the deepest borehole and retrieve it. Rope should be clearly marked in 6-inch (15-cm) increments.

3.2.2 Clamp or tape to secure rope to detector.

3.2.3 Optional lead collimator for scintillation probe. Collimator design based on specific project needs. (NOTE: Borehole logging can be done using a bare or collimated NaI detector. Uncollimated detectors are used for shallow or small diameter boreholes or for collecting general information concerning the vertical distribution of radioactive material in the borehole. Therefore, depending on the specific needs of the survey, items 3.2.3 and 3.2.4 are optional and are typically used for boreholes measuring 3 meters or greater in depth.)

3.2.4 Optional winch assembly for lowering and raising detector in deep boreholes.

3.2.5 Plastic (PVC) pipe, as required, of sufficient length and diameter to encase borehole to the desired logging depth. The pipe diameter will be determined by the dimensions of the drill bit or soil probe. For example, a 2-inch I.D. (internal diameter) Schedule 40 PVC pipe is recommended for most applications involving a Model 44-2 (1-inch sodium iodine) detector. This size pipe requires installation of a 2.5 inch diameter or larger borehole.

3.2.6 One PVC pipe end cap for each planned borehole, plus at least two extra end caps for contingencies.

3.2.7 PVC Pipe cement.

3.2.8 A saw or PVC pipe cutter to size PVC pipe lengths.

3.2.9 Plastic bags large enough to cover detector assembly when down hole.

3.2. 10 Record forms and pens.

3.2 Boring Equipment

3.2.1 Geoprobe with 3.25 inch sampling barrel and tool string.

3.2.2 Enough tube inserts for the 3.25 inch barrel to accommodate planned sampling at all locations and depths with extra for wastage.

3.2.3 Two tube caps for each insert.

3.0 INSTRUMENT ASSEMBLY

3.1 Assemble instrument/detector combination with long cable.

3.2 Securely attach support rope to detector. Use tape or wire ties to secure cable to support rope at approximately 1-meter intervals. Leave about 1-2 inches of slack in cable between the top of the detector and the first piece of tape or wire tie binding the rope to the cable. (NOTE: The weight of the detector should always be supported by a rope or equivalent. The detector should NEVER be lifted or supported by the long instrument cable.)

3.3 Perform daily instrument check on assembled unit as described in Procedure 2.1.

4.0 SITE PREPARATION PRIOR TO INSTALLATION OF A BOREHOLE

4.1 Refer to the Project Sampling Plan for the location of selected borehole.

4.2 (Optional) Have a licensed surveyor locate and clearly mark all sampling locations

4.2 Proceed to selected borehole location and record its coordinates using GPS coordinates and a unique borehole description or identification number.

4.3 Using a microrem meter, collect and record the dose rate, in mrem/h, at 1 meter above the ground.

4.4 Using the selected meter and detector combination (see 3.0, above), collect and record a 30 second measurement, in cpm, at 1 centimeter (~0.5 inch) above the ground.

5.0 SUBSURFACE SAMPLING PROCEDURE

5.1 Using a geoprobe

5.1.1 Position GeoProbe with a 3.25 inch soil probe (e.g. barrel) over the desired location of the borehole.

5.1.2 Collect the first soil core from hole.

5.1.3 Extract the tube liner containing soil core from the coring tool and cap the liner's ends. Seal the ends with electrical tape.

5.1.4 Use indelible ink to mark each liner with a) an arrow pointing to the top of the soil sample, b) the unique location identifier, and c) an estimate of the sample depth interval recovered (For example: <—Top, NSU#l, 0-22 inches).

5.1.5 Use the Geoprobe to collect the next soil core from the hole.

5.1.6 Extract the tube liner containing soil core from the coring tool and cap the liner's ends. Seal the ends with tape.

5.1.7 All tubes containing soil must be handled and stored in the vertical position with the top up.

5.1.8 Use indelible ink to mark each liner with a) an arrow pointing to the top of the soil sample, b) the unique location identifier, and c) an estimate of the sample depth interval recovered (For example:—Top, NSU#1, 23-41 inches).

5.1.9 If required, soil tubes can be scanned by a variety of instruments after they are sealed and properly labeled. If this is required, the instruments and scanning method will be specified in project specific documentation.

5.1.10 Labeled sample tubes containing soil can be stored in an upright 85 gallon drum until soil sample depths are from logging data.

5.1.11 Continue repeating steps 5.5 and 5.9 until the desired depth is reached or until refusal.

5.1.12 Once borehole sampling is complete, cut PVC pipe to a length that is equal to the depth of the borehole plus about 4 inches and glue one end-cap on PVC pipe. Place PVC pipe into hole (end cap on bottom and open end up). Push PVC pipe into hole until pipe is firmly seated in hole.

5.1.13 Move the Geoprobe to next hole.

5.2 Using a hand auger

5.2.1 Position auger (using a 3 inch diameter soil bucket) over the desired location of the borehole.

5.2.2 Collect the first 6" of soil from hole.

5.2.3 Empty auger bucket into a bag lined 5 gallon bucket (or equivalent) marked with 0-1'. (Note: sampling intervals may be modified to accommodate site specific as required.)

5.2.4 Retrieve next 6" soil increment from hole and place in the 0-1' bucket.

5.2.5 Decon auger bucket between each 1' increment.

5.2.6 Using the same method for each 6" increment, empty each1 foot increment into a uniquely identified bag lined bucket corresponding to that particular depth.

5.2.7 If required, 5 gallon buckets can be scanned by a variety of instruments after all properly labeled buckets are transported to the sample preparation area. If this is required, the instruments and scanning method will be specified in project specific documentation.

5.2.8 Continue repeating steps 5.2.5 through 5.2.7 until the desired depth is reached or until refusal.

5.2.9 Once borehole sampling is complete, cut a PVC pipe (or equivalent) to a length that is equal to the depth of the borehole plus about 4 inches and glue one end-cap on PVC pipe. Push PVC pipe into hole until pipe is firmly seated in the hole (end cap on bottom and open end up).

5.2.10 Survey the sampling equipment and decon with water as needed. Move the auger equipment to next hole.

5.2.11 Perform a gamma log of the borehole (see Section 7).

5.2.12 Remove PVC pipe from hole and backfill hole with designated fill material as required.

6.0 DOWNHOLE LOGGING PROCEDURE

6.1 Prior to inserting the detector down-hole, enclose the detector assembly, including the collimator if in use, in double plastic bags or tubular sheeting to protect detector against direct contact with water or soil from the borehole.

6.2 Set the scaler timer to accumulate counts over a period of 0.5 or 1 minute, depending upon contaminant and ambient detection level.

6.3 (Optional) If using the winch assembly, place it over the borehole.

6.4 Position the detector over the hole with bottom of the detector level with the ground surface. If using the collimator assembly, position the slots level with the ground surface.

6.5 Record this initial position as the 0 centimeter or surface measurement. If using the collimator assembly, reset the depth recorder to 0. Lower probe to bottom position of borehole and record the depth Collect the first timed measurement and record the results, in cpm, at this position.

6.6 Raise the detector slowly up the borehole, stopping at 6 inch intervals to collect and record timed measurements in cpm. Record the depths of these locations.

6.7 When the detector reaches the top of the borehole or borehole liner pipe record the last measurement.

6.8 Raise the detector to the surface and inspect the detector for signs of water infiltration into the plastic cover. Clean the cover or replace it, as needed.

7.0 COLLECTION OF SOIL SAMPLES

7.1 From geoprobe soil tubes

7.1.1 Once downhole logging is complete, the series of downhole radiation measurements from that borehole will be analyzed and a number of samples may be extracted from the soil tubes. The number and depths of these samples will be determined by the sampling plan or the supervisor of the sampling task.

7.1.2 The sample depth will generally be determined as the sum of the recovered soil in the sampling tubes, not the length of the plastic tube containing the soil.

7.1.3 Soil samples will be processed as described in Procedures 2.8 (Preparation of Transportation), 3.3 (Soil Sampling), and 3.7 (Sample Identification).

7.2 From augered soil in buckets

7.2.1 Once downhole logging is complete, the series of downhole radiation measurements from that borehole will be analyzed and a number of samples may be extracted from the plastic-lined buckets holding the soil samples collected at specific depth. The number and depths of these samples will be determined by the sampling plan or the supervisor of the sampling task.

7.2.2 Soil samples will be processed as described in Procedures 2.8 (Preparation of Transportation), 3.3 (Soil Sampling), and 3.7 (Sample Identification).

Procedure 2.7
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.7 MONITORING PERSONNEL AND EQUIPMENT FOR RADIOACTIVE CONTAMINATION

1.0 PURPOSE

1.1 To describe the general approach for monitoring personnel and equipment for radioactive contamination.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Upon exiting potentially contaminated areas, monitoring of clothing and exposed skin surfaces will be performed. Equipment and materials will also be monitored and shown to be free of contamination before release for use without radiological restrictions or controls.

3.2 Equipment

3.2.1 Ratemeter-scaler: Model 3 or Model 2221, Ludlum Measurements, Inc.; or equivalent, equipped with audible speaker or headphones.

3.2.2 Detector: Selected detectors are indicated below. Equivalent detectors are also acceptable.

Activity	Detector Type	Model
Alpha	ZnS scintillator	Ludlum 43-1 or43-5,Eberline AC3-7 or AC3-8
	Gas proportional	Ludlum 43-68, Ludlum 239-1
Beta	Gas proportional	Ludlum 43-68, Ludlum 239-1
	Geiger-Mueller	Ludlum 44-9, Eberline HP-260

3.2.3 Instrument cables

3.2.4 Check sources

3.2.5 Record Forms and/or field logbook

3.3 Quality Control Check

Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check and source responses following Procedure 2.1.

3.4 Surface Scanning

3.4.1 Headphones or other audible signal operating modes are used for scanning.

3.4.2 Set the instrument response for "FAST", response where possible.

3.4.3 Pass the detector slowly over the surface. The detector should be kept as close to the surface as conditions allow. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor. While scanning for alpha or beta activity, the detector is typically moved about one detector width per second.

3.4.5 Note increases in count rate as indicated by the audible meter output. Identifiable increases in the audible response suggest possible contamination and should be resurveyed at slower rate to confirm findings.

3.5 Personnel Monitoring

3.5.1 When monitoring for skin or clothing contamination, give particular attention to the hands, shoes, pant and shirt cuffs, knees, and other surfaces which have a high likelihood of contamination.

3.5.2 If there is detectable contamination, it should be removed as directed by the Health and Safety Committee (HSC) Chairperson. Decontamination guidance will be provided in the Survey Work Plan. The Site Safety Officer will implement decontamination or other contamination control actions at the project site.

3.6 Equipment Monitoring

3.6.1 For equipment surveys, attention should be given to monitoring cracks, openings, joints, and other areas where contamination might accumulate.

3.6.2 Measure levels of total and removable surface contamination (see Procedures 2.3 and 3.6) at locations of elevated direct radiation identified by the scan and at additional representative surface locations.

3.6.3 Acceptable surface contamination levels will be established on a project-specific basis, with details, including decontamination instructions, provided in the Survey Work Plan.

3.7 Document results of contamination surveys in field records.

Procedure 2.8
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.8 PREPARING SAMPLES FOR TRANSPORTATION

1.0 PURPOSE

1.1 To provide guidance for preparing samples for transportation to assure regulatory compliance.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

Regulations for transportation of radioactive materials (49 CFR 173) provide several options applicable to samples containing small quantities of radioactivity. One option, known as an "Exemption", is described in 49 CFR 173.403(y). This option exempts from classification as radioactive, material containing concentrations below 2000 pCi/g (total activity), averaged over the package contents; such exempt material requires no special packaging or labeling. For certain radionuclides, this concentration limit can be demonstrated by measure ment of the direct radiation level associated with the package. For example, if the contaminant is Ra-226 (plus progeny), calculations and experience have shown that the 2000 pCi/g total activity concentration limit will be satisfied, if direct radiation level at 30 cm from the package exterior (assuming a typical 48 quart cooler, used by GED for sample shipping) is less than 20 uR/h (or 20 rem/h), above background. For other radionuclides, the relationship between concentration and direct radiation level may differ from that of Ra-226, and appropriate decision levels must therefore be established for each project.

Another option is known as "Limited Quantity" and is described in 49 CFR 173.421. The activity that is permitted under this option depends on the specific radionuclide; for example, 50 uCi of Ra-226 is the activity permitted under this option. The Limited Quantity option for Ra-226 will be satisfied if the direct radiation level at 1 meter from the exterior of a 48 quart cooler does not exceed 20 uR/h (20 urem/h), above back ground. The 'Limited Quantity" option also has a maximum package surface contact radiation limit of 0.5 mrem/h above background. The quantity permitted in a package under this provision depends upon the radionuclide; which, in turn, determines the radiation levels associated with given quantities of the material. Therefore, guidance for demonstrating regulatory compliance will be developed on a project-specific basis. In addition to requirements imposed by transportation regulations, the analytical laboratory or other receiver of the shipped samples may have further restrictions or requirements which must be considered in preparation of the shipment.

The Health and Safety Committee will assist in preparing appropriate criteria for potential shipments, including specific radiation action levels at the container surface, at 30 cm from the surface, and at 1 in from the surface. Special packaging and labeling instructions will also be developed. This information will be incorporated into the Survey Work Plan.

The following is the process for preparing samples for transportation:

3.1 Select an appropriate outer container for the samples. The container must be strong and capable of retaining contents during conditions normally incident to transportation. The typical container used by GED is a 48 quart cooler.

3.2 Place a plastic liner inside the container.

3.3 Place the samples into the lined container. Do not exceed a net sample weight (including the individual sample containers) of 29 kg.

3.4 Scan the outside of the container with a gamma detector (Procedure 2.2) to determine the location of the maximum radiation level.

3.5 Measure the radiation level (see Procedure 2.4) at contact with the position on the surface of the container identified in Step 3.3 and at 30 cm and 1 m from the container at that same location. Record the results on the appropriate record form.

3.6 Compare the measurements obtained with the action levels provided in the Survey Work Plan. If the radiation levels satisfy the criteria for an "Exemption", proceed to Step 3.9. If radiation levels satisfy the criteria for "Limited Quantity" but not an "Exemption", proceed to step 3.7. If the radiation levels do not satisfy either set of criteria, rearrange or remove samples and repeat measurements. Contact the HSC Chairperson if the package still does not meet the specified action levels.

3.7 Affix the form containing a "Radioactive" label and a statement that "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material n.o.s., UN2910."

3.8 Survey the outer container surfaces for removable contamination in accordance with Procedure 3.6. If removable contamination exceeds 220 alpha dpm/100 cm2 or 2200 beta-gamma dpm/l00 cm2, clean and re-survey. Record results on the appropriate data form.

3.9 Fill spaces in the container liner with packing material to restrict sample movement during transport. If the container includes any freestanding liquids, include twice the sufficient absorbent material to absorb the liquid contents, in case of leakage.

3.10 Seal the inner plastic liner.

3.11 Enclose the Chain-of-Custody form and other paperwork.

3.12 Close and seal the outer container.

3.13 Complete shipping papers. If the package is "Exempt", shipping papers are the same as if the shipment did not contain radioactive material. For a shipment under the "Limited Quantity" option, the air-bill for hazardous material must be used with the bottom section removed. The proper shipping name to be entered is "Radioactive material, excepted package - limited quantity UN 2910". Mark the instruction box as "Dangerous Goods Declaration Not Required".

3.14 Attach the shipping papers and initiate the shipment.

Procedure 2.9
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.9 SETTING INSTRUMENT HIGH VOLTAGE AND INPUT SENSITIVITY

1.0 PURPOSE

1.1 To describe the procedure for adjusting detector high voltage and input sensitivity (also known as threshold or discriminator setting) on portable radiological survey instruments (ratemeters/scalers).

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Radiation detectors and portable readout instruments (i.e., ratemeters/scalers) may be calibrated separately (see Procedure 2.1). Detectors may then be used with various readout instruments, if the operating parameters, i.e., detector high voltage and instrument input sensitivity, are consistent with those used for the detector calibration, and if the response of the detector/instrument combination is within 20% of the expected response, as determined in accordance with Procedure 2.1.

3.2 Equipment

3.2.1 Pulser: Model 500-1, Ludlum Measurements, Inc.; or equivalent

3.2.2 Cable: with MHV-C or other connectors, appropriate for pulser and instrument

3.2.3 Portable survey instruments: Ludlum Measurements, Inc.; Models 3, 12, 2221, 2350, or equivalent

3.2.4 Instrument and detector labels 3.2.5 Calibration records for the detector

3.3 Procedure

3.3.1 Instruments without high voltage and/or input threshold display and integral adjustment capabilities

3.3.1.1 Remove the instrument case or cover plate to access adjustments for high voltage and threshold.

3.3.1.2 Plug in the pulser and turn it "On".

3.3.1.3 Set the pulser polarity to "neg" (negative).

3.3.1.4 Set the "Amplitude" switch to 50 MV and adjust the "Lo/Hi"tuning control till the analog meter on the pulser indicates 1; with these settings, the pulse amplitude is 10 millivolts.

3.3.1.5 Set the "Multiplier" switch to 10 and adjust the "coarse" approximately 500; with these settings, the pulse rate is approximately 5000 counts/minute, i.e., the digital display value times the multiplier factor.

3.3.1.6 Turn the pulser "Off'.

3.3.1.7 Connect the instrument input to the pulser, at the "Pulse Out"connector on the pulser front panel.

3.3.1.8 Turn on the pulser and instrument.

3.3.1.9 Determine, from the detector calibration records, the high voltage and threshold settings at which the detector calibration was performed. This information should also be indicated on a label, affixed to the detector.

3.3.1.10 Note the digital High Voltage meter; adjust the instrument high voltage adjustment until the value displayed on the meter agrees with that indicated on the detector calibration documents.

3.3.1.11 Adjust the amplitude of the pulse, using the "Amplitude" switch and the "Lo/Hi" tuning control, to attain the value given in the calibration documents for this detector.

3.3.1.12 Adjust the instrument threshold to the highest setting at which the countrate indicated by the instrument agrees with the pulser output setting (see step 3.2.5; any further increase in the input threshold adjustment beyond this point should result in a reduction in the instrument countrate.

3.3.1.13 Turn the pulser and instrument off; disconnect the instrument from the pulser; and replace the instrument adjustments cover.

3.3.1.14 Place a label on the instrument, indicating the current voltage and threshold settings.

3.3.1.15 Proceed with the checkout/quality control activities as described in Procedure 2.1.

3.3.2 Instruments with built-in high voltage and/or input threshold display and adjustment

3.3.2.1 Remove the instrument case or cover plate to access the adjustments for high voltage and threshold.

3.3.2.2 Determine the appropriate high voltage and input sensitivity settings for the detector from the detector calibration records.

3.3.2.3 Following the procedures, described in the instrument operating manual, adjust the high voltage and input sensitivity to the desired values.

3.3.2.4 Turn the instrument off and replace the instrument case or adjustments cover.

3.3.2.5 Place a label on the instrument, indicating the current voltage and threshold settings.

3.3.2.6 Proceed with the checkout/quality control activities as described in Procedure 2.1.

Procedure 2.10
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 2.10 OPERATION OF THE GLOBAL POSITIONING SATELLITE BACKPACK (GPS)

1.0 PURPOSE

1.1 To provide a procedure for establishing the operation and use of a Global Positioning Satellite system.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 SURVEY PREPARATIONS

3.1 Determine the gridding requirements and supervise on-site gridding activities to assure compliance with conditions of survey plans and subcontract agreements.

3.2 Areas to be surveyed may already be gridded as part of the prior decontamination and survey activities. Where possible, GED surveys will utilize this same grid system. The GED survey team will establish grids not already in place if required (see Procedure 1.1). If cases where no grid system is to be established at all, the surveyor may use reference marks or paint to guide the survey over the entire property.

3.3 Gridding of open land areas may be performed by a professional land survey organization under subcontract arrangements. Survey personnel may perform gridding of small land areas or may subdivide grids established by other groups.

3.4 The Project Manager will prepare or approve the necessary plans, subcontracts, and other documents describing and implementing gridding operations.

4.0 PROCEDURE

4.1 Surfaces are scanned to determine the level of gross activity present. Action levels are determined based on guidelines established for each site and serve as indicators that further investigation is necessary. Scans are conducted for all radionuclides potentially present based on the site history. Monitoring for the unexpected is also recommended.

