Supplemental Remedial Investigation Work Plan - Soil Investigation

Elmwood Preserve, NYSDEC BCP Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

Prepared for

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Acronyms and Abbreviations

AST	above-ground storage tank
bgs	below ground surface
BMP	best management practices
CAMP	community air monitoring plan
Carson Voci	Carson Voci Engineering and Geology, D.P.C.
ConEd	Consolidated Edison
DER	Division of Environmental Remediation
DER-10	*DER 10 / Technical Requirements for Site Investigation and Remediation*
DER-31	*DER-31 / Green Remediation*
DUSR	data usability summary report
EC	emerging contaminants
ESA	environmental site assessment
GSR	green and sustainable remediation
IDW	investigation-derived waste
mg/kg	milligrams per kilogram
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PEcoSCOs	Protection of Ecological Resource Soil Cleanup Objective
PFAS	per- and polyfluoroalkyl substances
PFAS Guidance	*Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS)*
PID	photoionization detector
PGW	Protection of Groundwater
QAPP	*Quality Assurance Project Plan*
RAWP	remedial action work plan
RI	remedial investigation
RIR	remedial investigation report
RIWP	*Remedial Investigation Work Plan*
Roux	Roux Environmental Engineering and Geology, D.P.C.
RRSCOs	restricted residential use soil cleanup objectives
RSCOs	residential use soil cleanup objectives
SRIWP-SI	*Supplemental Remedial Investigation Work Plan – Soil Investigation*
SCOs	soil cleanup objectives
SVOC	semivolatile organic compound

TAL	Target Analyte List
TCL	Target Compound List
UST	underground storage tank
UUSCOs	unrestricted use soil cleanup objectives
VOC	volatile organic compound

Engineering Certification

I, Nicholas Krasnecky, P.E., certify that I am a New York State registered Professional Engineer and that this *Supplemental Remedial Investigation Work Plan* was prepared in accordance with applicable statutes and regulations and in substantial conformance with the New York State Department of Conservation, Division of Environmental Remediation Program Policy "DER-10 / Technical Guidance for Site Investigation and Remediation."

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1/31/2025

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Date

1 Introduction

Carson Voci Engineering and Geology, D.P.C. (Carson Voci), an affiliate of Terraphase Engineering Inc., has prepared this *Supplemental Remedial Investigation Work Plan –Soil Investigation* (SRIWP-SI) on behalf of Ridgewood Elmwood Owner, L.L.C. (the “Applicant” and “Participant”) for the New York State (NYS) Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program Site No. C203162 identified as Elmwood Preserve at 850 Dobbs Ferry Road, White Plains, New York (Site; Figure 1).

This SRIWP-SI has been prepared to supplement the remedial investigation (RI) activities implemented by Roux Environmental Engineering and Geology, D.P.C. (Roux) in accordance with the NYSDEC-approved *Remedial Investigation Work Plan* (RIWP [Roux 2024]).

1.1 Site Location and Description

The Site is currently owned by the Applicant, a Participant in the Brownfield Cleanup Program. The approximately 106.8-acre Site is comprised of two parcels identified as 7.530-320.1..SG and 7.530-320-1..SE in the Town of Greenburgh, New York, Geographic Information System tax map (Figure 2). The immediate surrounding properties consist of residential homes to the north, a municipal park to the east, commercial properties to the south, and residential homes and a fire department to the west. In addition, the Site is bisected by parcel 7.530-320-3, owned by Consolidated Edison Company of New York, Inc. (ConEd).

The Site is improved by a former 18-hole golf course and country club that included several buildings for the main clubhouse and maintenance and storage shops. The buildings were located on the southwest portion of the Site and have since been demolished. The Site also included several tennis courts and a pool area. The buildings were accessed by a paved parking lot and two small roads that lead to Dobbs Ferry Road.

The planned redevelopment of the Site consists of the construction of approximately 113 private (single-family) residential homes.

1.2 Work Plan Purpose

The RI is a component of, and will facilitate but does not constitute, the overall remedy for the Site. The purpose of the RI is to determine the nature and extent of soil, groundwater, and soil vapor contamination at the Site, qualitatively assess the potential exposure to receptors, and collect additional data necessary to support the development of a remedial action work plan (RAWP).

The purpose of this SRIWP-SI is to refine the vertical extent of contaminated soils at the Site based on the evaluation of the data collected during the RI activities and utilizing the proposed future site use to evaluate data against the residential use soil cleanup objectives (RSCOs) and restricted RSCOs (RRSCOs [6 NYCRR Part 375]).[1]

This SRIWP-SI has been prepared in accordance with NYSDEC Department of Environmental Remediation (DER) procedures set forth in the Program Policy "DER-10 / Technical Requirements for Site Investigation and Remediation" (DER-10 [NYSDEC DER 2010]), and complies with all applicable federal, state, and local laws, regulations, and requirements.

1.3 Work Plan Organization

This SRIWP-SI is organized by the following sections:

1. **Introduction.**
2. **Background.** Presents pertinent information and characteristics of the Site and the results of previous environmental work relevant to the preparation of this SRIWP-SI.
3. **Supplemental Soil Investigation Sampling Plan.** Presents a detailed description of the SRIWP-SI objections, scope, procedures, and rationale.
4. **Schedule.** Presents the proposed implementation schedule for the SRIWP-SI activities.
5. **Reporting.** Presents the proposed reporting for the activities in this SRIWP-SI.
6. **References.** Presents a list of sources consulted in preparation of this SRIWP-SI.

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[1] "Environmental Remediation Programs," 6 NYCRR Part 375 (December 14, 2006), https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375.pdf.

2 Background

The background of the Site, including the setting, history, surrounding properties, and the results of previous environmental reports, were provided in the RIWP (Roux 2024). This section provides information about the Site background and results from the RI activities conducted at the Site pertinent to this SRIWP-SI.

2.1 Site Background

The Site was first developed in 1924 as the Pelhamhurst Golf & Country Club golf course. In 1946, the ownership transferred from John C. Von Glahn, a Trustee, to Elmwood Country Club Inc. The property continued to be managed as a private club and golf course from 1946 until its closure in 2017. The property was purchased by the Participant in 2017.

2.2 Remedial Investigation Results

Roux conducted the RI from May through July 2024 in accordance with the NYSDEC-approved RIWP to assess the nature and extent of contamination associated with the former Site use as a golf course and country club and the presence of metals and pesticide exceedances across the Site. The RI evaluated soil, groundwater, soil vapor, surface water, and sediment to determine the nature and extent of impacted media at the Site.

The RI results presented in this section are limited to soil as they provide the basis for the proposed SRIWP-SI scope provided in Section 3.

2.2.1 Remedial Investigation Soil Sampling Summary

To characterize the soil conditions and determine the nature and extent of soil contamination at the Site, 130 soil borings were advanced at the locations shown on Figure 3. The locations corresponded to the center of each approximately 200- by 200-foot grid in the grid system and 16 additional locations collected from a potential area of historical imported fill.