4.2 Surface Scanning

4.2.1 Equipment

4.2.1.1 Ratemeter-scaler: Ludlum 2221, Ludlum Measurements, Inc. or equivalent, equipped with audible speaker

4.2.1.2 Detector: Ludlum 44-10 NaI(Tl) probe

4.2.1.3 Trimble(TM) Global Positioning System

4.2.1.4 Check sources/batteries/chargers

4.2.1.5 Record forms, pin flags, grid markers and/or paint

4.2.2 Quality Control Check

4.2.2.1 Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and check source responses. Follow procedures described in Procedure 2.1.

4.2.3 Scanning

4.2.3.1 After ensuring that all equipment is connected properly, turn on the count rate (set to digital rate model) and data collection system (handheld unit) (depress on/off switch time). Select the "TerraSync" icon to access the data acquisition software. The unit will begin locating satellites and communicate with the GPS unit. If this does not occur automatically, select the "Setup" icon and press the GPS icon. This will begin the locating process.

4.2.3.2 Check the status of the GPS unit that enough satellites are in-view to provide positioning data. Four satellites are necessary to provide this information.

4.2.3.3 Select the "Setup" icon to program the detector interface. Internal count rate settings should be at one (1) second.

4.2.3.4 Select the "Data" icon to create a new file or use an existing file. Files are internally numbered with a time and date stamp. All new files open to a point generic type file by default and can be changed or renamed using the keypad.

4.2.3.5 Once a file has been opened, select "Map" from the drop down menu (top left screen) to view data points. Select the appropriate scale for the survey area.

4.2.3.6 Once the file has been selected, the unit will begin acquiring data. Ensure that the backpack unit is positioned at a predetermined start point. When the backpack is acquiring data, a beep at one-second intervals is generated by the handheld unit.

4.2.3.7 Start data acquisition and stop data acquisition icons are located at the top right of the screen below the "X" box. These may be used to pause data acquisition during a survey.

4.2.3.8 Select the "Map" icon to view survey progress. To ensure that readings are being recorded properly, select "Status" then "Sensor". The screen will display the number of points recorded and a count rate, which should change as points are recorded (numbers will increase if the system is working properly). The "Last String" should indicate the value – if this is not indicating a value, data is not being recorded

4.2.3.9 The surveyor should walk in a straight-line direction, holding the detector as close to the ground as possible. Spray paint or a suitable alternative should be used to mark the route traveled by the surveyor.

4.2.3.10 For each survey, two available landmarks such as building corners, telephone poles or distinctive site features should be identified. The GPS system should be used to record the locations of those benchmarks for future reference.

4.2.3.11 At the completion of the survey, select the "Stop" (X) button. When the handheld unit is turned off, all files are automatically. The data remains in the handheld unit and may be downloaded to a computer.

5.0 DATA PROCESSING

5.1 Completion of Survey

5.1.1 Upon completion of the survey, data shall be transferred to a computer for reduction or may be sent via e-mail to a data processing center.

5.1.2 Disconnect the 9-pin to 26-pin adapter from the handheld unit. (Do not loose this adapter.) Connect the computer and handheld unit together using the communications cable.

5.1.3 Ensure that the Trimble Pathfinder Office 3.00 software is installed on the computer.

5.1.4 Microsoft™ Activesync must be installed on the computer to extract data from the handheld unit. This program may be downloaded from the internet. The software prompts the user for extracting the data from the handheld unit.

5.1.5 Select Microsoftr™ ActiveSync icon and turn on the handheld unit. The program will connect the unit automatically and present a screen "Set up a Partnership". Highlight "No" and select "Next".

5.1.6 Select GPS Pathfinder Office software. The program will select the default Project name and folder. Click "OK". Select Utilities from the menu bar and click on Data Transfer. Click on "Add" and select Data File.

5.1.7 All non-transferred and appended files will be highlighted. If needed, the operator may select any file to be transferred and press the "Open" button.

5.1.8 After selection of file(s) are complete, press "Transfer All". After transfer, the software will convert the data and acknowledge file(s) successful transfer.

5.1.9 Close all programs, turn off handheld unit, and disconnect communication cable.

5.1.10 Once the data is present in the computer, attach the file(s) to an email message and send to the data processing center.

6.0 REFERENCES

6.1 Procedure 1.1 Reference Grid System

Procedure 3.1
Effective Date 02/01/2014
Revision No: 0

PROCEDURE 3.1 SURVEY PROCEDURE TRAINING (HEALTH PHYSICS TECHNICIAN QUALIFICATIONS)

1.0 PURPOSE

1.1 The purpose of this procedure is to provide consistent methodology for qualifying Greenwich Environmental Designs Health Physics Technicians (HPTs).

This procedure applies to HPTs assigned to support GED filed site. Project Laboratory technicians may also utilize this procedure for tracking of lab-related qualifications, as directed by the Laboratory Manager. When used in this manner, the Laboratory Manager will perform those functions identified for the Radiation Safety Officer (RSO).

2.0 RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO).
The RSO is responsible for implementation of this procedure and has overall authority for technician qualification.

2.2 Health Physics Technician (HPT) Trainer.
The HPT trainers are responsible for qualifying HPTs according to the requirements of this procedure.

2.3 Health Physics Technician (HPT)
The HPTs are responsible for submitting required documentation of training and experience to the RSO for review prior to qualification.

3.0 EQUIPMENT

None

4.0 GENERAL

4.1 Discussion

Qualification is necessary to ensure that assigned personnel have documented evidence of the experience and / or training necessary to provide quality radiological protection support to various GED field projects Project. HPT Training shall be performed by qualified Senior HPTs with a demonstrated knowledge of the GED Radiation Protection Program (RPP). The Radiation Safety Officer (RSO) approves HPT trainers. Required Reading is used to maintain HPT awareness of new pro gram documents and / or program changes affecting areas of technician responsibility.

4.2 Definitions

Junior HPT: An individual assigned to the project to perform administrative tasks, monitor control points, perform routine surveys, and assist Senior technicians with implementation of the GED Radiation Protection Program (RPP).

Qualification: The formal process of reviewing past work experience or demonstrating skill in the performance of a task or operation of an instrument to ensure understanding of RPP requirements and HPT responsibilities.

Senior HPT: An individual who meets the education and experience requirements for an HPT as defined by ANSI 3.1 and has been designated as a Senior Technician by the RSO.

5.0 PREREQUISITES

Prior to qualification, technicians shall have successfully met the Restricted Area access training and medical requirements identified in the GED SHP.

6.0 PRECAUTIONS AND LIMITATIONS

- Junior HPTs and unqualified Senior HPTs shall perform tasks related to implementation of the RPP under the supervision of a qualified Senior technician. The level of supervision required is established by the RSO.

- At a minimum, an HPT must meet the following criteria prior to obtaining status as a "qualified" Senior HPT:
  1. Meet the experience / training criteria established in the SHP.
  2. Complete qualification on the SHP and RPP Implementing Procedures.
  3. Receive RSO Approval.

7.0 RECORDS

- Completed HPT Qualification Records (i.e., "Qual-Cards") are maintained in individual employee training files (Attachment 1).
- Completed Required Reading Records are maintained in the Required Reading file (Attachment 2).
- Typical HPT Qual-Cards and Required Reading Records are attached to this procedure. Field implemented versions may differ slightly from those pictured based upon project needs or editorial changes.

8.0 PROCEDURE

8.1 Qualification Process

- The trainee shall be provided with a "Qual-Card" and copies of the GED Radiological Health and Safety Plan, applicable addenda, and operating procedures for review.
- The trainer will discuss SSHP contents and operating procedures with the trainee, as necessary. Emphasis should be placed on areas of technician responsibility and Maywood-specific protocols.
- The trainer or RSO will resolve any questions or concerns related to trainee review of program documents prior to qualification.
- In order to evaluate satisfactory comprehension, the trainer should discuss (D) the program document and / or observe (O) task performance prior to qualification. At a minimum, the observation (O) evaluation method should be used for instrument operations.
- The trainee and trainer complete a section of the qual-card for each program document reviewed by recording the following information:
  1. Specific program document or task;
  2. Trainee initials and date review completed;

3. Trainer initials and date evaluation completed; and
4. Method of evaluation (i.e., "D" or "O").

- Upon completion of the minimum requirements as defined in this section, the "Qual-Card" may be submitted to the RSO for approval for Senior HPT Status.

8.2 Required Reading

- The RSO, or designee, shall maintain a required reading file for HPTs. Required reading should include new and revised site work instructions, work plans, and regulatory documents that impact areas of HPT responsibility. The RSO determines required reading requirements.
- HPTs review the required reading as directed by the RSO and acknowledge acceptance and under standing on the Required Reading Record.

9.0 DOCUMENTATION

The RSO shall maintain records of technician experience, qualification status (i.e., "Qual-Card"), and Required Reading. These records shall be maintained according to Radiation Protection Document Control requirements.

10.0 REFERENCES

GED "Safety & Health Plan", Volume 1.

11.0 ATTACHMENTS

Attachments may be revised without formal review of this procedure and are attached as examples only. Please contact the RSO for a current copy of these attachments.
Attachment 1 HPT Qual-Card
Attachment 2 HPT Required Reading Record

RADIATION PROTECTION TECHNICIAN QUAL-CARD

Technician:

	Document Number	Document Title or Task Description	Review (Date/Init.)	Eval. by (Date/Init.)	Eval Method (D or O)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

RSO Approval

☐ Check if additional sheets attached

HPT REQUIRED READING RECORD

FUSRAP MAYWOOD RPT REQUIRED READING RECORD

	REQUIRED READING ITEM	Start Date	J. Cosgrove	T. Freeman	B. Miller	G. Moyer	G. Perry	B. Spillane	K. Thompson	W. Winner						
			Reviewers (Initial and Date Corresponding Block)													
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

RSO REVIEW

Procedure 3.2
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.2 SEDIMENT SAMPLING

1.0 PURPOSE

1.1 To describe the procedures for collecting samples of sediment.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Digging implement: garden trowel, post-hole digger, etc
3.2 Thin walled metal or plastic tube (Shelby tube-type sampler)
3.3 Ponar "clam-shell" dredge (with rope)
3.4 Wide-mouth plastic bottle (approximately 1 liter size)
3.5 Labels and security seals
3.6 Record forms and/or logbook
3.7 Indelible pen
3.8 Cleaning supplies, as appropriate

4.0 PROCEDURE

4.1 NOTE: This procedure applies to the usual requirements for shallow sediment samples for radiological contamination measurement. Special requirements will necessitate other sampling procedures and considerations; these will be evaluated and described in detail in site specific survey plans as the need arises.

4.2 Using a collecting tool, obtain approximately 1 kilogram of sediment. Include all material collected - rocks and foreign objects can be discarded during sample preparation, as appropriate.

4.3 Place the sediment into a plastic bottle and tighten the screw cap.

4.4 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.5 Record sample identification, location, depth, and other pertinent information on the appropriate record form.

4.6 Clean sampling tools, as necessary, according to the procedure described in the Quality Assurance Plan, before proceeding with further sampling.

Procedure 3.3
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.3 SOIL SAMPLING

1.0 PURPOSE

1.1 To describe the procedures for collecting soil samples.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Digging implement: garden trowel, shovel, spoons, post-hole digger, etc
3.2 Special sampling apparatus (cup cutter, shelby tube, metal or plastic tube, etc.) as required
3.3 Drilling equipment: drilling rig, portable motorized auger, manual auger
3.4 Subsurface sampling apparatus: split-spoon sampler, shelby tube sampler
3.5 Sample containers
3.6 Tape
3.7 Indelible pen
3.8 Labels and security seals
3.9 Equipment cleaning supplies, as appropriate
3.10 Record forms and/or logbook

4.0 PROCEDURE

4.1 NOTE: Typically, soil contamination criteria for radionuclides are applicable to the average concentration in 15 cm layers of soil, therefore, the sampling protocols described here are based on sampling 15 cm increments. The method used to sample soil will depend on the specific application and objective. Therefore, several techniques are described in this procedure and selection will be on a site-specific basis. Special situations (e.g., evaluating trends or airborne deposition, determining near-surface contamination profiles, and measuring non-radiological contaminants, necessitate special sampling procedures. These special situations are evaluated and incorporated into site specific survey plans as the need arises.

Direct surface and 1 meter gamma radiation measurements may be performed at each location be fore initiating sampling. This will identify the presence of gross radionuclide contamination that will require special handling and equipment cleanup procedures. If contamination is suspected, a beta-gamma "open" and "closed" measurement may also be desired before sampling.

4.2 Surface Soil

4.2.1 Loosen the soil at the selected sampling location to a depth of 15 cm, using a trowel or other digging implement.

4.2.2 Remove large rocks, vegetation, and foreign objects (these items may also be collected as separate samples, if appropriate).

4.2.3 Place approximately 1 kg of this soil into the sample container. If it is not possible to reach a depth of 15 cm using a hand tool (i.e. trowel or shovel) 1 kilogram of soil should be collected from the accessible depth. The actual depth should be recorded on the sample container and the appropriate record form.

4.2.4 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie the sample bag strings).

4.2.5 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.2.6 Record sample identification, location, and other pertinent data on appropriate record forms, maps, drawings, and/or site logbook.

4.2.7 If the location has been identified as having elevated activity, a measurement should be obtained after the sample is collected to determine the possibility of contamination at a depth greater than 15 centimeters. If a subsurface sample is deemed necessary, refer to the appropriate section below.

4.2.8 Clean sampling tools, as necessary, according to the procedure in the Quality Assurance Plan, before proceeding with further sampling.

4.3 Subsurface Soil (Option 1)

This procedure is applicable to depths of approximately 3 in when boreholes or trenches have been dug and remain uncollapsed or do not contain water.

4.3.1 When direct radiation measurements are required (surface and borehole logging) they are to be performed prior to sample collection in order to identify the presence of gross radionuclide contamination requiring special handling or cleanup (see the Quality Assurance Plan and/or Health and Safety Plan). If borehole logging is to be done it should be completed before sampling begins (see Procedure 2.6).

4.3.2 Place a plastic bag liner into the downhole sampler and secure with a large rubber band.

4.3.3 Lower the sampling tool to the desired depth in the borehole or trench.

4.3.4 Scrape the inside borehole or trench wall with the toothed edge of the tool until approximately 1 kg of sample is collected.

4.3.5 Transfer the plastic bag and sample into the container.

4.3.6 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie sample bag ties).

4.3.7 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.3.8 Record sample identification, location, depth, and other pertinent data on the appropriate record forms, map, drawing, and/or site logbook.

4.3.9 Clean sampling tools, as necessary, in accordance with instructions in the Quality Assurance Plan, before proceeding with further sample collection.

4.4 Fixed Geometry and Subsurface Soil (Option 2)

This procedure is appropriate for sampling at depths exceeding 3 m, in boreholes where walls do not remain intact or that fill with water and in situations where it is necessary to retain the orientation of the sample. An example where the latter may be the case, would be when it was necessary to analyze segmented aliquots to determine radionuclide concentrations as a function of depth. This approach could incorporate surface sampling as well as subsurface sampling.

4.4.1 If necessary, drill the borehole to the desired sampling depth using an auger.

4.4.2 Drive a split-spoon, shelby tube, or similar design sample collector through the specified sampling depth.

4.4.3 Withdraw the collecting device; the collected core may be removed at this time.

4.4.4 If the collected core is removed, place the entire core, or a portion of the core, into a sample container. The core may be split into multiple segments, representing different sampling depths. If the core is to remain in the sampling device, the ends are sealed and the orientation noted.

4.4.5 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.4.6 Record sample identification, location, depth, and other data on the appropriate record forms, map, drawing, and/or site logbook.

4.4.7 Monitor the sample hole to determine activity level. If the activity level is elevated, it may be desirable to repeat items 4.4.1- 4.4.6. If the activity level has dropped to background, record the measurement and monitor the area, including personnel and equipment, to determine the extent of decontamination that may be necessary.

4.4.8 Clean sampling tools, as necessary, in accordance with instructions in the Quality Assurance Plan, before proceeding with further sample collection.

Procedure 3.4
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.4 VEGETATION SAMPLING

1.0 PURPOSE

1.1 To describe the method for collecting samples of vegetation.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.
2.2 Survey team members are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Knife, shears, or similar cutting tool
3.2 Plastic bags
3.3 Burlap bags
3.4 Tape
3.5 Baggage tags
3.6 Labels and security seals
3.7 Indelible pen
3.8 Record forms
3.9 Cleaning supplies, as appropriate

4.0 PROCEDURE

4.1 Cut vegetation of desired type from selected location as close as possible to the surface. Attempt to avoid collecting soil.

4.2 Collect a total of approximately 1 kilogram of vegetation.

4.3 Place the sample in a plastic bag (if water is to be retained in the vegetation) or burlap bag (if vegetation is acceptable dry).

4.4 Secure the top of the bag with masking tape.

4.5 Attach a baggage tag.

4.6 Label and secure in accordance with Procedure 3.7 and Procedure 3.8. Record information on the the Chain-of-Custody record form.

4.7 Record all pertinent information on the appropriate record form.

4.8 Clean collecting equipment, as appropriate, before proceeding with additional sampling (Quality Assurance Plan).

Procedure 3.5
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.5 WATER SAMPLING

1.0 PURPOSE

1.1 To describe the procedure for collecting samples of water from surface sources.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Bailing implement (cup, can, pail or other appropriate device)
3.2 Four liter plastic container, storage boxes and tags, or other container type as applicable
3.3 Preservatives, as required
3.4 Labels
3.5 Indelible pen
3.6 Record forms and/or logbook
3.7 Cleaning supplies, as appropriate

4.0 PROCEDURE

4.1 Dip water carefully from the selected location, being careful to avoid collection of bottom sediment or vegetation.

4.2 Transfer the water into a container.

4.3 Collect approximately 4 liters of sample.

4.4 Add preservatives to the sample, if required. The appropriate preservative(s) will be identified in the Quality Assurance Plan for the project and will be based on the potential contaminants, anticipated analytical schedule, and other project- specific factors.

4.5 Cap the container tightly.

4.6 Label and secure the sample in accordance with Procedures 3.7 and 3.8. Record information on the Chain-of-Custody Form.

4.7 Record data on the appropriate record form and/or site logbook.

4.8 Clean sampling tools, as necessary, in accordance with the Quality Assurance Plan, before proceeding with further sample collection.

Procedure 3.6
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.6 REMOVABLE ACTIVITY SAMPLING

1.0 PURPOSE

1.1 To provide guidelines for measuring removable alpha and beta radioactivity on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring this procedure is implemented.
2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment and Materials

3.1.1 Filter papers (Whatman 50, 47 mm diameter; or equivalent)
3.1.2 Glassine or paper envelopes
3.1.3 Record forms
3.1.4 Counting equipment

3.2 Sample Collection

NOTE: Direct measurements will be completed before a smear sample is taken.

3.2.1 Grasp the smear (filter) paper by the edge, between the thumb and index finger.

3.2.2 Applying moderate pressure with two or three fingers, wipe the numbered side of the paper over approximately 100 cm2 of the surface.

3.2.3 Place the filter in an envelope.

3.2.4. Record the smear number, site, date, location of the smear, and name of sample collector on the envelope.

3.2.5 Label and secure in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

3.2.6 If the direct measurement was elevated, the smear should be monitored (procedures 2.2 and 2.3) to determine whether contaminated material was transferred to the smear. If an activity level greater than 250 cpm is detected, the smear envelope should be marked as such.

NOTE: Smears having activity levels greater than 2500 cpm should be counted using field instrumentation. Decisions regarding further analyses and method of disposal of contaminated smears will be made by the PM and SSM on a case-by-case basis.

3.3 Field Sample Measurement

3.3.1 If the object of the survey is to determine if radon or thoron daughter products or other short half-life radionuclides are present, the smears should be counted within 1-2 hours before significant decay of short-lived radionuclides has occurred.

3.3.2 If necessary, smears can be counted in the field using portable instrumentation (see Procedure 2.3).

3.3.3 Record count and counting time data on the appropriate record form.

3.3.4 Subtract the background count (determined by counting blank or unused smear) and convert net count to dpm/l00 cm2, using proper time and detector efficiency values.

$$\frac{DPM/100cm2 = \left(\frac{TotalSampleCounts}{SampleCountTime}\right) - \left(\frac{TotalBkgCounts}{BkgCountTime}\right)}{(E)\ (A)}$$

Where:

E = Instrument Efficiency

A = Area correction factor, if applicable

APPENDIX A

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDEa	AVERAGE bc dpm/100 cm2	MAXIMUM bd dpm/100 cm2	REMOVABLE be dpm/100 cm2
U-nat, U-235, U-238 and associated decay products	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th 228, Pa-231, Ac-227, I-125, I-129	100	, 300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U 232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	15,000	1,000

Notes:

a Where surface contamination by both alpha- and beta gamma emitting nuclides exists, the limits established for alpha- and beta gamma emitting nuclides should apply independently.

b As used in this table, dpm means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.

d The maximum contaminated level applies to an area of not more than 100 cm2.

e The amount of removable radioactive material per 100 cm2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

*Source: USCG / USEPA EM 385 1 80 Table 6 4 Acceptable Surface Contamination Levels, 1985.

Note: The acceptable surface contamination levels for Th nat will be used unless subsequent sampling indicate the presence Ra 226, Ra 228, Th 230, Pa 231, or Ac 227 in concentrations greater than that of the parent nuclide. The RSO will determine if contamination limits should be modified for a specific activity or location based on available data.

Procedure 3.7
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.7 ENVIRONMENTAL SAMPLE IDENTIFICATION

1.0 PURPOSE

1.1 To assure consistent sample identification.

2.0 RESPONSIBILITIES

2.1 The Corporate Secretary (or designated agent) is responsible for maintaining a list of site identification codes that have been used in the past or are in current use.

2.2 The Project Manager is responsible for selecting site identification code(s) appropriate for new site(s) and assuring that the site identification codes are unique.

2.3 The Site Survey Manager is responsible for selecting grid identification numbers, and developing a system for relating the grid identification numbers to an appropriate land survey convention.

2.4 The Site Survey Manger is responsible for assuring that this procedure is implemented.

2.5 Survey team personnel are responsible for following this procedure.

Note: The Site Survey Manager may modify any part of this identification system as needed in order to facilitate field work in a given situation, provided that no ambiguous sample numbers are produced in the process. The Site Survey Manager should keep departures from the standard format to a minimum, and is responsible for overseeing all consequent modifications to data handling/processing software and procedures that may be required by such modifications.

3.0 PROCEDURE

3.1 Field samples shall be identified by an alphanumeric code. This code shall be used on the sample container, on the chain-of-custody forms, and in the field records.

3.2 The general format of the code is typically: XXXXXXY123. Where:

3.2.1 XXXXXX= Four to six letter site identification code identified in Step 2.2, above.

3.2.2 Y= A one-digit code indicating the medium protocol.

A: Air
D: Sediment
R: Smears
S: Soil (including amorphous materials found in the soil, earthen or not)
V: Vegetation
W: Water
X: Misc. Not covered above

3.2.3 123 = alphanumeric characters (usually 3) indicating the particular number of a particular sample type or general category for the site. Each number will correspond to a location designation on a map or grid area. Additional characters may be included to further identify location such as depth of sampling.

3.2.4 Examples of some sample codes are:

RFYCTGS 143 - the 143rd soil sample collected for project RIFYICTG RFYCTGS

187.090 - a soil sample from the 90 cm depth at location 187 for the project RFYCTG

GIBONM W00l - the first water sample collected for project GIB/ONM

3.3 At a minimum, sampling date, sampler initials and the sample identification are placed on the sample.

3.4 The identification method for the project should be described in the project records.

3.5 Marking is performed using an indelible pen.

3.6 All samples known or suspected of containing levels of radioactivity, which could present a contamination or exposure problem, are to be placed in clean outer containers and clearly marked with descriptive information, as appropriate, according to the sample screening requirements.

Procedure 3.8
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.8 SAMPLE CHAIN-OF-CUSTODY

1.0 PURPOSE

1.1 To provide a method for sample chain-of-custody.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

Chain-of-custody is initiated upon collection (or receipt) of samples and continues until samples are transferred to another organization or are disposed. An acceptable chain-of- custody is maintained when the sample is under direct surveillance by the assigned individual; the sample is maintained in a tamper-free container; or the sample is within a controlled-access facility. The chain-of-custody is recorded on a standardized Greenwich Environmental form (see Appendix A) or a form provided by another organization, such as an analytical laboratory or another sampling agency.

3.1 Field Procedures

3.1.1 An individual present during sample collection is designated as the sample custodian and is responsible for maintaining surveillance of the sample until the custody of that sample is transferred to another party. Samples must, at all times, be in the possession and under the direct surveillance of the sample custodian, or secured in a locked vehicle, building, or container. The sample custodian initiates a chain-of-custody form, daily, for all samples collected or received on that day.

3.1.2 Samples may be listed on the form as an individual entry or group of samples having common characteristics and originating from the same site may be recorded as a single entry, provided information describing each sample in the group (e.g. a completed field data form) is attached to or referenced on the custody form.

3.1.3 If sample custody is to be transferred (relinquished), the container and its contents are inspected by the individual accepting custody to assure that tampering has not occurred and custody has therefore been maintained. If evidence of tampering is observed or if any deviations or problems are noted, a notation must be provided on the form by the individual accepting custody. The sample collector must sign the first "Relinquished by" block and the receiver must complete the first "Received by" block.

3.1.4 If sample custody will not be assured under one of the conditions in item 3.0 above, a security seal is placed on the container of the samples. A security seal is a wire, tape, or other such item, which is uniquely identified (numbered), and can be affixed to a package in a manner as

to require damaging the seal if the package is opened. Damage to the seal thereby alerts the recipient of a package to the possibility of tampering with the contents. The number of the seal is entered onto the Chain-of-Custody form. Samples, which are under security seals, do not have to be maintained in a secure area; however, precautions should be taken to restrict sample access to authorized individuals.

3.1.5 The original of the chain-of-custody form must contain all signatures and other pertinent records regarding custody. Therefore the original is retained in the possession of the individual who has custody.

3.1.6 As long as samples remain in custody of the sampler, both copies of the chain-of-custody form are to accompany the samples. If custody is transferred to another individual and the control requirements in item 3.0 above are not satisfied, the duplicate copy of the form is packaged with the samples and the original remains with the individual having custody.

3.1.7 Samples collected by other organizations and provided to GED personnel will have chain-of-custody initiated for them by the individual receiving the samples. When the organization has an established chain-of-custody in place, a copy of the form will be attached to the GED form.

3.2 Sample Transport

3.2.1 Samples must comply with regulations of the Department of Transportation, if they are to be transported over or through publicly accessible transport routes. The Health and Safety Plan describes the procedure for assuring compliance with this requirement.

3.2.2 Unsealed samples may be transported by a vehicle controlled by the person having custody of the samples, or in that person's hand carried baggage.

3.2.3 Transport by mail, checked baggage, common carrier, or other mode not controlled by the sample custodian of record, requires that security seals be used.

3.2.3 The method of transport is to be identified on the original chain-of-custody record. If inner containers are sealed, additional seals on outer packaging are not required.

3.3 Samples sent to other organizations

3.3.1 The custodian will sign the "Relinquished by" space and the original form will be packed with the samples.

3.3.2 Receiving organizations will be requested to check the container and its contents for signs of tampering and note any deficiencies in the "Comments" portion of the form.

3.3.3 When samples will not be returned to GED the receiving organization will be asked to return the original of the form. The form will be provided to the Project Manager, for inclusion with the project records.

3.3.4 If samples will be returned to GED the receiving organization will be asked to sign the "Relinquished by" space and pack the form with the samples for return shipment. Upon receipt, the samples and form will be provided to the Project Manager, who will sign the "Received" space and place a copy in the project file.

Procedure 3.9
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 3.9 AIR SAMPLING FOR RADIOACTIVITY

1.0 PURPOSE

This procedure establishes the basis and methodology for the placement and use of air monitoring equipment, as well as the collection, analysis, and documentation of air samples. Radiological air sampling and analysis is performed to monitor concentrations of radionuclides in the air for purposes of tracking internal radiation exposure to occupational radiation workers, determining appropriate respiratory protection devices, establishing radiological posting boundaries, verifying effluent airborne radioactivity concentrations, and providing information on radiological conditions in the work area.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

2.3 The Site Safety & Health Officer (SSHO), ensures all activities performed within this procedure conform to the requirements of the SSHP.

3.0 PROCEDURE

3.1 Air Monitoring Methods

3.1.1 Utilize the following monitoring methods to implement the radiological air monitoring program:

- General Area (GA) Air Monitoring
- Breathing Zone (BZ) Air Monitoring
- Passive Radon Monitoring
- Particulate Radon Grab Samples
- Perimeter Monitoring, frequently referred to as Air Environmental (AE)

3.1.2 Air sampling equipment should be placed so as to:

- Not directly contact a contaminated (transferable) surface.
- Minimize interference with the performance of work.
- Be easily accessible for changing filters and servicing.
- Be downstream of potential release points.
- Minimize the influence of supply airflow.

3.1.3 An airflow study of any indoor area to be monitored should be performed prior to placement of the sampler (other than BZ samplers). Additional studies should be performed after changes in the work area setup, ventilation systems, or seasons, if seasonal changes may affect airflow patterns.

3.1.4 Perform BZ air sampling in occupied areas where, under typical conditions, a worker is likely to be exposed to an air concentration of 10 % or more of the DAC.

3.2 General Area (GA) Air Sampling

3.2.1 GA samples are typically taken with low volume samplers such as LV-1 or equivalent.

3.2.2 GA sampling shall be performed with instrumentation operating at volumes capable of meeting the Minimum Detectable Concentration (MDC) values established in the "Technical Basis Document for Dosimetry and Air Sampling".

3.2.3 GA samples should be collected:

- During work activities as a supplement to Breathing Zone (BZ) sampling as deemed appropriate.
- At site boundaries to confirm effluent air discharge concentrations. These are the Air Environmental (AE) type samples.
- At discharge points to determine the worst case airborne radiological conditions.

3.2.4 Document airflow studies, if performed in the appropriate project logbook or as directed by the SSM.

3.2.5 Select a calibrated low / high volume sampler with the appropriate glass fiber air filter and place the sample head into position. The fuzzy side of the filter should face outwards.

3.2.6 Turn the sampler ON. At a minimum, document the following information on the air filter envelope or log sheet:

- Sampling Location
- Sample Purpose (e.g., "GA" or "AE")
- Applicable HWP
- Sampler model
- Serial number
- Date / time on
- Flow rate
- On by (individual starting sampler)

3.2.7 When air monitoring is complete, observe the sampler flow rate and turn the sampler off. At a minimum, document the following information on the air filter envelope or log sheet:

- Date / time off
- Flow rate
- Total Run Time (if available)
- Total Volume Sampled (if available)
- Off by (individual terminating sampler)

3.2.8 Remove and / or replace the sample head and filter using caution to prevent cross-contamination.

3.2.9 Store the filter in a protective container to minimize the loss of collected material.

3.2.10 Submit sample and associated sample-specific information to the counting lab for analysis.

3.3 Breathing Zone (BZ) Air Sampling

3.3.1 Collect BZ samples during entries into posted airborne radioactivity areas and during activities which have a reasonable potential of producing airborne radioactivity (e.g., excavating contaminated soils, surface destructive activities on surfaces with fixed contamination) as determined by the SSM.

3.3.2 Position the sampler on the individual representative of the worst-case exposure for the group if a single lapel sampler is used for multiple members of a work group. Base this selection on operating experience and consultation with the SSM. A single lapel sampler should be used for a group of no more than four workers spending greater than one hour in the work area under the same HWP.

3.3.3 Ensure the sample head is positioned as close to the breathing zone as practical without interfering with the work or the worker.

3.3.4 Operate sampler(s) according to the appropriate instrument use procedure. At a minimum, document the following information on the air filter envelope or log sheet:

- Primary Wearer's name(s) and/or site badge number
- Sample Purpose (i.e., "BZ")
- Applicable Hazardous Work Permit (HWP) number
- Sampler model / serial numbers
- Date / time On
- Flow rate (sampler must be running)
- On by (individual starting sampler)

3.3.5 Upon exit from the work area, note the flow rate, turn the sampler OFF and detach from the worker / object. Note that unless otherwise authorized by the SSM, BZ sampling should be suspended / restarted during the workday to facilitate break periods when no one is in the work area. Accurate volume tracking is crucial during these periods of non-operation.

3.3.6 Perform necessary post-operation sampler checks according to the specific instrument use procedure

3.3.7 Carefully, remove the air filter from the sample head and place in air filter envelope. Complete the pre-printed air filter envelope or sample log sheet:

- Date / time off
- Flow rate
- Total Run Time (if available)
- Total Volume Sampled (if available)
- Off by (individual stopping sampler)

3.3.8 Submit sample to Counting Room for analysis.

3.4 Radon and Thoron Progeny

3.4.1 High volume or low volume grab samplers such as HV-1, LV-1, or RAS-1 (typically in the 35-75 lpm range) should be used for collecting radon and thoron samples

3.4.2 Radon and thoron samples should be collected:

- During work activities as deemed appropriate by the SSM or designee.
- At restricted area boundaries as deemed appropriate by the SSM or designee.
- Each frequently occupied work location should have its own samplers.
- Airflow patterns should be considered in placing samplers so that the sampler is likely to be in the airflow downstream of the source.
- A simultaneous background sample shall be taken upwind of all activities when radon and thoron sampling is performed. This sample is critically important.
- When collecting a radon and thoron breathing zone sample, the sampler should be located in the breathing zone for the worker. Preferably it should be held immediately downwind of the worker and moved around with the worker.

3.4.3 Select a calibrated high volume sampler with a 47 mm filter and place the sample head into position. The preferred filter is a membrane filter. The preferred membrane filter is the F&J Specialty Products, Inc. model number A020A047A. Alternatively, a glass fiber filter is the F&J Specialty Products, Inc. model number AE-47.

3.4.4 Turn the sampler ON and complete the required information on the air filter envelope to include:

- RWP number, if appropriate
- Sampler model and serial number
- On date, time, and flow rate
- On by (site worker initials)
- Sample location

3.4.5 Collect a sample for exactly 5 minutes, with no more than a 5-second uncertainty. Exercise caution when handling sample head so as not to cross contaminate the air filter.

3.4.6 Remove air filter from sample head and place in air filter envelope. Complete the required information on the air filter envelope including:

- Off date, time, and flow rate
- Site worker stopping the sampler

3.4.7 Submit the sample to the counting room within 30 minutes after collection. Samples must be counted between 40 and 90 minutes, or they will be void.

3.4.8 Analyze the sample in accordance with Sections 8.1 or 8.2, whichever is appropriate

3.4.9 Alternate industry-accepted methods for radon-thoron monitoring may be used at the discretion of the SSM with concurrence from the Project Certified Health Physicist.

3.5 Perimeter/ Environmental Air (AE) Sampling

3.5.1 Perimeter/Environmental air samples are taken with high volume air samplers such as the Hi-Q Model HVP-3800AFC or equivalent. Low volume air samplers, such as the LV-1, may be used, at the discretion of the SSM.

3.5.2 AE samples are collected to verify compliance with off-site release criteria.

3.5.3 AE samples are collected at locations designated by the SSM. At least four continuously operating perimeter air-sampling stations are positioned along MISS boundaries. Vicinity property perimeter monitoring will be performed during remediation activities at these properties. The vicinity property air sampling stations will be established at the most likely downwind perimeter boundary, as determined by evaluation of local meteorological data, and / or the nearest perimeter boundary from active work areas.

3.5.4 All Maywood Interim Storage Site (MISS) perimeter samplers are to operate 24 hours a day 7 days a week. Vicinity property perimeter monitoring may be suspended by the SSM during non-work hours and terminated once Restricted Area postings have been removed.

3.5.5 Filters from continuously operating perimeter air samplers are normally changed out after one to four weeks of operation depending on dust loading and associated sampler performance capabilities. Filter change-out of perimeter air samplers will be performed at a frequency long enough to ensure acceptable counting statistics and short enough to maintain consistent sampler flow rates.

3.5.6 Perimeter sampler operation shall be verified on a daily basis around locations when airborne generating activities are in progress. This requirement may be relaxed by the SSM for samplers with data logging capability.

3.5.7 Document daily verification (i.e., flow rate) and notify the SSM of any discrepancies. Replace filter and investigate pump operation if daily flow rates vary by greater than 20%.

3.5.8 Any sampler that is out of service due to malfunction for more than 1 hour and any invalid samples should be brought to the attention of the SSM.

3.5.9 Samples are to be collected in accordance with Section 7.2, Steps 5-10.

3.6 Passive Radon Monitoring

3.6.1 Passive radon monitoring methods include the use of either alpha track-etch detectors or electrets.

3.6.2 Detectors should be placed for a length of time, so that the minimum detectable concentration is 0.1pCi/l or less, following manufacturer guidelines. The length of placement is generally 1 month or greater. Locations selected should be representative of the breathing zone, when practical. A simultaneous background sample should always be taken at a location unaffected by site activities. This sample is critically important.

3.6.3 Open the bag containing the detector and place the detector in a protective container to allow for air circulation. Follow manufacturer guidelines to activate the detector, as necessary.

3.6.4 Record in the logbook:

- Sample location
- Date and time of placement
- Serial number of the detector
- Initials of the worker placing the detectors

3.6.5 Ship the detector to the manufacturer's processing center for analysis.

3.7 Precautions and limitations

- Running air samplers for extended periods may cause excessive dust loading of the filter media. The frequency of filter change-out should be increased if excessive dust loading is observed.
- Air samplers shall not be used in combustible / explosive atmospheres.
- Air sampling and sample counting equipment shall not be operated beyond their respective calibration periods.
- Air samples shall be taken in such a manner as to not contaminate the filter with materials that were not airborne during the sample interval or by re-suspension of loose contamination from surfaces near the sampling head.
- Sampler exhaust may cause the re-suspension of loose surface contamination if the sampler is positioned improperly.
- Consider higher volume air samplers when covering short duration tasks.
- The decision to provide individual monitoring devices to workers is influenced by the expected levels of intake, likely variations in dose among workers, and the complexity of measurement and interpretation of results.
- Operating instructions for air sampling equipment are addressed in separate instrument-specific procedures.

4.0 ANALYSIS OF AIR SAMPLES

General Area (GA), Breathing Zone (BZ), and Air Environmental (AE) samples should be submitted to the counting room for gross alpha analysis. Samples may be analyzed for isotopic content, as deemed appropriate by the SSM. Data reduction and interpretation of results will be performed in accordance with the "Technical Basis Document for Dosimetry and Air Sampling".

4.1 Analysis for Radon and Thoron Progeny from a 5-Minute Low Volume Grab Sample

4.1.1 Count the sample twice (5-minutes each) for alpha activity using a Ludlum 2929, Ludlum 2000, or Equivalent.

- The first count should start at least 40 minutes after the end of the sample, but not greater than 90 minutes at the end of sample collection.
- The second count should start at least 5 hours after the end of the count, but not greater than 17 hours after the end of the first count.

> NOTE
> It is not recommended that a gas flow proportional counter be used for this analysis as there is a reasonably high probability of contaminating the instrument with radon and / or thoron progeny.

4.1.2 Calculate the thoron progeny (TDC) in working levels from the delayed (second) count as follows:

$$TDC = \frac{cpm_{net}}{E \cdot V \cdot CE \cdot SAF \cdot F_{Th}}$$

Where:

cpmnet = (gross counts/count time) - background cpm of counting instrument

V = Volume of air in liters

E = efficiency of counting instrument

CE = Filter collection efficiency (normally 0.998)

SAF = Self absorption factor (normally 0.7 for glass fiber filters and 1.0 for membrane filters)

FTh = Working level factor from Graph 1 (Attachment 1).

4.1.3 Calculate the radon progeny (RDC) in working levels from the first count as follows:

$$RDC = \frac{\left(\frac{cpm_{net}}{E \cdot V \cdot CE \cdot SAF} - TDC\ x16.5\right)}{F_{Rn}}$$

Where:

cpmnet = (gross counts/count time) - background cpm of counting instrument

V = Volume of air in liters

E = efficiency of counting instrument

CE = Filter collection efficiency (normally 0.998)

SAF = Self absorption factor (normally 0.7 for glass fiber filters and 1.0 for membrane filters)

FRn = Radon working level factor from Graph 2 (Attachment 2).