The soil samples at each location were collected from the following vertical intervals by hand or with a Geoprobe direct-push drill rig and submitted to Pace Analytical, an NYSDEC Environmental Laboratory Approval Program-certified analytical laboratory for the following analyses:

Vertical Sampling Interval	Lab Analyses
0 – 2-inch (0 – 0.2-foot)	Target Compound List (TCL) Pesticides and Herbicides Target Analyte List (TAL) Metals
2-inch – 2-foot (0.2 – 2-foot)	TCL/Part 375 plus 30/ TAL: • TCL/Part 375 Volatile Organic Compounds (VOC) + 10 tentatively identified compounds • TCL/Part 375 Base Neutral Acids/Semivolatile Organic Compounds (SVOC) + 20 tentatively identified compounds

Vertical Sampling Interval	Lab Analyses
2-inch – 2-foot (0.2 – 2-foot)	• TCL/Part 375 Polychlorinated Biphenyls (PCBs) • TAL/Part 375 Metals (including hexavalent chromium) • Total Cyanide Emerging Contaminants (ECs) – 1,4-dioxane and 40-per- and polyfluoroalkyl substances (PFAS)
2 – 4-foot (held, pending analyses)	TCL Pesticides and Herbicides TAL Metals
4 – 6-foot (held, pending analyses)	TCL Pesticides and Herbicides TAL Metals
6+ foot	TCL/Part 375 plus 30/ TAL and ECs (or subset of list)
0 -1-foot (potential historical import material)	TCL/Part 375 plus 30/ TAL ECs

Soil borings were geologically logged in accordance with the Unified Soils Classification System nomenclature, including evidence of contamination via visual and olfactory inspection, and field screened continuously for VOCs using a photoionization detector (PID) with a 10.6 electron volt lamp.

Table 1 provides a detailed list of the soil sampling locations, IDs, depth intervals, and laboratory analyses.

All data was reported in accordance with the NYSDEC Analytical Services Protocol Category B deliverables and will be reviewed and validated by an independent, third-party data validator. The data validator will prepare a data usability summary report (DUSR) before data is incorporated into the final RI report (RIR) for the Site. All data will be submitted to NYSDEC in electronic format in accordance with DER-10, Section 1.15.

2.2.2 Standards, Criteria, and Guidance - Soil Cleanup Objectives

The applicable standards, criteria, and objectives for soil at the Site (i.e., soil cleanup objectives [SCOs]) are presented in 6 NYCRR Part 375. The RIWP proposed unrestricted use SCOs (UUSCOs) for the Site, yet based on the proposed future Site uses, SCOs restricting specific use may also be applicable. The proposed development of the Site property west of the ConEd Parcel ("Western Parcel") consists of single-family housing. As such, the applicable SCOs for the "Western Parcel" include the RSCOs to facilitate the development of a Track 2 Cleanup approach consistent with the proposed use as a single-family housing development. Therefore, the RI results were compared and evaluated against UUSCOs and the applicable SCOs based on the proposed future Site use as detailed below:

Single-Family Residential Development (Site Property West of the ConEd Parcel; "Western Parcel")	Proposed Recreation Area Development (Site Property East of the ConEd Parcel; "Eastern Parcel")
RSCOs	RSCOs
Protection of Groundwater SCOs (PGWSCOs)	RRSCOs
Protection of Ecological Resources SCOs (PEcoSCOs)	PGWSCOs and PEcoSCOs

A summary of the results and findings from the soil investigation portion of the RI, including evaluation against the proposed SCOs, are presented in the following sections, separated by vertical sampling interval.

2.2.3 Soil Sampling - 0 to 0.2-foot Depth Interval

Soil samples from the 0 to 0.2-foot below ground surface (bgs) sampling depth interval were collected from each of the 115 sample locations associated with the grid system and analyzed as detailed in Section 2.2.1. The RI results from the samples collected from 0 to 0.2-foot bgs show widespread impacts of pesticides and metals in soil, which exceed the applicable SCOs. Specifically, when compared to RSCOs, and RRSCOs in the proposed recreation area, dieldrin, arsenic, chromium III, and mercury were identified to be present at concentrations above the applicable SCOs at numerous locations.

The summary tables and figures depicting the RI data are provided in Appendix A.

A summary of the soil data exceedances of the applicable SCOs from the 0 to 0.2-foot bgs interval are presented below.

Pesticides

Parcel	Chemical	Min. Detected (mg/kg)	Max. Detected (mg/kg)	Location of Max. Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Chlordane (total)	0.0017	0.78	E6_0-0.2	98	0.094	19	0.91	0	4.2	NA	2.9	0	1.3	0
Western	4,4'-DDD	0.00075	0.019	C11_0-0.2	98	0.0033	12	2.6	0	13	NA	14	0	0.0033	12
Western	4,4'-DDE	0.00062	1.5	F8_0-0.2	98	0.0033	89	1.8	0	8.9	NA	17	0	0.0033	89
Western	4,4'-DDT	0.0025	3.0	F7_0-0.2	98	0.0033	85	1.7	1	7.9	NA	136	0	0.0033	85
Western	Dieldrin	0.00074	1.1	G11_0-0.2	98	0.0050	53	0.039	36	0.20	NA	0.10	26	0.0060	50
Western	Endrin	0.0046	0.044	I7_0-0.2	98	0.014	1	2.2	0	11	NA	0.060	0	0.014	1
Western	Heptachlor epoxide	0.0013	0.40	F11_0-0.2	98	0.042	28	0.42	0	2.1	NA	0.38	1	0.14	11
Eastern	Chlordane (total)	0.0026	0.41	F13_0-0.2	17	0.094	3	0.91	0	4.2	0	2.9	0	1.3	0
Eastern	4,4'-DDD	0.0071	0.017	F13_0-0.2	17	0.0033	2	2.6	0	13	0	14	0	0.0033	2
Eastern	4,4'-DDE	0.0012	0.29	I13_0-0.2	17	0.0033	15	1.8	0	8.9	0	17	0	0.0033	15
Eastern	4,4'-DDT	0.0025	0.079	I13_0-0.2	17	0.0033	13	1.7	0	7.9	0	136	0	0.0033	13
Eastern	Dieldrin	0.0018	0.52	I13_0-0.2	17	0.0050	13	0.039	7	0.20	4	0.10	6	0.0060	13
Eastern	Heptachlor epoxide	0.0011	0.12	E14_0-0.2	17	0.042	7	0.42	0	2.1	0	0.38	0	0.14	0

Metals

Parcel	Chemical	Min. Detected (mg/kg)	Max. Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Arsenic	0.27	218	C10_0-0.2	98	13	**73**	16	**67**	16	NA	16	**67**	13	**73**
Western	Cadmium	0.10	3.3	G11_0-0.2	98	2.5	**2**	2.5	**2**	4.3	NA	7.5	0	4.0	0
Western	Chromium III	2.6	140	C10_0-0.2	98	30	**45**	36	**33**	180	NA		0	41	**30**
Western	Chromium VI	0.23	1.5	G2_0-0.2	98	1.0	**1**	22	0	110	NA	19	0	1.0	**1**
Western	Lead	1.0	287	B10_0-0.2	98	63	**53**	400	0	400	NA	450	0	63	**53**
Western	Mercury	0.057	76	E6_0-0.2	98	0.18	**78**	0.81	**39**	0.81	NA	0.73	**41**	0.18	**78**
Western	Nickel	0.21	32	A12_0-0.2	98	30	**1**	140	0	310	NA	130	0	30	**1**
Western	Zinc	5.2	214	H5_0-0.2	98	109	**7**	2200	0	10000	NA	2480	0	109	**7**
Eastern	Arsenic	4.7	193	I13_0-0.2	17	13	**12**	16	**12**	16	**12**	16	**12**	13	**12**
Eastern	Chromium III	18	126	H13_0-0.2	17	30	**6**	36	**6**	180	0		0	41	**6**
Eastern	Lead	6.4	203	I13_0-0.2	17	63	**7**	400	0	400	0	450	0	63	**7**
Eastern	Mercury	0.062	3.9	F13_0-0.2	17	0.18	**14**	0.81	**7**	0.81	**7**	0.73	**7**	0.18	**14**
Eastern	Zinc	30	294	H14_0-0.2	17	109	**1**	2200	0	10000	0	2480	0	109	**1**

Herbicides

Herbicides were not detected in any soil samples collected from the 0 to 0.2-foot bgs interval.