TDC = Thoron Progeny determined from second count

4.2 Alternate Method for the Analysis of Radon Progeny from a 5-Minute Low Volume Grab Sample

This section only applies to the determination of radon and not the determination of thoron.

4.2.1 Count the sample once for alpha activity using a Ludlum 2929, Ludlum 2000, or Equivalent. The count should start at least 40 minutes after the end of the sample, but not greater than 90 minutes at the end of the count. Count the sample for 5 minutes.

> NOTE
>
> It is not recommended to use a gas flow proportional counter for this analysis as there is a reasonably high probability of contaminating the instrument with radon and / or thoron progeny.

4.2.2 Calculate the radon progeny (RDC) in working levels from the first count as follows:

$$RDC = \frac{cpm_{net}}{E \cdot V \cdot CE \cdot SAF \cdot F_{Rn}}$$

Where:

cpmnet = (gross counts/count time) - background cpm of counting instrument

V = Volume of air in liters

E = efficiency of counting instrument

CE = Filter collection efficiency (normally 0.998)

SAF = Self absorption factor (normally 0.7 for glass fiber filters and 1.0 for membrane filters)

FRn = Radon working level factor from Graph 2 (Attachment 2).

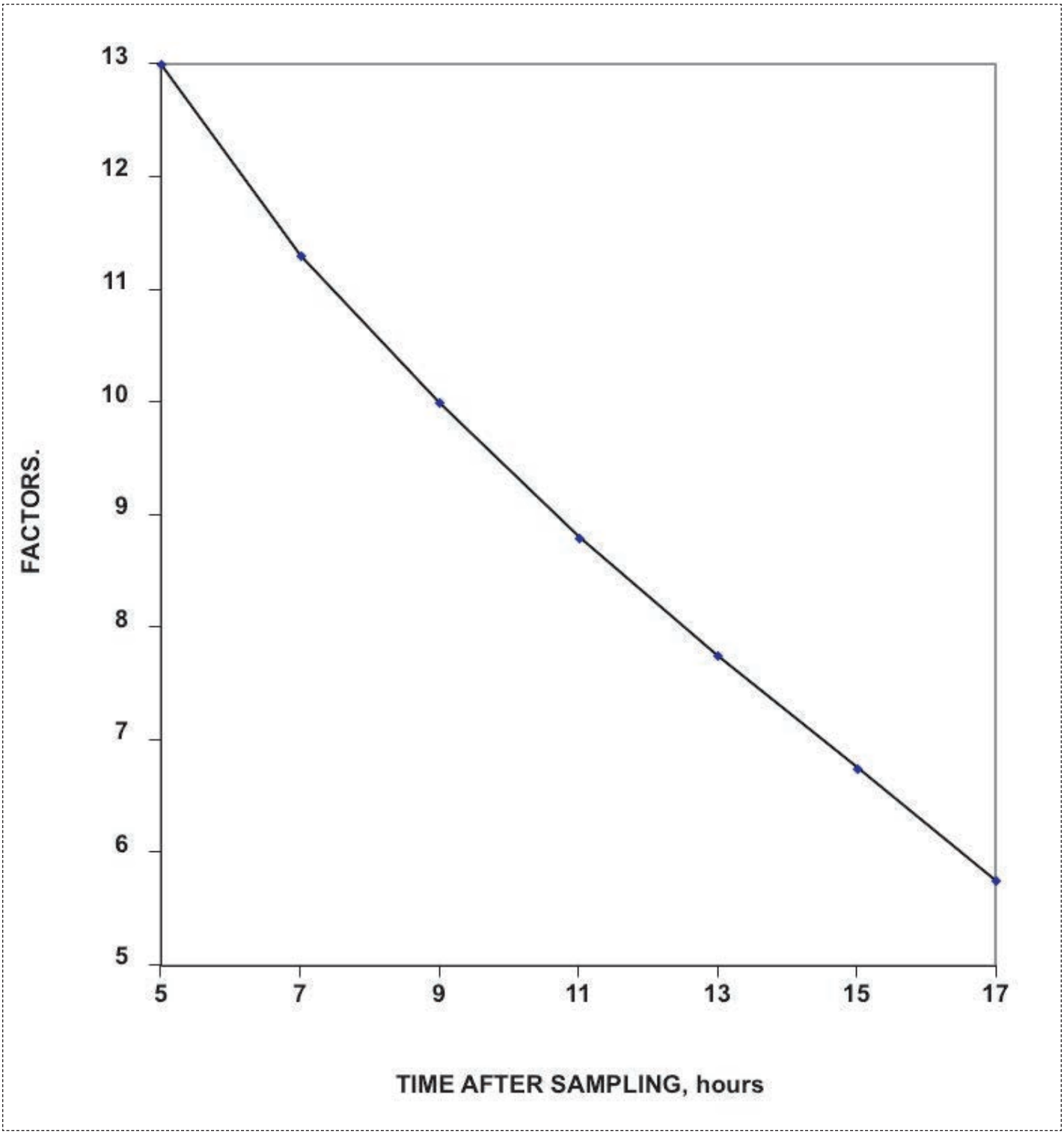
5.0 REFERENCES

- 10 CFR 20, "Standards for Protection Against Radiation."
- Greenwich Environmental Designs (GED), "Safety and Health Plan" (SHP).
- Rock, R.L., Sampling Mine Atmospheres for Potential Alpha Energy Due to the Presence of Radon-220 (Thoron)
- Daughters, Informational Report No. 1015, United States Department of the Interior, Mining Enforcement and Safety Administration, 1975.
- Kusnetz, H.L., Radon Daughters in Mine Atmospheres, A Field Method for Determining Concentrations, Am. Ind. Hyg. Assoc. Quat., Vol. 17, No. 87, 1956.
- ANSI N13.1, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.
- Regulatory Guide 8.25, Air Sampling in the Workplace.
- EM 385-1-80, United States Army Corp of Engineers (USACE) Radiation Protection Manual.
- EM 385-1-1, United States Army Corp of Engineers (USACE) "Safety and Health Requirements Manual."
- 29 CFR 1910.1096, United States Occupational Health & Safety, Ionizing Radiation.

6.0 ATTACHMENTS

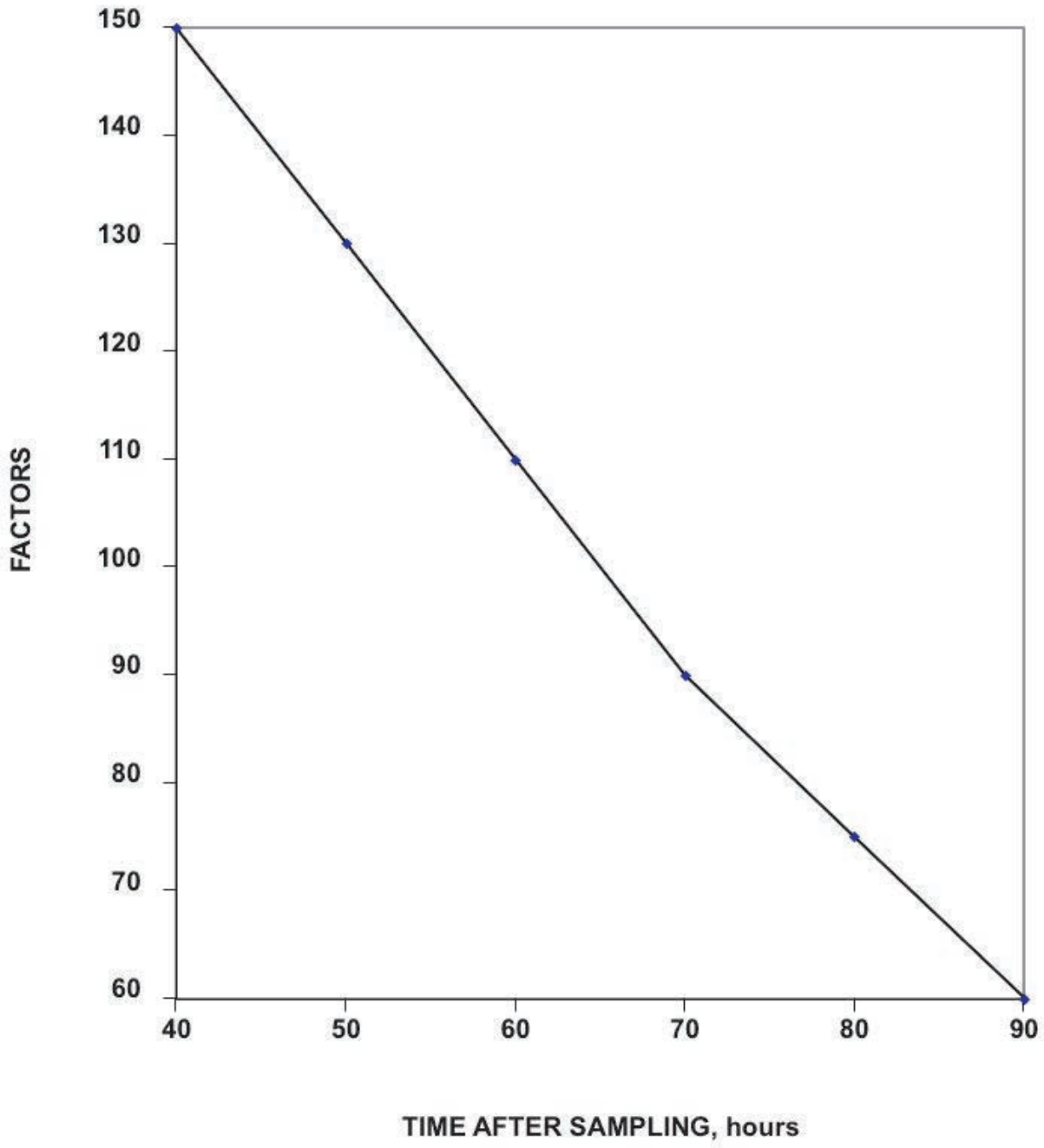
- **ATTACHMENT 1 GRAPH 1, THORON WORKING LEVEL FACTORS**
- **.ATTACHMENT 2 GRAPH 2, RADON WORKING LEVEL FACTORS**

ATTACHMENT 1 GRAPH 1, THORON WORKING LEVEL FACTORS



Time factors versus time after sampling for thoron daughter samples

. ATTACHMENT 2 GRAPH 2, RADON WORKING LEVEL FACTORS



Time factors versus time after sampling for radon daughter samples.

PROCEDURE 4.1 CALCULATING BASELINE RESPONSE RANGES.

1.0 PURPOSE

This procedure provides consistent methodology and guidelines for the determination of baseline response ranges to include Chi-squared testing and setting 95% confidence intervals to establish acceptable ranges for daily performance testing of field counting systems.

2.0 RESPONSIBILITY.

2.1 Site Survey Manager (SSM)

- Oversight of the onsite Radiation Measurement Instrument Program and for assuring that this procedure is implemented.
- Reviewing instrumentation documentation.
- Approves deviations from this procedure.

2.2 Health Physics Technician (HPT)

- Performing / overseeing daily performance checks and routine sample counting.
- Reviewing daily performance checks and routine sample counting documentation.

3.0 PROCEDURE

3.1 Discussion

Performance checks are performed daily, or prior to intermittent use, whichever is less frequent based off of the ranges established within this guidance.

The methods outlined in this procedure are intended to assure the clear and concise transfer of survey information. Variations or deviations from the protocols in this procedure are permitted if the clear transfer of information is maintained. Deviation from any aspect of this procedure does requires specific Site Survey Manager (SSM) approval.

3.2 Definitions

Minimum Detectable Activity / Minimum Detectable Concentration (MDA/MDC): The lowest activity or concentration of radioactive material in a sample that will yield a net count above system background, that will be detected with 95% confidence while accepting a 5% probability of a false positive (Type I error) or a false negative (Type II error). MDA / MDC depends upon the type of instrument, the counting geometry, and the radionuclide to be detected. MDA has the same meaning as Lower Limit of Detection (LLD).

The following MDA equation is to be used for a background count time equal to the sample count time:

$$MDA = \left(\frac{(3 + 4.65\sqrt{B}}{(E)(A)(T_S)} \right)$$

Where:

Ts = Sample count time
E = Instrument efficiency
A = Area correction factor, if applicable
B = Background cpm

The following equation is to be used for a background count time equal to 5 or more times the sample count time:

$$MDA = \left(\frac{(3 + 3.29\sqrt{B}}{(E)(A)(T_S)} \right)$$

Chi-Squared Test: A Chi-squared test is used to determine the precision of a counting system. It is a measure of the reproducibility of results. The Chi-squared value is calculated as:

$$X^2 = \frac{\Sigma\left(x_i - \bar{x}\right)^2}{\bar{x}}$$

Variance: Variance is defined as the amount of scatter of data points around the mean.

Standard Deviation: Standard Deviation is defined as the square root of the average squared variance and the population standard deviation is defined mathematically as:

$$\sigma = \sqrt{\frac{\Sigma\left(x_i - \bar{x}\right)^2}{n-1}}$$

Acceptable Range: Acceptable range for background and source efficiency is defined as plus or minus 2 standard deviations of the mean or average value.

3.3 Precautions and Limitations

3.3.1 Inspections, Chi-square tests, establishing acceptable ranges, and daily performance checks shall only be performed by trained technicians.

3.3.2 A physical inspection shall be performed prior to initiating any of the above operations. This inspection should include inspection of readouts, meters, slide-tray and cam-lock, cable(s), cords, and general physical condition of the instrument/detector. The inspection shall include confirmation of current calibration and that a current calibration sticker is affixed to both the instrument and the detector.

3.3.3 The Instrument shall have been calibrated within the previous 12 months.

3.3.4 Operating parameters shall be verified. These parameters should include operating voltage verified against the calibrated value and battery condition if in use.

3.3.5 Any instrument/detector failing the above inspections shall not be used until corrective action has been made. If the calibration is in question, tag the instrument out-of-service until corrective actions have been completed and a new calibration performed.

3.3.6 The background (BKG) count shall utilize the same counting geometry as the samples to be analyzed (i.e., a clean blank smear if smears are the media to be analyzed).

3.3.7 The geometry of the source should be the same as the sample to be analyzed (i.e., a 47-mm smear should use a 47-mm check source and a 25-mm air sample should use a 25-mm source).

3.3.8 Chi-squared tests shall use 20 points of reference; both background and source counts. An acceptable value obtained from the Chi-squared test must fall between the values 10.12 and 30.14. Values outside these limits indicate the instrument/detector is not functioning correctly. The instrument/detector shall not be used for data collection until corrective action has been taken and an acceptable Chi-squared value has been obtained.

3.3.9 An acceptable range for background and source efficiency shall be established prior to operational data collection.

3.3.10 Use gloves to handle the electroplated check sources. The use of tweezers may result in scratching the source and subsequent loss of activity.

3.4 Chi-Squared Test

3.4.1 Complete the required information on the "Chi-squared / Acceptable Range Data Sheet" (Attachment 1).

3.4.2 Place the appropriate background blank or source in the detector.

3.4.3 Select the appropriate count time. The count times shall be the same as the operational count times for both background and source counts.

3.4.4 Collect 20 background and 20 source counts. Alternate source and background counts.

3.4.5 Record the gross readings in the appropriate section on the "Chi-squared / Acceptable Range Data Sheet" (Attachment 1).

3.4.6 Enter the Gross BKG and gross source counts into the appropriate columns of the Chi-square Excel spreadsheet utility. The SSM or designee maintains this utility.

3.4.7 Compare the Chi-square results. The results must fall between the values of 10.12 and 30.14.

3.4.8 If a Chi-square value falls outside the range notify the Lead Radiation Protection Technician or SSM. The instrument shall not be used for data collection until corrective action has been taken and an acceptable Chi-square value has been obtained.

3.4.9 Obtain a printout of spreadsheet results.

3.5 Acceptable Range

3.5.1 Calculate and / or record the background counts per minute, (BKG cpm), Column B and the Source cpm, Column D on the Chi-square / Acceptable Range Data Sheet. A computer print out with duplicate data may be attached in lieu of this step.

3.5.2 Enter the above values into the appropriate columns of the Acceptable Range 'Excel spreadsheet'.

3.5.3 Obtain a printout of Acceptable spreadsheet results.

3.5.4 Assemble, review, and sign an instrument acceptance package consisting of:

- Chi-square / Acceptable Range Data Sheet
- Chi-square printout(s)
- Acceptable Range printout(s)

3.5.5 Submit the "Set-Up" package to the SSM or designee for review and signature.

3.5.6 If package is approved, initiate a Daily Field Source Check Log – Fixed Counting System form (Attachment 2). Transpose the following information from the "Set-Up" package:

- Instrument information
- Source Data
- Acceptable ranges (+/- 2 and 3 Sigma values)

3.5.7 Place the "Set-Up" package in onsite files until transmitted to Project Records. This data may need to be available for later review and to generate control charts.

3.5.8 Place the Daily Field Source Check Log – Fixed Counting System form in the designated instrument file / folder for later use.

3.5.9 The instrument is now available for sample counting.

4.0 RECORDS

- Chi-square / Acceptable Range Data Sheet (Attachment 1).
- Daily Field Source Check Log – Fixed Counting System (Attachment 2).

5.0 ATTACHMENTS

Attachments may be revised without formal review of this procedure and are attached as examples only.

Please contact the SSM for a current copy of these attachments.

- **ATTACHMENT 1 CHI-SQUARE / ACCEPTABLE RANGE DATA SHEET**
- **ATTACHMENT 2 DAILY FIELD SOURCE CHECK LOG**

ATTACHMENT 1

CHI-SQUARE/ACCEPTABLE RANGE DATA SHEET

DATE: _____ PERFORMED BY: _____

INSTRUMENT: _____ SERIAL #: _____ CAL DUE: _____

PROBE: _____ SERIAL #: _____ CAL DUE: _____

SOURCE: _____ SERIAL #: _____ CAL DUE: _____

BKG COUNT TIME: _____ SOURCE COUNT TIME: _____

CALIBRATED OPERATING VOLTAGE: _____

COUNT #	GROSS BKG (A)	BKG CPM (B)	GROSS SOURCE (C)	SOURCE CPM (D)	EFF (E)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Note: Columns B, D, and E are not required to be completed if data is tabulated via computer utility with printouts attached.

DATA ENTRY VERFIED BY: _____ DATE: _____

SET-UP REVIEWED BY: _____ DATE: _____

ATTACHMENT 2

DAILY FIELD SOURCE CHECK LOG
FIXED COUNTING SYSTEM

MONTH / YEAR: ____________________

INSTRUMENT DATA

	SCALER	DETECTOR
MODEL		
SERIAL #		
CAL DUE		

SOURCE DATA

ISOTOPE	
SERIAL #	
ACTIVITY dpm {C}	

ACCEPTABLE RANGES

	Background	Efficiency
+ 3 Sigma		
+ 2 Sigma		
- 2 Sigma		
- 3 Sigma		

Daily Efficiency Calculation:

[(A - B) / C] = D

Date/Time	Source Gross Counts	Source CNT TIME (min)	Source (cpm) {A}	Background Gross Counts	BKGD CNT TIME (min)	Background CPM {B}	NET CPM	Calculated Efficiency {D}	Tech. Initials

Remarks:

Reviewed by:

Procedure 4.2
Effective Date:02/01/2014
Revision No: 0

PROCEDURE 4.2 CALCULATING DETECTION SENSITIVITY

1.0 PURPOSE

1.1 To describe the method for calculating detection sensitivities applied to field survey activities.

2.0 RESPONSIBILITY

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

The detection sensitivity of a measurement system refers to the statistically determined quantity of radioactive material or radiation that can be measured or detected at a preselected confidence level. This limit is a factor of both the instrumentation and the technique or procedure being used. Several terms that are used to define detection sensitivity are:

- Minimum Detectable Activity (MDA)
- Critical Level ()
- Measurable Activity Level ()

Minimum Detectable Activity (MDA) is an a priori estimate of the detection capability of a sampling and/or measurement technique, based on nominal or expected performance characteristics of the instrumentation. This concept is used to develop initial estimates of measurement capabilities, when planning survey strategies and selecting instruments and techniques for specific applications. In estimating the MDA, it is assumed that there is a background level greater than zero, which will also be subject to structural variability.

Two types of errors are considered in performing this estimate:

Type I error (or "false positive") occurs when a detector response is considered to be above-background when in fact, above-background radiation is not present.

Type II error (or "false negative") occurs when a detector response is considered to be background when in fact above-background is present. If 5% false positives (Type I) and 5% false negatives (Type II) are selected to be acceptable levels for both types of errors, and it is assumed that the background and sample counting times are the same and the background level is not well known (a situation commonly encountered when conducting field survey activities), the MDA is calculated using the following relationship:

The following MDA equation is to be used for a background count time equal to the sample count time:

$$MDA = \left(\frac{(3 + 4.65\sqrt{B})}{(E)(A)(T_S)} \right)$$

Where:

Ts = Sample count time

E = Instrument efficiency

A = Area correction factor, if applicable

B = Background cpm

The following equation is to be used for a background count time equal to 5 or more times the sample count time:

$$MDA = \left(\frac{(3 + 3.29\sqrt{B})}{(E)(A)(T_S)} \right)$$

where:

The definitions of the parameters are the same as provided for the MDA.

Because both types of possible errors are considered in these calculations, the MDA estimate often yields a larger value than can be realistically achieved by field surveys and therefore provides a conservative approach for planning. For some applications, the MDA estimate may result in such conservatively high values that use of certain instruments or techniques may be unnecessarily negated for a given measurement. Therefore, while use of the MDA for planning purposes may be the conservative approach, for practical purposes use of a less conservative, although technically justified, approach is acceptable. The objective of field surveys is primarily to identify conditions exceeding established guidelines while avoiding "false negative" results; positive findings will typically receive further evaluation and therefore "false positive" findings will not be a factor in final survey data evaluation. The concept of critical level (L_c) is useful under these circumstances. The critical level is the lower bound (in net counts), below which there is less than a 5% probability that the measurement represents an above-background condition (i.e. is a "false negative" result).

This term is calculated by:

$$L_c = (2.32\sqrt{B * T_S})$$

where:

The definitions of the parameters are the same as provided for the MDA.

This value should be used when actually counting samples or making direct radiation measurements. Any net response above this level should be considered a positive result. The critical level is represented as a measurable activity level (M_L) for the purpose of evaluating and reporting survey data. The measurable activity level is the activity, concentration, or other equivalent of the critical level in units comparable to those of the guideline, and is calculated by:

$$M_L = \left(\frac{L_c}{(E)(A)(T_S)} \right)$$

where:

The definitions of the parameters are the same as provided for the MDA.

The calculated value of will be identified with survey data as the detection sensitivity for each measurement procedure and set of conditions.

Procedure 4.3
Effective Date: 12/01/94
Revision No: 0

PROCEDURE 4.3 CALCULATING SURFACE ACTIVITY LEVELS

1.0 PURPOSE

1.1 To describe the procedures for calculating levels of surface activity.

2.0 RESPONSIBILITY

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Obtain the field measurement data, developed from Procedure 2.3.

3.2 Calculate dpm/100 cm2 by subtracting background to obtain net counts and applying appropriate time, detector efficiency, and detector area factors.

$$DPM/100cm2 = \frac{\left(\frac{TotalSampleCounts}{SampleCountTime}\right) - \left(\frac{TotalBkgCounts}{BkgCountTime}\right)}{(E)\ (A)}$$

where:

E = Instrument efficiency (counts/disintegrations)

A = Area correction factor, (detector area(cm2/100)

3.3 Record the calculated values on the appropriate record form.

Procedure 4.4
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 4.4 DEVELOPING CORRELATION OF PORTABLE SURVEY INSTRUMENTS WITH PRESSURIZED IONIZATION CHAMBER

1.0 PURPOSE

1.1 To describe the method used to develop correlations between portable gamma survey instrument response and the response of a Pressurized Ionization Chamber (PIC).

2.0 RESPONSIBILITY

2.1 The Project Manager is responsible for assuring that this procedure is implemented.

2.2 Individuals designated by the Project Manger are responsible for following this procedure.

3.0 PROCEDURE

3.1 In this process the relationship (linear or quadratic) between instrument response and "true" exposure rate, as measured by PIC, is not determined a priori. Rather, for each specific project, data will be evaluated and a relationship will be used which best predicts the true exposure rate for the instruments of interest. This process can be divided up into three main steps:

1) Data are entered into a spreadsheet and plotted.
2) Several regression analyses are performed using a standard statistical package.
3) Regression data are evaluated and best fit(s) selected.

3.1.1 Step 1

A) Set up a spreadsheet that contains all pertinent information on PIC correlation measurements which were performed in the field.

B) Add to that spreadsheet the readings obtained from each instrument.

C) Plot the data.

3.1.2 Step 2

A) For the statistical analysis, save the spreadsheet from Step 1.

B) Perform a linear and a quadratic fit to all the data.

C) In some instances (e.g., response of NaI(Tl) detectors), the best fit of the data may be quadratic, but the data in the lower range of exposure rates may be best described with a linear equation. By visual inspection of the plotted data (instrument reading versus PIC measurement), determine if there is an inflection point in the data. If so, divide the data into two subsets and perform regression analyses on the individual subsets. If such an inflection point is not evident from visual inspection, it may become more apparent during Step 3.

3.1.3 Step 3

A) Enter all regression information into a spreadsheet. Arrange the data in order of increasing exposure rate. The spreadsheet uses the actual instrument readings, calculates predicted exposure rate values based on multiple regression scenarios (from Steps 2B and 2C), and provides percent differences between the calculated values and actual exposure measurements made by the PIC. If data were not divided into subsets in Step 2C, examine the calculated values in this spreadsheet for an inflection point. Examine the percent differences between calculated values and actual exposure rates. These differences should fluctuate around zero; if at any point there appears to be a systematic and continuing increase in either the positive or negative direction, that point may be an inflection point, and Step 2C should be repeated.

B) Based on the data from Step 3A, select a regression equation that has the least percent differences between predicted and observed values, the entire range of data.

Note: For one instrument, a set of two regression equations may be used if one best predicts values in lower exposure ranges and the other equation best predicts values at higher exposure ranges. In this case, the boundary point at which the regression equation changes must be selected.

C) If a set of two regression equations is used, the boundary point may be identified by solving the two regression equations for an intersection point. This value should also be verified by examining the percent difference values using both equations. At the boundary point there should not be a significant (>10%) difference between calculated values from the two equations. When solving for the intersection point, it is not un usual for the two equations to not have an intersection. In such a case, the spreadsheet in Step 3A should be examined to determine at which point the percent difference values for one regression equation are closer to zero than for the other equation.

Procedure 4.5
Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 4.5 DETERMINING AREA-WEIGHTED AVERAGES

1.0 PURPOSE

1.1 To describe the procedure for calculating weighted averages of direct measurements and soil concentrations.

2.0 RESPONSIBILITY

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 Guideline levels for soil and surface activity are typically expressed as average values over a given surface area. These areas are usually 1 m2 for structure surfaces and 100 m2 for land areas (soil). When individual measurements or sample concentrations exceed the average guideline values, the weighted average may be calculated for comparison with the guideline. This calculation takes into consideration the areas of the total averaging region that contain elevated direct radiation or radionuclide concentrations and the respective radiation or concentration levels in those areas. The weighted average is determined as follows:

3.1.1 Prepare a table of locations in the averaging region of interest, having radiation or radionuclide concentration levels above the guideline value.

3.1.2 Estimate the surface area associated with each location identified in Step 3.1.1.

3.1.3 Determine the average level of those measurements in the region which do not exceed the guideline value.

Note: Data used for this calculation may be in converted (pCi/g, dpm/100 cm2, etc.) or unconverted (counts or cpm) units and may have background included or subtracted, as long as all data are of the same type. To reduce the number of computations and to avoid calculations which may include negative values, it is often more practical to perform such calculations with unconverted data, before subtracting background, and perform the data conversion on the calculated average value.

3.1.4 Calculate the area-weighted average for the region, using the relationship:

$$\bar{x}_k = \frac{1}{n_s}\sum_{i=1}^{n_s} x_i \left(1 - \sum_{k=1}^{n_k} A_k\right) + \sum_{k=1}^{n_k} y_k A_k$$

where:

x_k = weighted mean including elevated area(s)

x_i = systematic and random measurements at point

n_s = number of systematic and random measurements

y_k = elevated area activity in area k

A_k = fraction of one area occupied by elevated area

n_k = number of elevated areas

3.1.5 If an averaging region does not include areas of elevated radiation or radionuclide concentrations, the average for that region is the arithmetic mean for all measurements performed in that region.

Effective Date: 02/01/2014
Revision No: 0

PROCEDURE 4.6

ROUTINE OPERATIONS FOR ISOCS MEASUREMENTS OF SURFACE SOIL

1.0 PURPOSE

This Standard Operating Procedure (SOP) – Routine Operations Procedure for ISOCS Measurements of Surface Soil is to be employed at a designated radiologically contaminated site when site soils are to be tested in-situ for radionuclides of concern.

This procedure describes use of the Canberra *In situ* Object Counting System (ISOCS) for gamma spectroscopy measurements of surface soil. Instructions are provided for proper ISOCS equipment set up, spectral acquisition, and reporting of analysis results. These instructions are intended to assist the knowledgeable user in accurately determining the nuclide activity concentrations in the measured soil. These results can then be directly compared to applicable contamination limits and acceptance criteria for surface soil at the measurement site.

This procedure is applicable for use by all personnel responsible for operation of ISOCS equipment for measurements of surface soil activities, specifically for measurements of nuclide activity concentration in a horizontal layer(s) of soil extending downward from the ground surface.

2.0 RESPONSIBILITIES

2.1 SITE SURVEY MANAGER

The Site Survey Manager (SSM) is responsible for ensuring that site personnel conduct ISOCS field measurements in accordance with this SOP and keeping the Project Management personnel informed of any procedural changes or measurement anomalies. The SSM shall concur with all changes to this SOP.

2.2 SURVEY PERSONNEL

All employees who are engaging in ISOCS measurement activities are required to follow the procedures in this SOP, unless superseded by project-specific requirements. All ISOCS measurement activities, including deviations to this SOP, will be recorded in field logbooks during on-site activities.

Field personnel trained in the use of ISOCS equipment are expected to carry out the ISOCS measurement activities. They are responsible for the calibration, care and maintenance of the ISOCS system. The site Project management team should be notified if any problems arise during this phase of the ISOCS measurement process.

Personnel assigned to a project team with the task of operating the ISOCS surface soil measurement system will be trained in specific techniques of ISOCS measurement.

3.0 PROCEDURE

3.1 INITIAL SYSTEM SETUP

3.1.1 Equipment

3.1.1.1 Provide adequate battery power for the InSpector and computer if AC power is not available at the measurement location. To maximize operating time in the field, ensure that all available batteries are fully charged before moving to remote measurement locations.

3.1.1.2 Move all necessary ISOCS system hardware to the desired measurement location, including the detector, laptop computer, InSpector MCA, connecting cables, and ISOXSHLD Shield components (if used).

3.1.1.3 Attach a short cable with a nine-pin connector on each end between the InSpector and the computer. A special composite cable (with preamp power, energy spectrum signal, high voltage, and high voltage inhibit connectors) is attached between the InSpector and the detector.

3.1.1.4 Securely mount the detector in a “downward-looking” position perpendicular to the ground surface. The tasks of moving, mounting, and aiming the detector shall be performed using the ISOXSHLD Shield. This device includes a wheeled cart with a fixed mounting location near the top to place the detector height at one foot above ground surface. This detector height shall be used for routine *in situ* measurements of surface soil at the project site.

3.1.1.5 The complete ISOXSHLD package includes both 2.5 cm (1.0 inch) thick and 5.0 cm (2.0 inch) thick lead shield assemblies. Each assembly consists of the following components: two back shield sections, two or three side shield sections, collimators

(for 30-degree and 90-degree fields of view), and an end plate. Unless directed otherwise by the ISOCS SSM, the 5.0 cm (2.0 inch) thick back shield, side shield components and the 90-degree collimator shall be used for routine ISOCS measurements of surface soil at the project site.

3.1.2 Acquisition Considerations

3.1.2.1 When the detector has been securely mounted and aimed at the desired point on the ground surface, spectral data can be acquired. This can be performed most efficiently by using the Sample Counting menu option within the PROcount software, which should be used for all routine ISOCS measurements. Use of this option allows spectra to be acquired, identified, stored and analyzed in an automated sequence.

3.1.2.2 Alternatively, spectral data can be acquired and stored without running PROcount, by using the Gamma Acquisition & Analysis application within standard Genie-2000. Analyses of stored spectra can then be performed manually, if desired. Procedures for data acquisition and analysis are provided in GED 4.9 "Application and Analysis within Standard Genie 2000 to Perform ISOCS Measurements ion the Field" to assist the more experienced user should operation under Genie-2000 be desired.

3.1.2.3 Typically the ISOCS efficiency calculation is performed first, then spectral data can be acquired either before or after the surface soil matrix has been characterized. If spectral data acquisition is performed first, the data must be stored for subsequent analysis.

3.2 DATA ACQUISITION WITH PROCOUNT

This section assumes that the user is already familiar with the PROcount application, and that an appropriate MCA Input named DET01 has been defined. Setup of PROcount for ISOCS measurements should include special Geometry and Sample Type definitions, as discussed in sections 3.2.2 – 3.2.4 below. Detailed instructions for proper use of PROcount are provided in the InSpector Spectroscopy System Basic Operations manual. The user should refer to that document whenever necessary to supplement the information provided in this section of the procedure.

3.2.1 Starting PROcount

3.2.1.1 Apply power to the InSpector and laptop computer.

3.2.1.2 Access the desktop screen and double click on the Genie2000 icon. This will open the

Genie2000 folder and display a GENIE2000 Icon View window or a GENIE2000 Details View window.

3.2.1.3 Double click on the PROcount icon. This will display a System Logon dialog box.

3.2.1.4 If the factory default security is still in effect, enter manager in the User name field of the System Logon dialog box, then click on the OK button. NOTE: If at some future time alternate user accounts are created using the Password File Editor, enter the appropriate User name and Password to ensure successful logon.

3.2.1.5 A Gamma Acquisition and Analysis (GAA) window will then be opened at the bottom of the screen, and the GENIE PROcount Main Selection Screen menu will be displayed at the top of the screen.

3.2.2 Geometry and Sample Type Definitions for ISOCS

Proper setup of PROcount requires creation of Geometry and Sample Type definitions that are appropriate for the type(s) of measurements to be performed. Prior to performing ISOCS measurements, special Geometries shall be defined.The Geometry Name editor and Sample Type File editor is used to enter these definitions.

3.2.2.1 Select System Maintenance from the Main menu. This will display the System Maintenance menu.

3.2.2.2 Select Editors to display the Editors menu.

3.2.2.3 Select Geometry Name Editor.

3.2.2.4 If the standard site geometry names are not present in the list of available Geometry names, use the dialog box, and add these names to the list.

NOTE: *Experienced users may wish to add other Geometry names, with the approval of the SSM, corresponding to specific types of measurements (e.g., to account for layers of asphalt or gravel at the ground surface), especially if the required ISOCS efficiency calibration files have already been generated.*

3.2.2.5 Use the OK button to exit the Geometry Name Editor dialog box.

3.2.2.6 When the Editors menu is redisplayed, select Sample Type File Editor.

3.2.2.7 Using this editor, create and edit a Sample Type file named “Surface Soil”.

3.2.2.8 A dialog box will be displayed. The editable fields in this dialog box are used to control the operation of the Sample Counting menu option whenever this Sample Type is selected.

3.2.2.8.1 The Analysis Sequence File (ASF) field specifies the default Analysis Sequence that will be executed during the Sample Counting operation. The "normal soil analysis – screen" entry in this field indicates that the acquisition will be analyzed immediately after the acquired spectral data is saved in a CAM file. This option allows the operator to view preliminary results in the field immediately following data acquisition.

3.2.2.8.2 The Sample Type File Editor should show a value of 1200 (seconds) in the Live Time field. This value will be used as the default preset live time for the Sample Counting operation whenever this Sample Type is selected, and has been shown to provide adequately low MDA values and counting uncertainties for all nuclides of interest at the project site. Proper setup of the Sample Counting operation will allow entry of an alternate live time value prior to starting the acquisition, which may be appropriate if the count time can be reduced while still achieving the required MDA values.

3.2.2.9 When editing of the ISOCS sample type file is complete, use the OK button to exit the Sample Type File Editor dialog box.

3.2.3 Setting the Operating Defaults

3.2.3.1 Return to the System Maintenance menu, then select the PROcount Setup option. This will display the Genie PROcount Setup dialog box.

3.2.3.2 The check boxes in the System Options section of this dialog box are used to control the Sample Counting operation. Place a check mark in the box labeled "Prompt for Sample Position" to allow prompting for an alternate preset live time value prior to starting spectral acquisition.

3.2.3.3 Click on OK button to exit the Genie PROcount Setup dialog box.

3.2.4 Initial Efficiency Calibration Requirements

Each Geometry defined in PROcount has a unique two-digit number associated with it, ranging from 01 to 99. Before a particular Geometry can be selected during the Sample Counting operation, a file must exist in the PROCOUNT\CALFILES directory with the name GnnDmm.CAL, where *nn* matches the number associated with that Geometry, and *mm* matches the number of the selected Detector.

For this discussion it will be assumed that DET01 is the Detector input and *nn* is the Geometry number to be selected for soil

measurements. For these conditions, a file named *GnnD01.CAL* must exist in the PROCOUNT\CALFILES directory. Spectral data will be stored in a CAM file and analyzed using the appropriate ISOCS efficiency calibration parameters.

3.2.5 Applying High Voltage to the Detector

Prior to acquiring new spectral data, high voltage must be applied to the detector. The preferred method for performing this task is described below:

Caution: Confirm that the detector has been properly cooled with liquid nitrogen prior to performing these steps.

3.2.5.1 Select Detector Management from the Main menu.

3.2.5.2 Select the desired detector from the Choose Detector section of the next dialog box, then click on the Hardware Control button.

3.2.5.3 Select High Voltage - On/Off/Reset from the Hardware Control menu.

3.2.5.4 Select On from the High Voltage Control dialog box. The HV indicator light on the InSpector front panel will be illuminated, and after a brief delay the Hardware Control menu will be redisplayed.

3.2.6 Adjusting Amplifier Gain and ADC Zero

Prior to the start of each counting session the system alignment should be checked. If the energy gain or ADC zero is beyond acceptable limits, they must be adjusted.

3.2.6.1 To check and adjust the amplifier gain and ADC zero settings, a suitable check source should be placed near the detector during spectral data acquisition. This check source should emit photons with emission rates sufficient to produce readily detectable photopeaks.

3.2.6.2 The centroid channel and corresponding energy value for each reference photopeak should be compared to the expected values. Observed photopeak centroids should typically be within ± 1.0 keV of the expected energy values. Adjust the vertical full scale of the displayed spectrum and use the Expand On button, as appropriate, to view the reference photopeaks.

3.2.6.3 Select System Maintenance from the Main menu, then select Gamma Acquisition & Analysis (GAA). From the MCA window, click on File, Open Datasource, and select detector DET01.

3.2.6.4 From the MCA window, click Acquire ON and note the position of the 121.8 keV and 1408 keV photopeaks in the spectrum.

3.2.6.5 If necessary, amplifier gain and/or ADC zero settings can be changed by selecting Adjust... from the MCA menu. This will display the Adjust dialog box.

3.2.6.6 The scroll bars in the Amp Fine gain, Amp S-fine gain, and ADC Zero sections of this dialog box should then be used to make the appropriate changes.

3.2.6.7 After each change, clear any previous spectral data and start a new acquisition to evaluate the new settings.

3.2.6.8 When spectral data acquisition using the traceable source indicates that the centroid channel of each reference photopeak is within ± 1.0 keV of the expected energy values, the new settings are deemed acceptable. Click on the Exit button to exit the Adjust dialog box.

3.2.6.9 To save the new parameter values, click on File in the GAA window menu bar, then select Save from the File menu.

3.2.7 Routine Sample Counting

In preparation for ISOCS measurements, all InSpector system hardware must be properly set up at the selected measurement location, with the detector placed in the desired position relative to the object being assayed. A Field Operations Checklist form (shown as Attachment 1 in this procedure) should be used to confirm proper equipment setup and documentation of results for each count. The tasks of acquiring, identifying and analyzing spectral data shall then be performed as described below:

3.2.7.1 Select the Sample Counting option from the Main menu.

3.2.7.2 As described earlier, a Sample Type named "Surface Soil" should be used for all routine surface soil ISOCS measurements at the project site.