2.2.4 Soil Sampling - 0.2 to 2-foot Depth Interval

Soil samples from the 0.2 to 2-foot bgs interval were collected from each of the 115 sample locations associated with the grid system and analyzed as detailed in Section 2.2.1. The RI results from the samples collected from 0.2 to 2-foot bgs show a reduction in concentration and number of soil samples containing pesticides and metals in soil, which exceed the applicable SCOs yet are still relatively prevalent across the Site. Specifically, when compared to RSCOs, and RRSCOs in the proposed recreation area, dieldrin, arsenic, and mercury were identified to be present at concentrations above the applicable SCOs at numerous locations. The RI results also indicate limited impacts of VOCs, SVOCs, PFAS, and PCBs.

The summary tables and figures depicting the RI data are provided in Appendix A.

A summary of the soil data exceedances of the applicable SCOs from the 0.2 to 2-foot bgs interval are presented below.

Pesticides

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Chlordane (total)	0.0016	0.50	E6_0.2-2	98	0.094	**6**	0.91	0	4.2	NA	2.9	0	1.3	0
Western	4,4'-DDD	0.00063	0.032	H8_0.2-2	98	0.0033	**4**	2.6	0	13	NA	14	0	0.0033	**4**
Western	4,4'-DDE	0.00047	0.71	G3_0.2-2	98	0.0033	**61**	1.8	0	8.9	NA	17	0	0.0033	**61**
Western	4,4'-DDT	0.0015	0.422	G3_0.2-2	98	0.0033	**46**	1.7	0	7.9	NA	136	0	0.0033	**46**
Western	Dieldrin	0.00056	0.42	I10_0.2-2	98	0.0050	**35**	0.039	**14**	0.20	NA	0.10	**7**	0.0060	**34**
Western	Heptachlor epoxide	0.0011	0.42	F11_0.2-2	98	0.042	**11**	0.42	0	2.1	NA	0.38	**1**	0.14	**3**
Eastern	4,4'-DDE	0.00051	0.22	I13_0.2-2	17	0.0033	**7**	1.8	0	8.9	0	17	0	0.0033	**7**
Eastern	4,4'-DDT	0.0014	0.069	I13_0.2-2	17	0.0033	**3**	1.7	0	7.9	0	136	0	0.0033	**3**
Eastern	Dieldrin	0.0010	0.68	H13_0.2-2	17	0.0050	**5**	0.039	**3**	0.20	**2**	0.10	**3**	0.0060	**5**
Eastern	Heptachlor epoxide	0.0010	0.10	H13_0.2-2	17	0.042	**2**	0.42	0	2.1	0	0.38	0	0.14	0

Metals

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Arsenic	0.33	121	D11_0.2-2	98	13	**31**	16	**21**	16	NA	16	**21**	13	**31**
Western	Chromium III	3.0	177	F11_0.2-2	98	30	**10**	36	**4**	180	NA		0	41	**3**
Western	Lead	1.3	130	D11_0.2-2	98	63	**9**	400	0	400	NA	450	0	63	**9**
Western	Mercury	0.049	50	E6_0.2-2	98	0.18	**30**	0.81	**11**	0.81	NA	0.73	**13**	0.18	**30**
Western	Nickel	0.30	39	A12_0.2-2	98	30	**1**	140	0	310	NA	130	0	30	**1**
Western	Zinc	5.1	136	F2_0.2-2	98	109	**1**	2200	0	10000	NA	2480	0	109	**1**
Eastern	Arsenic	1.4	134	I13_0.2-2	17	13	**3**	16	**3**	16	**3**	16	**3**	13	**3**
Eastern	Chromium III	13	105	H13_0.2-2	17	30	**3**	36	**3**	180	0		0	41	**3**
Eastern	Lead	4.4	144	I13_0.2-2	17	63	**3**	400	0	400	0	450	0	63	**3**

VOCs

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Acetone	0.0058	0.12	D13_0.2-2	98	0.050	**1**	100	0	100	NA	0.050	**1**	2.2	0
Eastern	Acetone	0.0065	0.11	F13_0.2-2	17	0.050	**1**	100	0	100	0	0.050	**1**	2.2	0

SVOCs

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Benzo(a)anthracene	0.022	15	F2_0.2-2	98	1.0	**1**	1.0	**1**	1.0	**1**		0
Western	Benzo(a)pyrene	0.057	16	F2_0.2-2	98	1.0	**1**	1.0	**1**	22	0	2.6	**1**
Western	Benzo(b)fluoranthene	0.033	20	F2_0.2-2	98	1.0	**1**	1.0	**1**	1.7	**1**		0
Western	Benzo(k)fluoranthene	0.036	5.6	F2_0.2-2	98	0.80	**1**	1.0	**1**	1.7	**1**		0
Western	Chrysene	0.020	14	F2_0.2-2	98	1.0	**1**	1.0	**1**	1.0	**1**		0
Western	Dibenz(a,h)anthracene	0.074	2.2	F2_0.2-2	98	0.33	**1**	0.33	**1**	1000	0		0
Western	Indeno(1,2,3-cd)pyrene	0.026	9	F2_0.2-2	98	0.50	**1**	0.50	**1**	8.2	**1**		0

PCBs

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	PCBs (total)	0.023	3.7	F2_0.2-2	97	0.10	**1**	1.0	**1**	3.2	**1**	1.0	**1**

PFAS

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Perfluorooctane-sulfonic Acid (PFOS)	0.000090	0.0011	A4_0.2-2	12	0.00088	**1**	0.0088	0	0.0010	**1**		0

Herbicides

Herbicides were not detected in any soil samples collected from the 0.2 to 2-foot bgs interval.

2.2.5 Soil Sampling - 2 to 4-foot Depth Interval

Soil samples from the 2 to 4-foot bgs interval were collected from 78 of the 115 sample locations associated with the grid system and analyzed as detailed in Section 2.2.1. The RI results from the samples collected from 2 to 4-foot bgs show limited impacts of pesticides and metals in soil, which exceed the applicable SCOs. Specifically, when compared to RSCOs, and RRSCOs in the proposed recreation area, dieldrin and mercury were identified to be present at concentrations above the applicable SCOs.

The summary tables and figures depicting the RI data are provided in Appendix A.

A summary of the soil data exceedances of the applicable SCOs from the 2 to 4-foot bgs interval is presented below.

Pesticides

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	4,4'-DDD	0.00073	0.12	G4_2-4	60	0.0033	**3**	2.6	0	13	NA	14	0	0.0033	**3**
Western	4,4'-DDE	0.00041	0.28	B12_2-4	60	0.0033	**19**	1.8	0	8.9	NA	17	0	0.0033	**19**
Western	4,4'-DDT	0.0018	0.062	G3_2-4	60	0.0033	**8**	1.7	0	7.9	NA	136	0	0.0033	**8**
Western	Dieldrin	0.00071	0.051	I9_2-4	60	0.0050	**5**	0.039	**1**	0.20	NA	0.10	0	0.0060	**4**
Eastern	4,4'-DDE	0.00047	0.0067	I12_2-4	8	0.0033	**1**	1.8	0	8.9	0	17	0	0.0033	**1**
Eastern	Dieldrin	0.00059	0.0073	I12_2-4	8	0.0050	**2**	0.039	0	0.20	0	0.10	0	0.0060	**2**

Metals

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Mercury	0.047	3.2	A13_2-4	42	0.18	**7**	0.81	**2**	0.81	NA	0.73	**2**	0.18	**7**
Western	Nickel	5.7	45	H4_2-4	42	30	**3**	140	0	310	NA	130	0	30	**3**
Western	Zinc	26	283	H2_2-4	42	109	**3**	2200	0	10000	NA	2480	0	109	**3**
Eastern	Nickel	6.7	110	I13_2-4	5	30	**1**	140	0	310	0	130	0	30	**1**

2.2.6 Soil Sampling - 4 to 6-foot Depth Interval

Soil samples from the 4 to 6-foot bgs interval were collected from 19 of the 115 sample locations associated with the grid system and analyzed as detailed in Section 2.2.1. The RI results from the samples collected from 4 to 6-foot bgs show limited impacts of pesticides and metals in soil, which exceed the applicable SCOs. Specifically, when compared to UUSCOs and PEcoSCOs, 4,4’-DDD, 4,4’DDE, 4,4’-DDT, mercury, and nickel were identified to be present at concentrations above the applicable SCOs at multiple locations. All chemical concentrations were below the RSCOs, and RRSCOs in the proposed recreation area.

The summary tables and figures depicting the RI data are provided in Appendix A.

A summary of the soil data exceedances of the applicable SCOs from the 4 to 6-foot bgs interval is presented below.

Pesticides

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	RRSCOs (mg/kg)	# RRSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	4,4'-DDD	0.0053	0.018	G4_4-6	13	0.0033	**3**	2.6	0	13	NA	14	0	0.0033	**3**
Western	4,4'-DDE	0.00057	0.12	B12_4-6	13	0.0033	**5**	1.8	0	8.9	NA	17	0	0.0033	**5**
Western	4,4'-DDT	0.0027	0.021	B12_4-6	13	0.0033	**4**	1.7	0	7.9	NA	136	0	0.0033	**4**
Eastern	Dieldrin	0.016	0.016	F13_4-6	1	0.0050	**1**	0.039	0	0.20	0	0.10	0	0.0060	**1**

Metals

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Copper	11	63	B8_4-6	9	50	**1**	270	0	1720	0	50	**1**
Western	Mercury	0.055	0.69	G4_4-6	9	0.18	**3**	0.8	0	0.73	0	0.18	**3**
Western	Nickel	13	39	A12_4-6	9	30	**2**	140	0	130	0	30	**2**

2.2.7 Soil Sampling - 6+ foot Depth Interval

Soil samples taken deeper than 6 feet bgs were collected from 6 of the 115 sample locations associated with the grid system and analyzed as detailed in Section 2.2.1. None of the RI samples collected from below 6-foot bgs intervals exhibited concentrations above the applicable SCOs.

The summary tables and figures depicting the RI data are provided in Appendix A.

2.2.8 Soil Sampling - 0 to 1-foot Depth Interval

Soil samples from the 0 to 1-foot bgs interval were collected from 15 sample locations associated with potential historical import material and analyzed as detailed in Section 2.2.1. The RI results from the samples collected from 0 to 1-foot bgs show limited impacts of SVOCs, pesticides, and metals in soil, which exceed the applicable SCOs. Specifically, multiple polycyclic aromatic hydrocarbons, aldrin, dieldrin, arsenic, and mercury were identified to be present at concentrations above the RSCOs.

The summary tables and figures depicting the RI data are provided in Appendix A.

A summary of the soil data exceedances of the applicable SCOs from the 0 to 1-foot bgs interval is presented below.

Pesticides

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Aldrin	0.0017	0.024	TS-08_0-1	15	0.0050	**1**	0.019	**1**	0.19	0	0.14	0
Western	Dieldrin	0.0017	0.48	TS-02_0-1	15	0.0050	**6**	0.039	**3**	0.10	**2**	0.0060	**5**

Metals

Parcel	Chemical	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	UUSCOs (mg/kg)	# UUSCO Exceeds	RSCOs (mg/kg)	# RSCO Exceeds	PGW SCOs (mg/kg)	# PGW SCO Exceeds	PEco SCOs (mg/kg)	# PEco SCO Exceeds
Western	Arsenic	3.9	81	TS-02_0-1	15	13	**4**	16	**4**	16	**4**	13	**4**
Western	Mercury	0.11	3.3	TS-01_0-1	15	0.18	**10**	0.81	**6**	0.73	**6**	0.18	**10**

2.2.9 Conclusions

As described in the previous sections, soil across the Site is primarily impacted by pesticides and metals. Other chemicals (i.e., VOCs, SVOCs, PCBs, and PFAS) were also found to be present at levels above the applicable SCOs in localized areas and to a much lesser extent. The RI data demonstrates that contamination generally decreases with depth (i.e., the higher concentrations were found closer to the surface), which is consistent with a historical surficial application of pesticides. However, soil data collected during the RI investigation insufficiently characterizes the vertical distribution of contamination due to the broader 2-foot bgs sampling intervals selected after the 0 to 0.2-foot bgs sampling interval. Additional sampling is warranted to obtain a more refined characterization of contaminant concentrations in soil as compared to the applicable SCOs.

3 Supplemental Remedial Investigation - Soil Investigation Sampling Plan

The purpose of the soil-based supplemental RI is to further refine and delineate the vertical extent of contamination in the soils across the Site. As detailed in the RI results presented in Section 2.2, the horizontal and vertical distribution of contamination in the soil is consistent with site-wide historical turf maintenance, including the surficial application of pesticides, that was conducted during prior Site use as a golf course. Based on the surficial historical application of pesticides, a decreasing concentration trend is expected and has been observed in the RI data collected.

This section presents the basis, objectives, scope, and rationale for the proposed soil-based supplemental RI.