3.2.7.3 A dialog box will be displayed to allow selection of the desired Sample Type. Select the Surface Soil option to continue.

3.2.7.4 A site derived geometry is intended for routine surface soil measurements, unless it is determined by the SSM that an alternate geometry is more representative of the current sample and/or collimator configuration.

3.2.7.5 A dialog box will be displayed to allow selection of the desired Geometry. In this case, select the appropriate Geometry option to continue.

3.2.7.6 The next dialog box to be displayed allows entry of an alternate preset live time value.

3.2.7.7 The title bar of this dialog box includes the selected Sample Type name. The value initially displayed in the Live Time field is the default value previously specified in the Sample Type File Editor. Accept the default live time value unless instructed otherwise by the SSM.

3.2.7.8 Click the OK button to exit this dialog box.

3.2.7.9 Acquisition of spectral data will be started at this point.

3.2.7.10 The spectrum can be viewed in the GAA window at the bottom of the screen. The message "Please wait while sample parameters screen is prepared" will be displayed, followed by the Sample Counting | Sample Parameters dialog box.

3.2.7.11 Enter appropriate text in the Sample ID and Description fields. The Sample ID is a unique identifier for each ISOCS surface soil measurement location, an example naming convention is as follows:

Sample ID =XXX-AAA-NNN-n-#####

where: "XXX" is a unique 3-character property code
"AAA" is an Activity Designator
"NNN" is a Station Number
"n" is the Sample Type
"#####" is a Sequential sample Number

3.2.7.12 A value of 1 should be entered for Sample Quantity.

3.2.7.13 The default entries in the Sample Units and Sample Date fields should be left
unchanged. Enter appropriate comments regarding the measurement location in the Sample Description fields.

3.2.7.14 To allow normal termination of the Sample Counting operation, use the OK button after
parameter entry is completed. Complete sections A through C of the field operations checklist form.

3.2.7.15 The Main menu will be redisplayed and data acquisition will continue until the preset live time has elapsed.

3.2.7.16 When the acquisition stops, a CAM file will be saved in the directory named PROCOUNT\CAMFILES\ISOCS. The name of the CAM file will be SUSnnnnn.CNF, where SUS is the Sample Type code and nnnnn is an integer incremented by 1 for each successive count.

3.2.7.17 Procount will return the user to the Main Selection screen. From this screen select Detector Management.

3.2.7.18 Click on View Last Report. This will display the results of the last acquisition. The Operator should review these results to ensure that the expected K-40, Ra-226 and Th-232 photopeaks are observed at the proper channels, and that reported nuclide activity values are within expected limits. Complete section D of the Field Operations Checklist form.

The Sample Counting operation can be repeated at this time, if desired. For each count, sufficient information must be obtained about the conditions (by conditions, we mean the nature of the measurement surface; i.e., the physical condition of the ground surface; alternate efficiencies are determined from observing obvious differences in the measurement location from bare soil (e.g., gravel, asphalt layer)) to ensure that the default ISOCS efficiency is correct or if an alternate efficiency must be defined and used to analyze the acquisition. An alternate efficiency can only be used with the approval of the SSM.

3.2.8 Analyzing a Sample Data File

After normal termination of the Sample Counting operation, the resulting CAM file can be edited and reanalyzed using additional PROcount menu options. This allows the user to reanalyze spectral data files with alternate efficiencies, if required. Any alternate efficiency, if selected, cannot be employed for reanalyzing files without the concurrence of the SSM or his equivalent. In most cases, alternate efficiencies will be taken from the test cases results (see Method Validation Element A of the Method Validation Protocol for Field Measurements using Canberra’s In-Situ Gamma Spectrometer).

The most likely conditions that would require reanalysis of the acquired spectra are when a layer of asphalt, gravel, or uncontaminated soil is present at the ground surface covering a layer of contaminated soil. For these conditions, the default ISOCS model (i.e., assumed uniform activity distribution in normal soil at all depths below ground surface) would yield inconsistent measured activity values for low energy and high energy photopeaks associated with the radionuclides of concern (ROC) (measured ROC activity values should be consistent for low energy and high energy photopeaks if the default ISOCS model efficiency calibration is correct.).

Preliminary activity values for the ROC that are significantly greater for high energy photopeaks compared to low energy photopeaks indicate that a layer of low-activity absorbing material is present at the ground surface and is not properly included in the ISOCS efficiency model. Activity values for the ROC that are significantly greater for low energy photopeaks compared to high energy photopeaks indicate that the activity concentration is non-uniform and decreases significantly as the depth below surface increases. When either of these conditions is observed, the SSM should be consulted to determine the optimum

available alternate ISOCS efficiency calibration for reanalysis of the acquired spectrum.

To reanalyze a previously acquired spectral data file, proceed as follows:

3.2.8.1 Return to the System Maintenance menu.

3.2.8.2 Select Analyze Sample Data File. Two dialog boxes are displayed to select the specific CAM file to be analyzed.

3.2.8.3 Highlight the Surface Soil Sample Type, then click on the Choose by Sample Type button.

3.2.8.4 The next dialog box will list all files stored in the PROCOUNT\CAMFILES\ISOCS directory corresponding to the selected sample type. Highlight the desired file in this list, then use the Select button to select that file and exit the dialog box.

3.2.8.5 After selecting a specific CAM file, the Analyze Sample Data File operation will continue by displaying the analysis options menu. The first option in this menu is not normally required for analysis of ISOCS measurement CAM files. The remaining five options in this menu are discussed below.

3.2.8.5.1 Loading ISOCS Calibration Parameters.

A. To load ISOCS efficiency calibration parameters in the currently selected CAM file, select the second option listed in the Re-Analyze a PROcount Sample menu (Select Alternate External Efficiency Calibration).

B. A dialog box will be displayed listing the calibration files stored in the appropriate CALFILES subdirectory.

C. Use the scroll bar to view additional entries in this list.

D. Highlight the desired file, then click on the Select button. This will load the new calibration parameters, exit the dialog box, and redisplay the Re-Analyze a PROcount Sample menu.

3.2.8.5.2 Changing the Default Analysis Sequence

A. To specify an alternate Analysis Sequence for the currently selected CAM file, select that option from the Re-Analyze a PROcount Sample menu.

B. This will display a dialog box to allow selection of a specific Analysis Sequence file (ASF).

C. Use the drop down arrow to display a list of descriptions for the available Analysis Sequence files.

D. Select the desired option from the drop down list, then click on the OK button.

E. This will load the new Analysis Sequence, exit the dialog box, and redisplay the Re-Analyze a PROcount Sample menu.

If necessary, the Analysis Sequence Editor may be used to modify an existing Analysis Sequence and create additional ASF's. This editor can be accessed from the Editors menu.

3.2.8.5.3 Modifying the Sample Information (Optional)

A. If necessary, the descriptive information entered during the Sample Counting operation can be edited by selecting Modify Sample Information from the Re-Analyze a PROcount Sample menu.

B. Make the desired changes in the dialog box, click on the OK button.

C. This will load the new sample information, exit the dialog box, and redisplay the Re-Analyze a PROcount Sample menu.

3.2.8.5.4 Performing the Analysis

After loading the appropriate ISOCS efficiency calibration parameters:

A. Select the desired Analysis Sequence

B. Make any necessary modifications to the sample information

C. Select Perform Analysis, Show Report to start the analysis.

D. A message saying "Please wait - performing analysis on..." will be displayed during execution of the selected Analysis Sequence.

E. A report of analysis results will be displayed on the screen.

F. Hardcopy reports will be generated if requested in the Reporting steps of the Analysis Sequence and a suitable printer is connected to the computer.

G. Review the analysis reports to determine if additional modifications or analyses of the currently selected CAM file are required. Alternate efficiency calibration parameters can be loaded and reanalyses performed to obtain comparative results, if appropriate.

H. After reviewing the final analysis results, return to the Re-Analyze a PROcount Sample menu.

3.2.8.5 Saving Changes to the CAM File

To save the final analysis results and other changes made to the currently selected CAM file, select Save Changes and Exit from the Re-Analyze a PROcount Sample menu. This will save the new data and close the CAM file, then redisplay the System Maintenance menu.

3.2.9 QC Procedures

Reproducibility of counting system response shall be verified by performing the following three types of quality control counts: Calibration Check, Background Check, and QC Replicate. A Calibration Check count and a Background Check count shall be performed at the start of each counting shift. QC Replicate counts (two consecutive counts at the same measurement location) shall be performed at 10% of the field locations.

3.2.10 Calibration Check Counts

3.2.10.1 Mount the NIST-traceable Eu-152 source at the established position relative to the detector endcap face. The SSM or Project Health Physicist shall determine the appropriate distance between the source and the detector endcap, provide a suitable source jig to facilitate reproducible positioning, and instruct all operators in proper handling of the Eu-152 check source.

3.2.10.2 From the Main Selection Screen, select Quality Control.

3.2.10.3 From the Quality Control Screen, select Calibration Q.C. Count.

3.2.10.4 Select “Generic ISOCS” from the list of Geometry names.

3.2.10.5 A screen showing the preset count time will be displayed. The routine Calibration Check count time should be 300 sec. Click on OK to continue.

3.2.10.6 The count will start and the data screen will be displayed. Enter a sample ID such as the check source identification and source information such as nuclide types.

3.2.10.7 The count will now proceed to completion. The results will be stored in the Calibration Check count QA file established for the selected geometry-detector combination, and the Main Selection Screen displayed. The Operator should now view the results to ensure that all QC parameters are acceptable in accordance with 3.2.10.10.

3.2.10.8 From the Main Selection Screen, select Quality Control, then select Last Measurement Report.

3.2.10.9 From the Last Measurement Report Screen, select

Calibration Check. From the next menu, select "Generic ISOCS".

3.2.10.10 The Calibration Check Report will be displayed to the screen. Values for Peak Location, Peak Count Rate and Peak FWHM will be displayed. If any value is flagged "IN" (for investigate) or "AC" (for action), repeat steps 3.2.10.1. – 3.2.10.9 above and review the results of the second Calibration Check count. If all results are acceptable, proceed to section 3.2.11 below. If any results of the second Calibration Check count are flagged with "IN" or "AC", additional counting shall be discontinued until the cause of the unexpected results has been determined and the condition corrected.

3.2.11 Background Check Counts

3.2.11.1 Remove the Eu-152 check source from the detector field of view, and position the detector at the designated indoor location for routine Background Check counts. The SSM shall determine the appropriate detector position for these counts.

3.2.11.2 From the Main Selection Screen, select Quality Control.

3.2.11.3 From the Quality Control Screen, select Background Q.C. Count.

3.2.11.4 Select "Generic ISOCS" from the list of Geometry names.

3.2.11.5 A screen showing the preset count time will be displayed. The routine Background Check count time should be 900 sec. Click on OK to continue.

3.2.11.6 The count will start and the data screen will be displayed. Enter appropriate information to identify the count.

3.2.11.7 The count will now proceed to completion. The results will be stored in the Background Check count QA file established for the selected geometry-detector combination, and the Main Selection Screen displayed. The Operator should now view the results to ensure that all QC parameters are acceptable.

3.2.11.8 From the Main Selection Screen, select Quality Control, then select Last Measurement Report.

3.2.11.9 From the Last Measurement Report Screen, select Background Check. From the next menu, select "Generic ISOCS".

3.2.11.10 The Background Check Report will be displayed to the screen. Values for Gross cps (low energy region), Gross cps (high energy region), and K-40 peak cps will be displayed. If any value is flagged "IN" (for investigate) or "AC" (for action), repeat steps 3.2.10.1 – 3.2.10.9 above and review the results of the second Background Check count. If all results are acceptable, prepare for routine field measurements. If any results of the second Background Check count are flagged with "IN" or "AC", additional counting shall be discontinued until the cause of the unexpected results has been determined and the condition corrected.

3.2.12 QC Replicate Counts

3.2.12.1 To verify system reproducibility, replicate counts shall be performed at approximately 10% of the field measurement locations. The frequency of QC Replicate counts may be increased as the project progresses, as specified by project management personnel.

3.2.12.2 Each QC Replicate will be counted as a normal sample count, following the procedures defined in 3.2.9 These counts should be identified by inclusion of "QC Replicate" as part of the sample description.

3.2.12.3 The SSM shall evaluate these QC Replicate counts.

3.2.13 Exiting PROcount

When all sample counting is completed and additional use of the detector is not required, high voltage should be turned off before disconnecting the power cables. Turning off the high voltage should be performed as follows:

3.2.13.1 Select Detector Management from the Main menu.

3.2.13.2 Select the desired detector from the Choose Detector section of the next dialog box.

3.2.13.3 Click on the Hardware Control button.

3.2.13.4 Select High Voltage - On/Off/Reset from the Hardware Control menu.

3.2.13.5 Select Off from the High Voltage Control dialog box.

When all CAM file analyses are completed and no other PROcount operations are required, return to the Main menu and click on the Exit button. This will exit the PROcount application and redisplay the desktop screen.

4.0 REFERENCES

4.1 ISOCS Procedure for Implementation of QC Protocol

4.2 InSpector Portable Spectroscopy System User's Manual, Canberra Industries.

4.3 Canberra Genie 2000 Operators Manual

Appendix D

Data Validation SOPs

Procedure 4.8
Effective Date: 06/09/2015
Revision No: 0

PROCEDURE 4.8 DATA VALIDATION PROTOCOL FOR FIELD DATA COLLECTED USING CANBERRA'S IN-SITU GAMMA SPECTROMETER

1.0 PURPOSE

1.1 This Standard Operating Procedure (SOP) - Data Validation Protocol for Field Data Collected Using Canberra's In-Situ Gamma Spectrometer, is to be employed at the GED Field sites soils are to been tested in-situ for radionuclides of concern, 232Th, 226Ra, and 238U. Procedure 4.9, "Acquisition and Analysis Application Within Standard Genie2000 to Perform Ex-Situ ISOCS/LABSOCS Measurements" provides instructions for routine setup and spectral acquisition and reporting of ISOCS analysis results.

2.0 RESPONSIBILITY

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 The following quality elements must be evaluated to ensure that quality control guidelines described in GED Standard Operating Procedures 4.9 Acquisition and Analysis application within standard Genie2000 to perform ISOCS/LABSOCS measurements, are being followed if required to meet field data quality objectives. Items such as normalized absolute difference in field duplicates, gamma spectrums, minimum detectable activity (MDA), and calibration results shall be examined.

3.2 Calibration

Check to ensure that the ISOCS system was properly calibrated using a standard known reference standard and an ISOCS generated efficiency for that reference within one month of the time that all ISOCS measurements of interest were taken. The reference standard shall be approved by the project management team. Ensure that adjustments to the system hardware and/or ISOCS models were made and recorded in the field notebook if the calibration readings fell outside of the following ranges (rep resenting ± 95% confidence level around the mean of each value):
If the acceptance criteria were exceeded, verify that adjustments were made and recorded, and that calibration reference standards levels were remeasured two consecutive times with acceptable results prior to routine use. If the calibration reference standard was not remeasured, all subsequent ISOCS measurements should be rejected.

3.3 Selection of geometry/efficiency

Check to ensure that the default geometry was used. If not, verify that the alternate selected geometry was approved for use by the SSM or his designee and that the selected geometry is consistent with the results of the test cases. If not approved by the SSM, subsequent ISOCS measurements should be qualified estimated J, and the SSM should review and approve, if appropriate, the selected geometry.

Verify that the energy uncertainty values were checked no less frequently than weekly and that the errors were less than the following default values:

For the 63.4 and 92.6, keV lines	-	10%
For the 295.2 and 351.9	-	8%
For the 609.3 keV lines	-	6%
For the 1120.2, and 1764	-	4%

If any errors were greater than the default errors shown, verify that the instrument was taken out of service and the problem resolved. Any data obtained with energy uncertainty values greater than the default values is not usable.

3.4 Field operations checklist

Verify that the Field Operations Checklist forms have been properly filled out, reviewed, and signed off. If the checklist has not been filled out, the data should be qualified R, rejected. If the checklist has not been signed off, the data should be estimated J and a nonconformance report (NCR) must be generated.

3.5 Daily qc calibration check

Verify that a Daily QC Calibration Check with an operational, LCS check source has been performed at the beginning of each day or field measurement shift, whichever is more frequent. If a Daily QC Calibration Check has not been performed, any data collected during that day or shift is not useable. In that case, all data would be qualified rejected, R.

Guidelines for Acceptability of Various Calibration Check Parameters:

QC Calibration Check Parameter Description	Acceptable Results	Qualify Results Estimated J	Qualify Results Rejected R
Low energy photopeak centroid channel	Within fixed channel limits'	Observed peak centroid within the range of 1.0 – 2.0 keV	Observed peak centroid > 2.0 keV from theoretical
High energy photopeak centroid channel	Within fixed channel limits'	Observed peak centroid within the range of 1.0 – 2.0 keV	Observed peak centroid > 2.0 keV from theoretical
Low energy photopeak FWHM	Mean +/- 2 std. deviations*	Photopeak energy at 2 – 3 std devs. From theoretical	Photopeak energy > 3 std devs. From theoretical
High energy photopeak FWHM	Mean +/- 2 std. deviations*	Photopeak energy at 2 – 3 std devs. From theoretical	Photopeak energy > 3 std devs. From theoretical
Low energy photopeak net counts/second	Mean +/- 2 std. deviations*	Photopeak counts per sec. at 2 – 3 std devs. From theoretical	Photopeak counts per sec. > 3 std devs. From theoretical
High energy photopeak net counts/second	Mean +/- 2 std. deviations*	Photopeak counts per sec. at 2 – 3 std devs. From theoretical	Photopeak counts per sec. > 3 std devs. From theoretical

: Observed peak centroids should typically be within ± 2.0 keV (approx. ± 3 channel limits)

* : The mean and standard deviation values for these QC parameters are established by performing a set of 10 – 20 initial counts. Subsequent count results are then compared to the established "investigation level" range of [mean +/- 2 std. dev.] and "action level" range of [mean +/- 3 std. dev.].

The following questions shall be asked and the responses documented when evaluating daily QC check data.

1. Were any of the results outside applicable ranges? If yes, were counts remeasured as they must be?
2. Was the remeasured count within acceptable ranges? If not, was the instrument taken out of service and that action documented as they must be? If the answer to the second part of this question is no, any data collected with the "out of calibration" system will be rejected.
3. If the instrument was taken out of service and adjustments/corrective actions taken, were two consecutive QC Calibration Check counts obtained with acceptable results prior to approving the system for routine use as they must be? If not, there is no way of knowing that the system has been successfully recalibrated. In that case any subsequent measurements would be rejected.

3.6 Replicate counts

A. Verify that routine replicate counts were performed on 10% of the field measurement samples. If the quality control action levels established as per bullet B below were exceeded, verify that input parameters were subsequently reevaluated. All data associated with the suspect field repli cate readings shall be considered estimated. Data obtained after SSM approved corrective actions have been taken shall be considered acceptable.

B. In order to perform the data evaluation for replicate counts, refer to the ISOCS replicate count control chart (the control chart was constructed after taking morning and afternoon readings for ten days using the LCS). Control limits (normalized absolute difference (NAD)) are + 2 standard deviations from the mean. Verify that ISOCS measurements were taken daily and recorded. Verify that the results of replicate measurements were used to establish quality control action levels for sample replicate measurements.

C. Verify that if a sample replicate measurement falls outside the control limit for one or more radionuclides, a second measurement was taken. If the results of the second measurement fell within 2 standard deviations of the control chart mean, the replicate count is considered ac ceptable. If the results of the second measurement falls outside of 2 standard deviations of the control chart mean, the replicate count is unacceptable. In this case, verify that an instrument adjustment was made prior to retaking a replicate count measurement.

If an instrument adjustment was not made, and the ISOCS was subsequently used for field measurements, all field measurement results shall be qualified as follows:

- Estimated J if the second measurement was > 2 but < 3 standard deviations away from the control chart mean;
- Rejected R if the second measurement was > 3 standard deviations away from the control chart mean.

3.7 Background checks

A. Verify that a documented background check was performed at the start of each field measurement shift.

The acceptable ranges of results are summarized in the following table:

Background Check Count Parameter Description	Acceptable Range of Results
Gross counts/second in channels 100 – 8000	Mean +/- 2 std. deviations*
K-40 1460 keV photopeak net counts/second	Mean +/- 2 std. deviations*

*The mean and standard deviation values for these parameters are established by performing a set of 10 – 20 initial counts. Subsequent count results are then compared to the established "investigation level" range of [mean +/- 2 std. dev.] and "action level" range of [mean +/- 3 std. dev.].

B. Verify that the background measurement was retaken (if the background results were outside two standard deviations from the mean) after removing potential sources of background that may have been overlooked for the first measurement. If the results of the second count were within the acceptable ranges, the ISOCS system shall be approved for routine use. If the results of the second count were outside the acceptable ranges, verify that the ISOCS system was taken out of service and that this action was documented. Verify that the problem was resolved by the CQCSM and that two consecutive Background Check counts with acceptable results were taken prior to approving the system for routine use.

C. Any sample measurements associated with a background measurement that fell between two and three standard deviations of the background mean shall be qualified as estimated J.

3.8 Counting times

Verify that counting times were selected to yield MDA values < 25% of the cleanup action level for each nuclide of interest. The anticipated action levels and corresponding required MDA values, which are to be used, are summarized in the following table:

Nuclide*	Action Level (pCi/g)	Required MDA (pCi/g)
Ra-226	5	1.25
Th-232	5	1.25
U-238	50	12.5

* Each parent nuclide listed above is assumed to be in equilibrium with daughter-nuclide decay products.

To achieve the required MDA values for all routine field measurements, an initial counting time of 1800 seconds (30 minutes) will be used for surface soil measurements.

4.0 REFERENCES

1. USACE Kansas City and St. Louis district radionuclide data quality evaluation guidance for alpha and gamma spectroscopy

2. Acquisition and Analysis application within standard Genie2000 to perform Ex Situ ISOC/ LABSOCS measurements

5.0 ATTACHMENT 1 : VALIDATION CHECKLIST FOR SOIL DATA

ATTACHMENT 1 VALIDATION CHECKLIST FOR SOIL DATA

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
Data Package				1	Data Package contains the necessary information for validation.	Contact the Validata PM.	
				2	Data package contains results for all samples listed on the COC.	Contact the Validata PM.	
Non-conformance and Corrective Action Reports				3	Non-conformance and Corrective Action Reports are submitted with data package. If no non-conformances were found, a statement to that effect is provided.	Contact the Validata PM.	
				4	Non-conformance and Corrective Action Reports are approved by CDM Smith.	Contact the Validata PM.	
Initial Calibration				5	Initial calibration performed prior to sample analysis.	Prof. Judgment UJ or R	Prof. Judgment J or R
				6	Initial calibration met project-specified criteria; *See ISOCS Quality Assurance Procedure 4.8.*	Prof. Judgment UJ or R	Prof. Judgment J or R
Background				7	Background measured at the start of each field measurement shift.	Prof. Judgment UJ or R	Prof. Judgment J or R
				8	Background measurements met project-specified acceptance criteria; *See ISOCS Quality Assurance Procedure 4.8 for instrument background monitoring criteria.*	Prof. Judgment UJ or R	Prof. Judgment J or R
Continuing Calibration Verification				9	Continuing calibration verification performed at the project-specific frequency; at minimum, daily prior to sample analysis or prior to each field measurement shift. *See ISOCS Quality Assurance Procedure 4.8.*	Prof. Judgment UJ or R	Prof. Judgment J or R
				10	Continuing calibration remains within 2σ of the expected value of the control chart.	Prof. Judgment UJ or R	Prof. Judgment J or R
				11	As applicable, peak resolutions and peak locations met project-specified criteria; *See ISOCS Quality Assurance Procedure 4.8.*	Prof. Judgment UJ or R	Prof. Judgment J or R
Nuclide Identification (NID)				12	The target radionuclide energies were within the project-specified criterion of ± 2keV of the known energy.	Prof. Judgment UJ or R	Prof. Judgment J or R
Sample Analysis Raw Data				13	Instrument run logs with analysis dates are provided.	Contact the Validata PM.	
				14	Raw count data are provided.	Contact the Validata PM.	
Reported Sample Results				15	Sample results summation is provided for all samples in SDG.	Contact the Validata PM.	
				16	Sample results summation includes documentation that the project-specified required MDA (maximum 25% of Action Level) was adhered to.	Prof. Judgment UJ or R	Prof. Judgment J or R
				17	Analyte quantitation: If a result is reported less than the sample-specific MDA, consider the result undetected, and apply the indicated Qualifier.	U	N/A
				18	Negative results: No analytes have an absolute value of negative result greater than the 2 σ TPU.	If the absolute value is between the 2S and 3S total propagated uncertainty, UJ. If the absolute value is greater than 3S total propagated uncertainty, qualify R.	
LCS for all analytes				19	LCS run at project-specified frequency (at the beginning of each day or field measurement shift)	Contact the Validata PM.	
				20	Photo peak counts per second (cps) within QC limits of ± 2σ of the expected value. If NO, qualify all affected analytes in associated samples.	If cps at 2 - 3σ, qualify affected non-detected results UJ.	If cps at 2 - 3σ, qualify affected detected results J.
						If cps > 3σ, qualify affected non-detected results R.	If cps > 3σ, qualify affected detected results R.
Sample Replicate				21	Replicate analyzed at project-specified frequency (10% of the field measurement samples)	Contact the Validata PM.	
				22	Normalized absolute difference (NAD) within QC limits of ± 2σ from the mean. If NO, qualify all affected analytes in associated samples.	If NAD at 2 - 3σ, qualify affected non-detected results UJ.	If NAD at 2 - 3σ, qualify affected detected results J.
						If NAD > 3σ, qualify affected non-detected results R.	If NAD > 3σ, qualify affected detected results R.

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
Reanalyses/Dilutions (REs/DLs)				23	No REs/DLs reported for any client sample by any method.	Review and determine qualifications for both replicates, determine best overall data set, and apply X qualifier to extraneous analyses per project instructions.	
Data Validation Narrative				24	Prepare a Data Validation Narrative in accordance with the Validata project format. Describe in detail data quality, qualifications, and applicability of the SDG data for its intended use.	N/A	
Table of Qualified Results				25	Prepare a Table of Qualified Results listing all data qualifications applied in data validation per this checklist (See Section at end of Narrative). If there were no qualifications, include a statement to that effect.	N/A	
Peer Review				26	Submit Data Validation Narrative with Table of Qualified Results and Completed Checklist to designated Peer Reviewer.	N/A	
				26	Modify Data Validation Report elements based on Peer Review.	Modify as necessary in Data Validation Narrative and Table of Qualified Results	

Notes:

[1]The requirements presented in this table are general and may not support all analytical methods proposed by individual laboratories.

[2]When more than one qualifier is applicable to a sample result, the priority of qualifiers for detected results is: X > R > J > no qualifier; the priority of qualifiers for results considered non-detected is: X > R > UJ > U.

CSU = combined standard uncertainty
LCL = lower control limit
LCS = laboratory control sample
MDA = minimum detectable activity
QC = quality control
%R = percent recovery
CSU = total propagated uncertainty
UCL = upper control limit
Z = Z-score (normalized difference)

Procedure 4.9
Effective Date: 06/09/2015
Revision No: 0

PROCEDURE 4.9 ACQUISITION AND ANALYSIS APPLICATION WITHIN STANDARD GENIE2000 TO PERFORM EX SITU ISOCS/LABSOCS MEASUREMENTS

1.0 PURPOSE

1.1 This SOP describes use of the Gamma Acquisition and Analysis application within standard Genie2000 to perform ex-Situ ISOCS/LABSOCS measurements in the field. Non-routine ISOCS/LABSOCS measurements may require the flexibility of the Genie2000 software for successful assay.

2.0 RESPONSIBILITY

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team personnel are responsible for following this procedure.

3.0 PROCEDURE

3.1 The steps described in this procedure include:

- acquiring spectral data
- entering sample information
- saving the data in a CAM file
- loading ISOCS/LABSOCS calibration parameters
- analyzing the CAM file
- reporting the analysis results

All of these steps are performed by opening a Gamma Acquisition and Analysis (GAA) window, then selecting the appropriate menu option.

This section assumes that the user is already familiar with the GAA application within Genie2000. Detailed tutorial and reference chapters for these applications are provided in the InSpector Spectroscopy System Basic Operations manual. The user should refer to that document whenever necessary to supplement the instructions provided in this section.

3.2 Starting the GAA Application

- Apply power to the InSpector and laptop computer.

- Access the desktop screen and double click on the Genie2000 icon. This will open the Genie2000 folder and display a GENIE2000 Icon View window or a GENIE2000 Details View window.

- Double click on the Gamma Acquisition & Analysis icon. This will open a GAA window. Re-size (enlarge) this window as desired.

3.3 Opening a Detector Datasource

- Click on File in the GAA window menu bar, then select Open Datasource... from the File menu. This will display the Open Datasource dialog box.
- Click on the button labeled "Detector" in the Datasource Type section.
- All previously defined detectors will be listed in the Inputs section.
- Double click on the desired input name. This will exit the Open Datasource dialog box, and display the name of the selected input (e.g., DET01) in the GAA window title bar.
- Clear previously acquired spectral data displayed in the graphics region of the GAA window by clicking on Clear in the menu bar, then select Both from the Clear menu.

3.4 Applying High Voltage to the Detector

- 'Top off" fill level of LN2 of the detector dewar prior to applying high voltage - if the unit has not been refilled this day.

  Caution: Confirm that the detector has been properly cooled for 24 hours with liquid nitrogen before performing this step. Detectors that warm up during operation (aka thermo-cycle) will require warming to room temperature for 48 hours and another 24 hours of re-cooling before stabilization and reuse.

- Prior to acquiring new spectral data, high voltage must be applied to the detector.
- Click on MCA in the GAA window menu bar, then select Adjust from the MCA menu. This will display the Adjust dialog box.
- Click on the HVPS button near the top of this dialog box.
- Confirm that the numerical value in the Voltage section is appropriate for the selected detector or use the scroll bar to enter the correct voltage value.
- Click on the On button in the Status section. The HV indicator light on the InSpector front panel will be illuminated, and the word "Wait" will be displayed in the upper left corner of the dialog box until the voltage has ramped up to the specified value.
- Click on the Exit button to exit the Adjust dialog box. An asterisk will appear in the GAA window title bar, indicating that one or more of the parameters for the selected detector has been changed.

3.5 Changing a Preset Live Time Value

The current value for preset live time is displayed in the TIME INFO status page.

- To change this value, click on MCA in the GAA window menu bar, then select Acquire setup... from the MCA menu. This will display the Acquire Setup dialog box.
- Click on the Live Time and Sec buttons, then enter the desired time value (in seconds) in the editable field of the Time Preset section.

- Click on the OK button to exit the Acquire Setup dialog box.

3.6 Acquiring Spectral Data

The GAA window can be used to start and stop spectral data acquisition in several ways:

Click on the Acquire On button at the top of the control panel. The name of this button will then change to Acquire Off, and clicking on this renamed button will stop the acquisition

.

or

Press F4, which functions as the keyboard accelerator for the Acquire On and Acquire Off buttons. Pressing F4 again will stop the acquisition in progress.

or

Click on MCA in the menu bar, then select Acquire start. Selecting Acquire stop from the MCA menu will stop the current acquisition.

Prior to acquiring spectral data for ISOCS measurements, amplifier gain and ADC zero settings should be checked and adjusted if necessary, as described in the next section. All InSpector system hardware must then be properly set up at the selected measurement location, with the detector placed in the desired position relative to the object being assayed.

3.7 Adjusting Amplifier Gain and ADC Zero

- To check and adjust the amplifier gain and ADC zero settings, a suitable check source should be placed near the detector during spectral data acquisition. This check source should emit photons with emission rates sufficient to produce readily detectable photopeaks. The Eu-152 source used for routine Calibration Check counts is adequate for this purpose

- The centroid channel and corresponding energy value for each reference photopeak should be compared to the expected values. Observed photopeak centroids should typically be within + 1.0 keV of the expected energy values. Adjust the vertical full scale of the displayed spectrum and use the Expand On button, as appropriate, to view the reference photopeaks.

- If necessary, amplifier gain and/or ADC zero settings can be changed by selecting Adjust... from the MCA menu. This will display the Adjust dialog box.

- The scroll bars in the Amp Fine gain, Amp S fine gain, and ADC Zero sections of this dialog box should then be used to make the appropriate changes.

- After each change, clear any previous spectral data and start a new acquisition to evaluate the new settings.

- When the new settings are deemed acceptable, click on the Exit button to exit the Adjust dialog box.

- To save the new parameter values, click on File in the MVC window menu bar, then select Save from the File menu.

3.8 Identifying Sample Spectra

Descriptive information is entered to uniquely identify each acquired spectrum. This can be done while data acquisition is in progress, or after acquisition has stopped.

- Click on Edit in the GAA window menu bar, then select Sample info... from the Edit menu. This will display the Edit Sample Information dialog box which includes descriptive fields for:

  - Sample Title
  - Collector Name
  - Sample Description
  - Sample ID
  - Type
  - Units
  - Sample Geometry

- Editable fields are also provided for Quantity, Uncertainty, Random Error, and Systematic Error.

- Select the None button in the Buildup Type section.

- A Load Cal... button is also included in the Edit Sample Information dialog box. Clicking on this button will display the Load Calibration dialog box. This allows selection of a previously stored calibration file. Use this feature, as appropriate, only after an ISOCS efficiency calibration file has been generated for the object being assayed.

- Make all desired entries in the fields of the Edit Sample Information dialog box, then click on the OK button to save the information and exit this dialog box.

3.9 Saving a Spectral Data File

After descriptive sample information has been entered and spectral acquisition has stopped, the spectral data and related information can be saved in a file. This step is required before analyses of the acquired spectrum can be performed.

- Click on File in the GAA window menu bar, then select Save as... from the File menu. This will display the Save As dialog box.

- Enter the desired name, up to eight characters followed by the .CNF extension, in the File name field.

- Enter an appropriate supplemental text string (up to 32 characters) in the Description field. Enter text that will be helpful in selecting this file when attempting to identify it at some later time.

- Click on the OK button to save the file and exit the Save As dialog box. The default directory used to store these files is GENIE2K\CAMFILES.

- To collect additional spectra, clear existing spectral data from the graphics region of the GAA window.

3.10 Opening a Previously Saved CAM File Datasource

To open a previously saved CAM file datasource:

- Activate and maximize a GAA window.

- Click on File in the GAA window menu bar, then select Open Datasource... from the File menu. This will display the Open Datasource dialog box.

- Click on the CAM File button in the Datasource Type section, if it is not already selected.

- The names of all CAM files currently stored in the GENIE2K\CAMFILES directory will be listed in the Files section of the dialog box.

- Use the vertical scroll bar in this section until the desired file name is shown, then double click on that file name. This will exit the Open Datasource dialog box, and display the name of the selected CAM file in the GAA window title bar.

- If the desired CAM file cannot be identified by file name alone, additional descriptive information can be displayed to ensure selection of the correct file. Single click on the file name under consideration, then click on the Info... button.

  A File Info screen will be displayed with fields labeled:

  - File Name
  - File Descriptor
  - File Type
  - Sample Title
  - Acquisition Start Time

- Review the listed information, then click on the OK button to exit the File Info screen and return to the Open Datasource dialog box.

- Single click on another name in the Files list and repeat this process, or double click on a file name to open that CAM file datasource.

3.11 Loading ISOCS Calibration Parameters

ISOCS Calibration Software must be used to generate an efficiency calibration file appropriate for the object being assayed. The desired ISOCS calibration parameters can be loaded and saved with the spectral data. The spectral data file can then be analyzed to determine nuclide activity.

- After opening the desired CAM file datasource, click on Calibrate in the GAA window menu bar.

- Select Load from the Calibrate menu. This will display the Load Calibration dialog box. The File Names section in this dialog box will contain a list of all calibration files currently stored in the directory specified by the environment variable CALFILES.

- When the Load Calibration dialog box is first displayed, the boxes labeled Energy/Shape and Efficiency will contain a check mark. Click on the box labeled Energy/Shape to remove the check mark from this box. This will allow new efficiency calibration parameters to be loaded without changing the original energy/shape calibration parameters, which is appropriate for ISOCS measurements.

- Use the vertical scroll bar in the File Names section until the desired ISOCS calibration file name is shown then double click on that file name. This will exit the Load Calibration dialog box, and load the efficiency calibration parameters from the selected file into the open CAM file datasource.

- If the desired ISOCS calibration file cannot be identified by file name alone, additional descriptive information can be displayed to ensure selection of the correct file. Click on the file name under consideration, then review the information displayed in the fields above the File Names section.

- To display more information, click on the Info... button.
  A File Info screen will be displayed with fields labeled:

- File Name
- File Descriptor
- File Type
- Sample Title
- Calibration Time

- Review the listed information, then click on the OK button to exit the File Info screen and return to the Load Calibration dialog box.

- Single click on another name in the File Names list and repeat this process, or double click on a file name to load the calibration parameters from that file.

3.12 Analyzing a Spectral Data File

After opening a CAM file datasource and loading the appropriate ISOCS efficiency calibration parameters, spectral data analysis can be performed. The Manual and Analyze options in the GAA window menu bar can be used to perform these analyses. The user should refer to the InSpector Spectroscopy System Basic Operations manual for a complete description of these menu options. These options are discussed briefly in the sections below.

- The Manual Menu

A. Click on Manual in the GAA window menu bar to display the Manual menu.
This menu lists the individual analysis modules which can be selected and performed one at a time, including:

- Peak Locate
- Peak Area
- Area Correction
- Efficiency Correction
- Nuclide Identification
- Detection Limits
- Reporting

B. The first option in this menu is Algorithm Selection, which can be used to specify alternate algorithms for some of the other analysis modules.

C. After selecting one of the analysis modules from the Manual menu, a dialog box for that module will be displayed. This dialog box can be used to change various parameter values for the selected analysis algorithm. For example, if "Unidentified 2nd Diff." was specified as the default algorithm for the Peak Locate module, selecting Peak Locate from the Manual menu will display a dialog box, which includes editable fields for:

- Start channel
- Stop channel
- Significance threshold
- Tolerance

D. The parameter setup dialog box for each analysis module includes an Execute button in the lower right corner. When the desired parameter values have been entered, click on this button to exit the dialog box and execute the selected analysis module. Analysis results will be added to the open CAM file datasource, but will not automatically be reported.

E. To report the results of previously executed analysis modules, select Reporting from the Manual menu. When the Standard Report Setup dialog box is displayed, use the editable fields and check boxes to specify the desired report format, then click on the Execute button.

F. Hardcopy reports can be generated if a suitable printer is properly connected to the com puter but a pdf version should be generated by clicking export report to pdf

- The Analyze Menu

The individual analysis modules discussed in the previous section can be combined and executed more efficiently by using the Analyze option. This option is typically preferable to the Manual menu when analyzing CAM files within the GAA application.

A. Click on Analyze in the GAA window menu bar to display the Analyze menu. This menu provides a list of text descriptions associated with previously defined Analysis Sequence files. A text description will be listed for each file stored in the GENIE2K\CTLFILES directory with the .ASF file name extension. Each of these files includes a combination of analysis modules to be executed in a specified sequence.

B. The Analysis Sequence editor can be used to change an existing Analysis Sequence file, or create a new one.

C. When a CAM file datasource is open, this editor can be invoked by clicking on Edit in the GAA window menu bar, then selecting Analysis sequence... from the Edit menu. This will display the Edit Analysis Sequence dialog box.

This dialog box allows loading, editing, storing, and executing a specified sequence of analysis steps.

This procedure assumes that the user is familiar with the Analysis Sequence editor, and with the options listed in the Analyze menu.

D. For routine analysis of the open CAM file datasource, select an option from the Analyze menu which corresponds to the desired Analysis Sequence file. This will execute the specified sequence of analysis steps. The selected option should typically include all of the following steps: Peak Locate, Peak Area, Efficiency Correction, Nuclide Identification, and Detection Limits. These steps are listed in the Current Steps section of the Edit Analysis Sequence dialog box.

E. An appropriate NID library file including all nuclides of interest must be specified during setup of the Nuclide Identification step.

F. The selected Analysis Sequence file should also include Reporting steps to print and/or display all desired analysis results.