3.1 Objectives and Basis

The proposed refinement of the vertical extent of contamination is related to the RI sampling depth intervals being approximately 2 feet, after the surficial (0 to 0.2-foot bgs) soil sample was collected. The 2-foot sampling interval does not provide sufficient resolution of the distribution of contaminants from a surficial historical application of pesticides, as the concentrations of contaminants may be significantly higher in the 0.5 to 1-foot bgs interval when compared to the 1.5 to 2-foot bgs interval. The basis of this is evidenced in the significant reduction of concentrations and exceedances of applicable SCOs between the RI soil samples collected from the 0 to 0.2 and 0.2 to 2-foot bgs sampling intervals.

During the RI soil investigation, soil from the 2-foot sampling intervals is understood to have been homogenized prior to collection into sample jars and submitted for laboratory analysis. Therefore, the results of these samples could present exceedances of applicable SCOs throughout a 2-foot vertical interval, where they may only exist in a shallower portion of that vertical interval (i.e., 0.5 to 1 foot). As the anticipated remedy will involve soil management, an understanding of the actual volume of soil that needs to be managed is required to develop the RAWP.

The objectives of this soil-based supplemental RI are as follows:

- Collect soil samples at 6-inch vertical sampling intervals to provide data to refine the vertical extent of contaminants in soil where a 2-foot sampling interval exceeds proposed use-based SCOs;
- Complete vertical and horizontal delineation of soils where required; and
- Confirm the underground storage tank (UST)/above ground storage tank (AST) and septic tank locations have not caused an impact since the environmental site assessment was conducted, per the *Revised RIWP Elmwood Preserve S*ite Letter (NYSDEC 2024) and *Revised Supplemental Remedial Investigation Work Plan Conditional Approval Letter* (NYSDEC 2025).

3.2 Scope of Work

The scope of the soil-based supplemental RI will include the collection of sufficient soil samples and data to accomplish the objectives presented in Section 3.1, and includes the following:

- Site reconnaissance and geophysical survey to confirm proposed sampling locations;
- Collection of soil samples via hand-auger and GeoProbe® boring methods at the locations shown on Figure 4;
- Implementation of a community air monitoring plan (CAMP) during ground intrusive activities; and
- Management of investigation-derived waste (IDW) generated during the investigation.

The following subsections provide details of these components.

3.2.1 Site Reconnaissance and Utility Clearance

Prior to intrusive sampling, a site reconnaissance will be completed to verify and mark-out the proposed sample locations with stakes and flags (or equivalent). GPS coordinates will be collected for each location as a secondary location marker. The actual sampling locations will be surveyed (horizontal coordinates and elevation) upon completion of the investigation.

Prior to the start of any intrusive work, a public utility mark-out will be performed by calling New York 811 and recording the ticket number assigned. Utility mark-outs will be logged to document compliance with mark-out requirements. A minimum of 72 hours will be allowed to complete mark-outs starting on the business morning following the time of the initial mark-out call. Additional time may be required to ensure that all mark-outs are completed. A private utility detection company will be employed, as necessary, to verify the location of utilities and subsurface structures and to ensure clearance for proposed boring and sample locations requiring a GeoProbe®.

3.2.2 General Investigation Guidance

The supplemental RI sampling will be conducted in general accordance with the appropriate techniques presented in DER-10, the general field sampling procedures presented in Sections 4.3 through 4.5 of this SRIWP-SI, and within the *Quality Assurance Project Plan* (QAPP (Appendix B).

Samples must be collected using equipment that has been properly decontaminated and procedures appropriate to site-specific factors, including the matrix, the parameters to be analyzed, and the data quality objectives of specific tasks.

The volume of the sample collected must be sufficient to perform the analyses requested, as well as the quality assurance/quality control requirements. Sample volumes, container types, and preservation techniques will also be confirmed with the approved laboratory.

Before leaving the Site, the sampler will:

- Check all paperwork for accuracy and completeness.
- Match the physical samples with the associated paperwork. The sampler will check for proper samples in the correct containers and that the field number on the samples corresponds with the numbers on the completed chains of custody.
- Verify that samples are properly stored and secure for transport.
- Clean and package all non-disposable equipment.
- Confirm the items on the sample tags, request forms, chain-of-custody record, and logbook match.
- Bag all disposable items to be discarded.
- Ensure that all sample containers are free of any debris.

To avoid cross contamination, sampling equipment (defined as any piece of equipment which may contact a sample) will be decontaminated, as described in Section 3.2.4.

3.2.3 Soil Sampling

The proposed soil sampling scope consists of the collection of 103 samples (with up to an additional 239 placed on laboratory “hold”) at 79 locations based on the following:

- RI sample locations on the “Western Parcel” with 2-foot sampling depth intervals exceeding the RSCOs.
- RI sample locations on the “Eastern Parcel” with 2-foot sampling depth intervals exceeding the UUSCOs.
- Vertical delineation of RI sample locations with 2-foot sampling depth intervals exceeding the UUSCOs for soils above bedrock, without a demonstrated clean sample at a deeper interval.
- Investigation of fill material associated with the screening sample IDs denoted as TS-##, and vertical delineation below the fill material.
- Horizontal delineation of RI sample location A04 containing PFAS concentrations exceeding the UUSCOs.
- Six boring locations requested by NYSDEC in the vicinity of former USTs, ASTs, and septic tank.

The proposed samples, depths, analytical parameters, and rationale are detailed in Table 2 and the proposed soil sampling locations are presented on Figure 4. The approximate locations of the USTs, ASTs, and septic tank and associated proposed soil sampling locations are presented on Figure 5.

The following procedures will be utilized to collect the soil samples at each location:

- Soil samples at sampling depths less than 2 feet will be collected via a hand auger. The hand auger will be advanced in 6-inch lifts at the designated sample depths and a sample(s) collected from each lift. The hand auger head will be swapped with a clean head between each lift and decontamination of all heads will be conducted in accordance with Section 3.5 at the completion of the sample location

- Soil samples at sampling depths greater than 2 feet will be collected on a nominal continuous basis by advancing a 4- to 5-foot-long, stainless-steel macrocore sampler with a direct-push drill rig from the surface to the targeted termination depth. Each macrocore sampler will be equipped with factory-decontaminated, plastic acetate liners.
- Soil borings will be inspected and classified in accordance with the Unified Soil Classification System. Soil borings will be field screened utilizing a PID equipped with a 10.6 electron volt lamp and by visual and olfactory inspection for the presence of impacts. A graphic log of each soil boring will be prepared with appropriate stratification lines, lithologic descriptions, sample identifications, PID readings, sample depth intervals, and dates.
- The soil samples will be collected from the designated 6-inch intervals in Table 2. If a VOC aliquot is to be collected it will be placed in En Core® samplers, per United States Environmental Protection Agency Method 5035A, and immediately placed on ice. The aliquot for the remaining analytical parameters will be homogenized and placed in a laboratory-provided glass sample jar and immediately placed on ice.
- One sample will be collected from each of the proposed sampling intervals. The shallowest sample at each location will be submitted to the laboratory for analysis, while the deeper samples will be placed on “hold” and a determination to analyze the sample will be made pending the results on the sample directly shallower.
- TS-##R soil borings will be advanced down to approximately 4 feet bgs at each location and are anticipated to be inclusive of the fill material (where present) and the underlying native soils. The samples from these borings will be collected from the designated intervals and run for the analytical parameters shown in Table 2, based on the results of the screening samples collected and detailed in Section 2.2.8. The samples collected from the 0-1 feet bgs (or associated fill material interval) and the 6-inch interval below the fill material will be submitted to the laboratory for analysis, while the deeper samples will be placed on “hold” and a determination to analyze the sample will be made pending the results on the sample directly shallower.
- The soil samples from the soil borings in the vicinity of the UST/AST and septic tank will be collected from the 6-inch interval exhibiting the highest PID reading and/or visual and olfactory indication of impacts (if present) in both a shallow and deeper interval. If impacts are not present, samples will be collected between 0-2 feet bgs and at a deeper interval pending total boring depth. The VOC aliquot will be placed in En Core® samplers, per United States Environmental Protection Agency Method 5035A, and immediately placed on ice. The aliquot for the remaining analytical parameters will be homogenized and placed in a laboratory-provided glass sample jar and immediately placed on ice. The number of samples collected at this location will be determined based on field screening.
- Samples for PFAS will be collected in accordance with the NYSDEC Part 375 Remedial Programs’ 2023 *Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS)* guidance document (NYSDEC 2023), which includes ensuring all materials which may come in contact with the soil to be sampled are compatible.
- Upon termination of each boring, the boring will be backfilled with Site soils to grade, restored with asphalt or equivalent, to match existing conditions.

- All non-disposable sampling equipment (defined as any piece of equipment which may contact a sample) will be decontaminated as outlined in Section 3.2.4 prior to advancing the next soil boring.

All analyses will be performed by an Environmental Laboratory Approval Program-certified laboratory for the parameter being analyzed. Results will be provided with NYS Analytical Services Protocol Category B deliverables and will be reviewed and validated by a third-party data validator who will prepare a DUSR before data is incorporated into the final RIR for the Site. Additional details regarding laboratory analyses are included in the QAPP (Appendix B). All data will be submitted to NYSDEC in electronic format in accordance with DER-10, Section 1.15.

Quality assurance/quality control samples, including field duplicates and field blanks, shall be collected pursuant to Table 1 and in accordance with the QAPP. Blind duplicates will be collected at a frequency of 1 per 20 samples. Field blanks will be collected at a frequency of once per day. A laboratory-prepared trip blank will be provided and analyzed alongside the field samples. Details regarding sampling methods and analyses are provided in the QAPP (Appendix C).

3.2.4 Decontamination Procedures

Sampling equipment will be decontaminated between boreholes for GeoProbe® and hand auger sampling, and between each sample for hand auger sampling, if needed, as using the following procedures:

- New disposable gloves will be used for each decontamination procedure to prevent cross-contamination of equipment.
- Equipment shall be scrubbed with brushes using a solution of Alconox™ and distilled water.
- Equipment shall then be triple rinsed with analyte-free distilled water.
- Sampling equipment that is not readily decontaminated shall be discarded after each use. Discarded decontamination solutions shall be accumulated and containerized in United States Department of Transportation 17H-rated drums or equivalent.

3.2.5 Investigation-Derived Waste Management

IDW is expected to be generated during the RI activities and will be managed in accordance with applicable federal, state, and local regulations. The anticipated IDW generated, and the management procedures, are outlined below:

- It is anticipated all soil boring cuttings will be utilized to backfill borings. Direct-push well installation methods generally do not generate waste. Excess soil boring cuttings not used to backfill borings will be collected into United States Department of Transportation -approved 55-gallon drums and temporarily staged on Site for off-site disposal at a permitted facility.
- Unless significantly soiled, personal protective equipment wastes will be disposed in the trash.

IDW procedures have been developed to minimize both the risk of exposure to contamination and the spread of contamination during field activities at the Site. All personnel who come into designated work areas, including contractors and observers, will be required to adhere strictly to the conditions imposed herein and to the provisions of the site-specific *Health and Safety Plan*, included as Appendix C.

3.2.6 Surveying Assessment

All soil sample locations completed as part of this soil-based supplemental RI will be surveyed by a New York Licensed Surveyor to obtain horizontal and vertical coordinates and grade elevations. Horizontal coordinates will be based upon the NYS Plane Coordinate System, Long Island Zone, North American Datum of 1983 in United States survey feet.[2] Vertical elevations will be measured for grade elevations referenced to North American Vertical Datum of 1988.[3]

3.2.7 Community Air Monitoring Plan

A CAMP will be implemented during any intrusive subsurface activities to conduct monitoring and protection for potential off-site receptors. The CAMP scope of work will include the use of one downwind and one upwind or work zone air monitoring station, each equipped with one PID and one particulate meter. Upwind concentrations will be measured at the start of each workday, and periodically throughout the day, to establish background concentrations. CAMP reports will be provided daily to NYSDEC and NYS Department of Health (NYSDOH) as part of the BCP daily reports. The CAMP reports will include a figure showing wind direction, work zones, locations of upwind and downwind CAMP monitors, and downloaded 15-minute CAMP averages. Any CAMP exceedances and corrective measures taken will be provided to NYSDEC and NYSNYSDOH within one business day. CAMP exceedances and corrective measures taken will be reported to NYSDEC and NYSDOH within a business day. CAMP data results will be included in the final RIR along with locations of monitoring stations, monitoring equipment, procedures, and contaminant action levels. The *New York State Department of Health Generic Community Air Monitoring Plan* is included as Appendix D.

3.2.8 Qualitative Exposure Assessment

The data collected during the supplemental RI will be incorporated into the qualitative human health exposure assessment to be performed following the collection of all RI data in accordance with Section 3.3(c)4 of DER-10 and NYSDOH guidance for performing a qualitative exposure assessment (DER-10, Appendix 3B [NYSDEC 2010]). The results of the qualitative exposure assessment will be provided in the final RIR. According to Section 3.10 of DER-10, and the “Fish and Wildlife Resources Impact Analysis Decision Key” in DER-10 Appendix 3C, a fish and wildlife exposure assessment is anticipated to be needed for this Site.

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[2] https://www.ngs.noaa.gov/datums/horizontal/north-american-datum-1983.shtml

[3] https://www.ngs.noaa.gov/datums/vertical/north-american-vertical-datum-1988.shtml

3.3 Green and Sustainable Remediation

Green and sustainable remediation (GSR) principles and techniques will be implemented to the extent feasible in the design, implementation, and site management of the remedial investigation as per "DER-31 / Green Remediation" (DER-31).

Best Management Practices (BMP), as defined by the U.S. Environmental Protection Agency, aim to reduce the environmental footprint of activities associated with assessing and remediating contaminated sites. The BMPs involve specific activities to address the core elements of greener cleanups as per DER-31, including (1) reduce total energy use and increase the percentage of energy from renewable resources, (2) reduce air pollutants and greenhouse gas emissions, (3) reduce water use and preserve water quality, (4) conserve material resources and reduce waste, and (5) protect land and ecosystem services.

- BMPs taken for the remedial investigation will include: Selecting service providers, product suppliers, and analytical laboratories from the local area;
- Identifying the nearest facility to be used for disposing of non-hazardous and/or hazardous waste;
- Reducing travel through increased teleconferencing;
- Integrating sources of on-site renewable energy to power hand-held devices, portable equipment, and stationery monitoring systems;
- Using non-invasive or minimally invasive technologies such as portable vapor/gas detection systems using photoionization for screening purposes.
- Choosing products, packing material, and equipment that have reuse or recycling potential;
- Minimizing the need for disposable single-use items, such as plastic bags; and
- Choosing fixed laboratories demonstrating a strong commitment to environmental performance, such as routine use of management practices identified by the International Institute for Sustainable Laboratories.