G. Analysis reports should typically include the following sections: Header, Peak Analysis, NID, and MDA.

H. Hardcopy reports can be generated if a suitable printer is connected to the computer and pdf copies should be generated and stored with the same name and file extensions as the .cnf file from which they were generated.

- Saving the Analysis Results

A. After the desired analysis steps have been completed, save the results to the CAM file by clicking on File in the GAA window menu bar.

B. Select Save from the File menu. Alternatively, selecting Close or Exit from this menu will display a message screen asking if changes to the open CAM file should be saved.

C. Select Yes to save the latest analysis results and any other changes made while the CAM file datasource was open.

3.13 Quality Control Checks

- Place the daily Background sample container on the detector and close the system lid, acquire a spectra as outlined above in 3.12 and save that file into the reference checks QDB Background folder for the date (Example 08-15-2015-QDB).

- Execute the analysis sequence containing the proper parameters for the geometry of the samples you wish to analyze as outlined in the steps above. Note any anomalies in the logbook and ensure that the energy calibration is within a tolerance of 1.5 kev for all peaks identified.

- Additionally, weekly background checks should be collected during periods when the detector collection time can be set for an extended period for inclusion in the background subtraction analysis. This is typically done over the weekend. Place the weekly Background sample container on the de tector and close the system lid, acquire a spectra as outlined above in 3.12 and save that file into the reference checks QWB Background folder for the date (Example 08-15-2015-QWB).

- Place the daily LCS sample container on the detector and close the system lid, acquire a spectra as outlined above and save that file into the reference checks LCS folder for the date (Example 08-15-2015-LCS.

- Execute the analysis sequence as outlined above in 3.12 containing the proper parameters for the geometry of the LCS sample container which should be the same as outlined in the background collection above. Ensure that the energy calibration is within a tolerance of 1.5 kev for all peaks identified and their shape is normal. Note any anomalies in the logbook.

- The results of the LCS analysis above should be entered into the QA performance tracking spread sheet to verify the consistent performance of the ISOCS detection system (GED-ISXTRK). This sheet will specifically track the accuracy of the detector across the required energy range (eg 63.4, 295.2, 351.9, 1120.2 kev)

- All results of the morning performance checks will be saved for daily transmission to the data validator.

3.14 Exiting the GAA Application

- When all spectral data acquisitions and CAM file analyses have been completed, click on File in the GAA window menu bar.

- Select Exit from the File menu.

- If a datasource with unsaved changes was still open in the GAA window, a message screen will be displayed asking whether the latest changes should be saved. Respond appropriately to any such message.

- This will exit the GAA window and return to the GENIE2000 Icon View (or GENIE2000 Details View) window on the desktop screen.

4.0 ATTACHMENTS

- **ATTACHMENT I**
  ISOCS MARINELLI SOIL MEASUREMENTS - FIELD OPERATIONS CHECKLIST

- **ATTACHMENT II**
  QC EVALUATION CHECKLIST

ATTACHMENT 1

ISOCS MARINELLI SOIL MEASUREMENTS - FIELD OPERATIONS CHECKLIST

A. Prepare for Data Acquisition (Steps to be Performed if not Already Completed)

1. _____ Attach detector and collimator pieces to cart
2. _____ Aim detector at marked location, and stabilize cart
3. _____ Connect cables to detector
4. _____ Turn on Inspector and laptop PC
5. _____ Launch Genie2000 from Genie2000 folder
6. _____ Turn on high voltage to detector

B. Start Sample Count

1. _____ Select Sample Counting from t main menu
2. _____ Select proper Sample Type
3. _____ Select the proper Geometry efficiency ID
4. _____ Accept default value for preset live time (e.g., 1200 s)
5. _____ Wait 60s and confirm ADC Dead Time is <10%
6. _____ Enter appropriate Sample ID and Description info

C. Document Count Information

1. File No. (SUSnnnnn): _____

2. Sample ID: _____

3 Acquisition start date/time:_____

D. Document Preliminary Analysis Results

1. _____ Wait for preset live time to elapse
2. _____ Wait an additional 30 s for analysis to complete
3. _____ Select Detector Management from main menu
4. _____ Select View Last Report
5. _____ Confirm correct Sample ID and Acquisition start time
6. _____ Confirm if proper geometry was used for efficiency geometry
7. Results: K-40 pCi/g Ra-226 pCi/g Th-232 pCi/g U-238\pCi/g

   _____ _____ _____ _____
8. _____ Confirm acceptable MDA values for unidentified nuclides
9. _____ Return to PROcount main menu

E. Prepare for Next Sample Count

1. _____ Relocate equipment without disassembly, if possible

   - OR -

2. _____ Turn off HV to detector, shut down laptop PC, turn off Inspector, disconnect cables, disassemble equipment and transport to next measurement location

ATTACHMENT II

QC EVALUATION CHECKLIST

1
Was a measurement taken of the radionuclide concentrations in the standardized calibration geometry prior to field sample measurements? Yes / No

2
Were these LCS readings within the acceptable? Yes / No

3
Was the field checklist filled out properly, and comments made to indicate that appropriate decisions were made? Yes / No

4
Are field replicate measurements being taken at a minimum frequency of 10% of the total? Yes / No

5
Is the percent difference between each field duplicate measurement pair less than the established action levels? If not, were appropriate corrective actions taken? Yes / No

6
Are the mean and standard deviation of these measurements up-to-date? Yes / No

7
Are the action levels being used for field replicate percent differences based on the most current measurements? Yes / No

8.
Are background measurements being collected daily? Yes / No

9
Were all QC parameter results within the acceptable ranges? Yes / No

10
Are the printed QA file results properly maintained? Yes / No

11
Have all sample and reference standard results been sent for proper data validation? Yes / No

Validata
Chemical Services, Inc.

SDG No.: _____

Validation Checklist for Soil/Water/Sediment Data

QC Check	(Check One) Yes	No	N/A	#	Criterion	Assign Qualifier Listed Below if Criterion = No: Non-detected Analyte	Detected Analyte
Data Package				1	Data Package is compliant with Laboratory Statement of Work.	Contact the Validata PM.	
				2	Data package contains results for all samples and method types listed on the COC.	Contact the Validata PM.	
Electronic Data Deliverable (EDD)				3	EDD data are verified to be 100% correct (populated fields match corresponding values in the data package) by the following methodology: - Compare entire contents of EDD for a single sample against hardcopy. Compare 100% of the following against hardcopy for all samples: Activity, TPU, and MDC. Review 100% of any manually loaded data.	Contact the Validata PM.	
Sample Receipt				4	Chain-of-Custody Form is present and documents all samples submitted for analysis.	Contact the Validata PM.	
				5	Chain-of-Custody Form documents condition of all samples upon receipt in laboratory.	Contact the Validata PM.	
				6	Chain-of-Custody Form documents project-specified preservation method of all samples.	Contact the Validata PM.	
				7	Chain-of-Custody Form documents control of sample custody of all samples during entire sampling to disposition processes.	Contact the Validata PM.	
Non-conformance and Corrective Action Reports				8	Non-conformance and Corrective Action Reports are submitted with data package. If no non-conformances were found, a statement to that effect is provided.	Contact the Validata PM.	
				9	Non-conformance and Corrective Action Reports are approved by laboratory management and CDM Smith.	Contact the Validata PM.	
National Institute of Standards and Technology (NIST) Traceability				10	Defensible documentation provided to demonstrate NIST-traceability of radioactive standards used in analysis of samples.	Contact the Validata PM.	
				11	Defensible documentation provided to verify NIST-traceability of on-going laboratory measurement processes. These may include, but is not limited to: - oven temperature logs - balance calibration logs - pipette calibration logs	Contact the Validata PM.	
Project-Specific Sample Processing Requirements				12	Water filtration log data submitted for all water samples in Sample Delivery Group (SDG).	Prof. Judgment UJ or R	Prof. Judgment J or R
				13	Method for filtration of water samples was approved for project.	Prof. Judgment UJ or R	Prof. Judgment J or R
				14	Hold time for filtration of water samples met hold time requirement for project.	Prof. Judgment UJ or R	Prof. Judgment J or R
				15	Method for drying, grinding, homogenization, and sub-sampling of soil samples was approved for project.	Prof. Judgment UJ or R	Prof. Judgment J or R
				16	Drying log data submitted for all soil samples in SDG.	Prof. Judgment UJ or R	Prof. Judgment J or R
				17	Grinding log data submitted for all soil samples in SDG.	Prof. Judgment UJ or R	Prof. Judgment J or R
				18	Sub-sampling records data submitted for all soil samples in SDG.	Prof. Judgment UJ or R	Prof. Judgment J or R
Project-Specific Sample Preparation Requirements				19	Specific project-approved standard operating procedure (SOP) was used.	Contact the Validata PM.	
				20	Preparation analyst is identified.	Contact the Validata PM.	
				21	Documentation of NIST-traceable standards used.	Prof. Judgment UJ or R	Prof. Judgment J or R
				22	Sample preparation dates are documented.	Prof. Judgment UJ or R	Prof. Judgment J or R
				23	Chemical separation dates required to calculate final results are documented.	R	R

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
				24	Documentation of NIST-traceable volumetric and gravimetric measurements that affect calculated final results is provided. This may include, but not be limited to: - sample aliquant - tracer volume	Prof. Judgment UJ or R	Prof. Judgment J or R
Initial Calibration				25	Initial calibration performed prior to sample analysis.	Prof. Judgment UJ or R	Prof. Judgment J or R
				26	Initial calibration met method-specific and project-specified criteria; see guidance presented in MARLAP Section 18.5.6 or ASTM D7282. *See laboratory/method specific instruction sheet.*	Prof. Judgment UJ or R	Prof. Judgment J or R
Background				27	Background measured at the method-specific frequency presented in MARLAP Section 18.5.6 or ASTM D7282. *See laboratory/method specific instruction sheet for analytical backgrounds (used for subtraction) criteria and instrument background monitoring criteria.*	Prof. Judgment UJ or R	Prof. Judgment J or R
				28	Background measurements met method-specific and project-specified acceptance criteria; see guidance presented in MARLAP Section 18.5.6 or ASTM D7282. *See laboratory/method specific instruction sheet for analytical backgrounds (used for subtraction) criteria and instrument background monitoring criteria.*	Prof. Judgment UJ or R	Prof. Judgment J or R
Continuing Calibration Verification				29	Continuing calibration verification performed at the method-specific frequency presented in MARLAP Section 18.5.6; at minimum, daily prior to sample analysis. *See laboratory/method specific instruction sheet.*	Prof. Judgment UJ or R	Prof. Judgment J or R
				30	Continuing calibration remains within 3σ of the expected value of the control chart.	Prof. Judgment UJ or R	Prof. Judgment J or R
				31	As applicable, peak resolutions and peak locations met method-specific and project-specified criteria; see guidance presented in MARLAP Section 18.5.6 or ASTM D7282. *See laboratory/method specific instruction sheet.*	Prof. Judgment UJ or R	Prof. Judgment J or R
Sample Analysis Raw Data				32	Instrument run logs with analysis dates are provided.	Contact the Validata PM.	
				33	Raw count data are provided.	Contact the Validata PM.	
				34	As applicable, individual sample spectra are provided.	Contact the Validata PM	
Reported Sample Results				35	Sample results summation is provided for all samples in SDG.	Contact the Validata PM.	
				36	Sample results summation includes documentation that the project-approved SOP was used for the given analysis.	Contact the Validata PM.	
				37	Sample results summation includes documentation that the project-specified required method uncertainty (maximum 10% of Action Level) was adhered to for results below the project-specified analyte Action Level.	N/A	Prof. Judgment J or R
				38	Sample results summation includes documentation that the project-specified required method uncertainty (maximum 10% relative uncertainty) was adhered to for results at or above any project-specified analyte Action Level.	N/A	Prof. Judgment J or R

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
				39	**Water/Sediment (Not Applied to Soil):** Analyte quantitation: If a result is reported greater than the project-specified critical value but less than project-specified Action Level, consider the result detected, and apply the indicated Qualifier.	N/A	J
				40	Analyte quantitation: If a result is reported less than the project-specified critical value, consider the result undetected, and apply the indicated Qualifier.	U	N/A
				41	Negative results: **Water/Sediment:** No analytes have an absolute value of negative result greater than the project-specified critical value. **Soil:** No analytes have an absolute value of negative result greater than the 2 σ TPU.	**Water/Sediment:** If the absolute value is between the project-specified critical value and the MDC, qualify UJ. If the absolute value is greater than the project-specified MDC, qualify R. **Soil:** If the absolute value is between the 2S and 3S total propagated uncertainty, UJ. If the absolute value is greater than 3S total propagated uncertainty, qualify R.	
LCS for all analytes				42	LCS run at project-specified frequency (one per preparation batch)	Contact the Validata PM.	
				43	Percent Recovery (%R) within QAPP limits. If NO, qualify all affected analytes in associated samples.		If %R > QC limit, qualify affected detected results J.
				44			If %R is unusually high, examine other QC elements to determine if detected results require qualification of R
				45		If %R < QC limit, qualify non-detected results UJ.	If %R < QC lmit, qualify detected results J.
				46		If %R is unusually low, qualify non-detected results R.	If %R is unusually low, examine other QC elements to determine if detected results require qualification of R
Laboratory Duplicates				47	Laboratory duplicate run at project-specified frequency (one per preparation batch) - *May be the client's sample, or a batch duplicate of another client's sample.*	Contact the Validata PM.	
				48	Duplicates: |Z| < 1.96. If NO, qualify all affected analytes in associated samples.	For all affected analytes in asso-ciated samples: If |Z| >1.96, qualify nondetected results UJ.	For all affected analytes in associated samples: If |Z| >1.96, qualify detected results J.
Field Duplicates				49		If |Z| >2.58, examine other QC elements to determine if results require qualification of R.	

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
Matrix Spike				50	Matrix spike run at project-specified frequency (one per preparation batch). *Not required for Gamma Spec. or for analyses in which a stable carrier or radio-tracer are utilized for determining chemical recovery.*	Contact the Validata PM.	
				51	Percent Recovery (%R) within QAPP limits. If NO, qualify all affected analytes in associated samples.		If %R > QC limit, qualify affected detected results J.
				52			If %R is unusually high, examine other QC elements to determine if detected results require qualification of R
				53		If %R < QC limit, qualify non-detected results UJ.	If %R < QC lmit, qualify detected results J.
				54		If %R is unusually low, qualify non-detected results R.	If %R is unusually low, examine other QC elements to determine if detected results require qualification of R
Method blank				55	Method blank run at project-specified frequency (one per preparation batch)	Contact the Validata PM.	
				56	Positive Blank Results: Is blank < MDC? If not, calculate Z_{DER} for each affected analyte in each associated sample	N/A	For affected analytes in associated samples: If Z_{DER} > 2.58, no qualification required.
				57		N/A	If Z_{DER} < 2.58, qualify affected detected results J.
				58		N/A	If Z_{DER} < 1.96, qualify affected detected results J.
				59	Negative blank results: Is |blank| < MDC? If not, calculate Z_{DER} for each affected analyte in each associated sample.	N/A	For affected analytes in associated samples: If Z_{DER} > 2.58, no qualification required.
				60		If Z_{DER} < 2.58, qualify affected non-detected results UJ.	If Z_{DER} < 2.58, qualify affected detected results J.
				61		If Z_{DER} < 1.96, qualify affected non-detected results R.	If Z_{DER} < 1.96, qualify affected detected results J.

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
Equipment (Rinse) Blank (Evaluate only when full set of parameters is run.)				62	Evaluation at 99% confidence level does not show a substantial difference from the corresponding source water sample. Z-Score < 2.58. If NO, compare with associated sample results (with adjustment for matrix differences). If samples do not differ from corresponding rinse blank result at 99% confidence level, Z-Score > 2.58, qualify as noted.	N/A	Positive sample results J.
Chemical Yield				63	Chemical yield is documented for each sample, as required by project-specified individual analytical methods.	Contact the Validata PM.	
				64	Chemical yield is within laboratory control limits - upper limit 110%, and lower limit 40% for methods that employ a stable carrier or 30% for methods that employ a radioactive tracer (provided that the 1 σ counting uncertainty does not exceed 5% (e.g., 400 counts).	If the yield is above the upper limit, qualify non-detected results UJ.	If the yield is above the upper limit, qualify detected results J.
				65		N/A	**Water/Sediment:** If the yield is below the lower limit, qualify detected results J. **Soil:** If the yield is below the lower limit, determine whether there is sufficient technical justification to use the data without further qualification or to require qualification of J as estimated values.
				66		If the yield is grossly above or below the control range, evaluate the data to determine if affected results require qualification of R.	If the yield is grossly above or below the control range, evaluate the data to determine if affected results require qualification of R.

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte
				67	Is 1 σ counting uncertainty < 5% (e.g., 400 counts) for radioactive tracers?	If the result is less than the critical value, qualify UJ.	**Water/Sediment:** If the result is greater than the Action Level, qualify J. **Soil:** If the counting uncertainty of the tracer is NOT reflected in the sample CSU, qualify results J. If the counting uncertainty of the tracer IS reflected in the sample CSU, determine whether the sample results may be used without further qualification or require a qualifier of J. If less than 100 tracer counts are acquired qualify as R.
Reanalyses/Dilutions (REs/DLs)				68	No REs/DLs reported for any client sample by any method.	Review and determine qualifications for both replicates, determine best overall data set, and apply X qualifier to extraneous analyses per project instructions.	
Calculation/Transcription Verifications				69	Verified by independent recalculation of randomly selected sample result for activity concentration, combined standard uncertainty, critical value, and minimum detectable concentration. Document on Validata calculation spreadsheet.	Contact the Validata PM.	
				70	Independent recalculation of the calibrated instrument counting efficiency verifies the proper decay correction of the radioactive calibration source. Document on Validata calculation spreadsheet.	Contact the Validata PM.	
				71	Free from errors in spot check of transcription from raw data to summary forms for both a sample and QC results.	Contact the Validata PM.	
Data Validation Narrative				72	Prepare a Data Validation Narrative in accordance with the Validata project format. Describe in detail data quality, qualifications, and applicability of the SDG data for its intended use.	N/A	
Table of Qualified Results				73	Prepare a Table of Qualified Results listing all data qualifications applied in data validation per this checklist (See Section at end of Narrative). If there were no qualifications, include a statement to that effect.	N/A	
Peer Review				74	Submit Data Validation Narrative with Table of Qualified Results, Completed Checklist, and Calculation Sheets to designated Peer Reviewer.	N/A	
				75	Modify Data Validation Report elements based on Peer Review.	Modify as necessary in Data Validation Narrative and Table of Qualified Results	

Notes:

[1]The requirements presented in this table are general and may not support all analytical methods proposed by individual laboratories. Additional information is presented in laboratory/method specific instructions sheet.

QC Check	(Check One)			#	Criterion	Assign Qualifier Listed Below if Criterion = No	
	Yes	No	N/A			Non-detected Analyte	Detected Analyte

[2]When more than one qualifier is applicable to a sample result, the priority of qualifiers for detected results is: X > R > J > no qualifier; the priority of qualifiers for results considered non-detected is: X > R > UJ > U. Qualifiers are defined in Table 3.4.

[3]LCSs will be processed and counted to yield the same target MDCs as in associated environmental samples in order to minimize uncertainty in these QC samples and provide appropriately rigorous control.

CSU = combined standard uncertainty
CU = counting uncertainty
LCL = lower control limit
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MARLAP = Multi-Agency Radiological Laboratory Analytical Protocols Manual
MDA = minimum detectable activity
MDC = minimum detectable concentration MQC = minimum quantifiable concentration MS = matrix spike
QC = quality control
%R = percent recovery
CSU = total propagated uncertainty
UCL = upper control limit
Z = Z-score (normalized difference)

Definitions of Data Validation Qualifiers

Qualifier	Definition
No qualifier	Confirmed identification. The analyte was positively identified at the reported value. The reported concentration is within the calibrated range of the instrument and the result is not affected by any deficiencies in the associated quality control criteria.
J	The analyte was detected at the reported concentration; the quantitation is an estimate.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria.
U	Not considered detected. The associated number is the reported concentration.
UJ	Not considered detected. The associated number is the reported concentration, which may be inaccurate.
X	Excluded. The data point is associated with reanalyses or diluted analyses and is excluded because another result has been selected as the definitive result for the analyte.