The following metrics have been identified to be tracked throughout the investigation to truth test assumptions and assess progress towards the GSR goals:

- Materials Management, including off-site disposal and on-site material import quantities;
- Greenhouse Gas Emissions and Air Pollutants; and
- Total Energy Use

The GSR techniques and principles implemented during the investigation activities, including BMPs and the tracking metrics, will be summarized in the RIR.

4 Reporting and Deliverables

Carson Voci and the Participant will commence implementation of this SRIWP-SI following receipt of NYSDEC's approval. Carson Voci will notify NYSDEC no less than 7 days in advance of SRIWP-SI implementation, unless NYSDEC provides written agreement to a shorter period. Carson Voci will also provide NYSDEC notice as to any change in the approved project schedule.

4.1 Daily Reports

Daily report submittals to be provided to NYSDEC and NYSDOH during intrusive activities during the RI field implementation will include the following:

- A summary of on-site work completed;
- Immediate notification to NYSDEC and NYSDOH (within 24 hours) of any CAMP exceedances and corrective actions taken;
- Prompt communication to NYDEC's project manager of any discovery of previously unknown contaminated media during RI activities; and
- Provision of a Site map to identify locations discussed in progress reports provided to NYSDEC.

The frequency of the reporting period may be revised in consultation with the NYSDEC Project Manager based on planned project tasks. As discussed in Section 3.2.7, CAMP reports will be provided daily to NYSDEC and NYSDOH as part of the daily reports. Daily email reports are not intended to be the mode of communication for notification to the NYSDEC of emergencies (accident, spill), requests for changes to the SRIWP-SI, or other sensitive or time critical information. However, such conditions will be included in the daily reports. Emergency conditions and changes to the SRIWP-SI will be addressed directly to NYSDEC Project Manager via personal communication.

4.2 Monthly Reports

Monthly reports will be submitted to NYSDEC and NYSDOH project managers during intrusive activities only. Monthly reports will be submitted within 1 week following the end of the month of the reporting period and will include:

- Activities relative to the Site during the previous reporting period and those anticipated for the next reporting period, including a quantitative presentation of work performed (i.e., tons of material exported and imported, etc.);
- Description of approved activity modifications, including changes to scope of work and/or schedule;
- Sampling results received following internal data review and validation, as applicable; and
- An update of the remedial schedule, including the percentage of project completion, unresolved delays encountered or anticipated that may affect the future schedule, and efforts made to mitigate such delays.

4.3 Remedial Investigation Report and Remedial Action Work Plan

A RIR will be prepared to summarize the results and findings of the completed RI, inclusive of any supplemental RIs. The RIR will include all data developed during the RI, summarize the results of the RI, and outline the recommended remedial actions along with Site management procedures based on the findings of the RI. The RIR will also summarize the actions taken to implement the RIWP, include a detailed synopsis of all RIWP work performed, figures depicting the layout of the Site with sampling locations, figures presenting the analytical results and analyses performed, soil boring logs, monitoring well installation logs, tables presenting all laboratory data results, soil-vapor screening level comparison, laboratory data packages, DUSRs, and sampling field forms.

Following completion of the RIR, a RAWP will be prepared to determine the favorable remedial technologies to demonstrate and achieve the appropriate attainment goals for each media impacted at the Site. The RAWP may be submitted with the RIR.

5 Schedule

The estimated project schedule is presented in the table below:

Remedial Task	Estimated Implementation Timeframe
Submittal of SRIWP-SI	December 11, 2024
NYSDEC/NYSDOH Review of SRIWP-SI	December 11, 2024 – January 31, 2024
Approval and Implementation of SRIWP-SI	February 2025
Submittal of RIR/RAWP	May 2025
Approval of RIR	June 2025
RAWP Public Comment Period	June 2025 – July 2025
Begin Implementation of RAWP	August 2025
Submit Draft Final Engineering Report	June 2026
Issuance of Certificate of Completion	December 2026

6 References

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Tables

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	A04	A4_0-0.2	0-0.2					X	X	X
		A4_0.2-2	0.2-2	X	X	X	X	X	X	X
		A4_2-4	2-4					X		X
Western Parcel	A05	A5_0-0.2	0-0.2					X	X	X
		A5_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	A06	A6_0-0.2	0-0.2					X	X	X
		A6_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	A07	A7_0-0.2	0-0.2					X	X	X
		A7_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	A08	A8_0-0.2	0-0.2					X	X	X
		A8_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	A09	A9_0-0.2	0-0.2					X	X	X
		A9_0.2-2	0.2-2	X	X	X	X	X	X	X
		A9_2-4	2-4					X		X
Western Parcel	A10	A10_0-0.2	0-0.2					X	X	X
		A10_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	A11	A11_0-0.2	0-0.2					X	X	X
		A11_0.2-2	0.2-2	X	X	X		X	X	X
		A11_2-4	2-4					X		X
		A11_4-6	4-6					X		
Western Parcel	A12	A12_0-0.2	0-0.2					X	X	X
		A12_0.2-2	0.2-2	X	X	X		X	X	X
		A12_2-4	2-4							X
		A12_4-6	4-6							X
Western Parcel	A13	A13_0-0.2	0-0.2					X	X	X
		A13_0.2-2	0.2-2	X	X	X	X	X	X	X
		A13_2-4	2-4					X		X
		A13_4-6	4-6					X		X
		A13_7-9	7-9	X	X	X	X	X	X	X
Western Parcel	B04	B4_0-0.2	0-0.2					X	X	X
		B4_0.2-2	0.2-2	X	X	X		X	X	X
		B4_2-4	2-4					X		
		B4_4-6	4-6					X		
Western Parcel	B05	B5_0-0.2	0-0.2					X	X	X
		B5_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	B06	B6_0-0.2	0-0.2					X	X	X
		B6_0.2-2	0.2-2	X	X	X		X	X	X

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	B07	B7_0-0.2	0-0.2					X	X	X
		B7_0.2-2	0.2-2	X	X	X		X	X	X
		B7_2-4	2-4					X		X
Western Parcel	B08	B8_0-0.2	0-0.2					X	X	X
		B8_0.2-2	0.2-2	X	X	X		X	X	X
		B8_2-4	2-4					X		X
		B8_4-6	4-6							X
Western Parcel	B09	B9_0-0.2	0-0.2					X	X	X
		B9_0.2-2	0.2-2	X	X	X		X	X	X
		B9_2-4	2-4					X		
Western Parcel	B10	B10_0-0.2	0-0.2					X	X	X
		B10_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	B11	B11_0-0.2	0-0.2					X	X	X
		B11_0.2-2	0.2-2	X	X	X		X	X	X
		B11_2-4	2-4					X		X
Western Parcel	B12	B12_0-0.2	0-0.2					X	X	X
		B12_0.2-2	0.2-2	X	X	X		X	X	X
		B12_2-4	2-4					X		
		B12_4-6	4-6					X		
Western Parcel	B13	B13_0-0.2	0-0.2					X	X	X
		B13_0.2-2	0.2-2	X	X	X		X	X	X
		B13_2-4	2-4					X		X
Western Parcel	C03	C3_0-0.2	0-0.2					X	X	X
		C3_0.2-2	0.2-2	X	X	X		X	X	X
		C3_2-4	2-4					X		X
		C3_4-6	4-6					X		
Western Parcel	C04	C4_0-0.2	0-0.2					X	X	X
		C4_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	C05	C5_0-0.2	0-0.2					X	X	X
		C5_0.2-2	0.2-2	X	X	X	X	X	X	X
		C5_2-4	2-4							X
Western Parcel	C06	C6_0-0.2	0-0.2					X	X	X
		C6_0.2-2	0.2-2	X	X	X		X	X	X
		C6_2-4	2-4					X		
Western Parcel	C07	C7_0-0.2	0-0.2					X	X	X
		C7_0.2-2	0.2-2	X	X	X		X	X	X
		C7_2-4	2-4					X		

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	C08	C8_0-0.2	0-0.2					X	X	X
		C8_0.2-2	0.2-2	X	X	X		X	X	X
		C8_2-4	2-4					X		
Western Parcel	C09	C9_0-0.2	0-0.2					X	X	X
		C9_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	C10	C10_0-0.2	0-0.2					X	X	X
		C10_0.2-2	0.2-2	X	X	X		X	X	X
		C10_2-4	2-4					X		X
		C10_4-6	4-6					X		
Western Parcel	C11	C11_0-0.2	0-0.2					X	X	X
		C11_0.2-2	0.2-2	X	X	X		X	X	X
		C11_2-4	2-4					X		X
		C11_4-6	4-6					X		X
Western Parcel	C12	C12_0-0.2	0-0.2					X	X	X
		C12_0.2-2	0.2-2	X	X	X	X	X	X	X
Western Parcel	C13	C13_0-0.2	0-0.2					X	X	X
		C13_0.2-2	0.2-2	X	X	X	X	X	X	X
		C13_11-13	11-13	X	X	X	X	X	X	X
Western Parcel	D03	D3_0-0.2	0-0.2					X	X	X
		D3_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	D04	D4_0-0.2	0-0.2					X	X	X
		D4_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	D05	D5_0-0.2	0-0.2					X	X	X
		D5_0.2-2	0.2-2	X	X	X		X	X	X
		D5_2-4	2-4					X		
Western Parcel	D06	D6_0-0.2	0-0.2					X	X	X
		D6_0.2-2	0.2-2	X	X	X		X	X	X
		D6_2-4	2-4					X		
Western Parcel	D07	D7_0-0.2	0-0.2					X	X	X
		D7_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	D08	D8_0-0.2	0-0.2					X	X	X
		D8_0.2-2	0.2-2	X	X	X		X	X	X
		D8_2-4	2-4					X		
Western Parcel	D09	D9_0-0.2	0-0.2					X	X	X
		D9_0.2-2	0.2-2	X	X	X		X	X	X

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	D10	D10_0-0.2	0-0.2					X	X	X
		D10_0.2-2	0.2-2	X	X	X		X	X	X
		D10_2-4	2-4					X		X
Western Parcel	D11	D11_0-0.2	0-0.2					X	X	X
		D11_0.2-2	0.2-2	X	X	X		X	X	X
		D11_2-4	2-4					X		X
Western Parcel	D12	D12_0-0.2	0-0.2					X	X	X
		D12_0.2-2	0.2-2	X	X	X		X	X	X
		D12_2-4	2-4					X		X
		D12_4-6	4-6					X		
Western Parcel	D13	D13_0-0.2	0-0.2					X	X	X
		D13_0.2-2	0.2-2	X	X	X		X	X	X
		D13_2-4	2-4					X		X
Western Parcel	E03	E3_0-0.2	0-0.2					X	X	X
		E3_0.2-2	0.2-2	X	X	X		X	X	X
		E3_2-4	2-4					X		X
		E3_4-6	4-6							X
Western Parcel	E04	E4_0-0.2	0-0.2					X	X	X
		E4_0.2-2	0.2-2	X	X	X		X	X	X
		E4_2-4	2-4					X		
Western Parcel	E05	E5_0-0.2	0-0.2					X	X	X
		E5_0.2-2	0.2-2	X	X	X	X	X	X	X
Western Parcel	E06	E6_0-0.2	0-0.2					X	X	X
		E6_0.2-2	0.2-2	X	X	X		X	X	X
		E6_2-4	2-4					X		X
		E6_4-6	4-6							X
Western Parcel	E07	E7_0-0.2	0-0.2					X	X	X
		E7_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	E08	E8_0-0.2	0-0.2					X	X	X
		E8_0.2-2	0.2-2	X	X	X	X	X	X	X
		E8_2-4	2-4							X
Western Parcel	E09	E9_0-0.2	0-0.2					X	X	X
		E9_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	E10	E10_0-0.2	0-0.2					X	X	X
		E10_0.2-2	0.2-2	X	X	X		X	X	X
		E10_2-4	2-4					X		X
		E10_4-6	4-6					X		

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	E11	E11_0-0.2	0-0.2					X	X	X
		E11_0.2-2	0.2-2	X	X	X		X	X	X
		E11_2-4	2-4					X		
Western Parcel	E12	E12_0-0.2	0-0.2					X	X	X
		E12_0.2-2	0.2-2	X	X	X		X	X	X
		E12_2-4	2-4					X		X
Western Parcel	E13	E13_0-0.2	0-0.2					X	X	X
		E13_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	F02	F2_0-0.2	0-0.2					X	X	X
		F2_0.2-2	0.2-2	X	X	X		X	X	X
		F2_2-4	2-4							X
Western Parcel	F03	F3_0-0.2	0-0.2					X	X	X
		F3_0.2-2	0.2-2	X	X	X		X	X	X
		F3_2-4	2-4					X		
		F3_4-6	4-6					X		
Western Parcel	F04	F4_0-0.2	0-0.2					X	X	X
		F4_0.2-2	0.2-2	X	X	X		X	X	X
		F4_2-4	2-4					X		
Western Parcel	F05	F5_0-0.2	0-0.2					X	X	X
		F5_0.2-2	0.2-2	X	X	X		X	X	X
		F5_2-4	2-4					X		
Western Parcel	F06	F6_0-0.2	0-0.2					X	X	X
		F6_0.2-2	0.2-2	X	X	X		X	X	X
		F6_2-4	2-4					X		
Western Parcel	F07	F7_0-0.2	0-0.2					X	X	X
		F7_0.2-2	0.2-2	X	X	X		X	X	X
		F7_2-4	2-4					X		X
Western Parcel	F08	F8_0-0.2	0-0.2					X	X	X
		F8_0.2-2	0.2-2	X	X	X		X	X	X
		F8_2-4	2-4					X		X
Western Parcel	F09	F9_0-0.2	0-0.2					X	X	X
		F9_0.2-2	0.2-2	X	X	X		X	X	X
		F9_2-4	2-4					X		
Western Parcel	F10	F10_0-0.2	0-0.2					X	X	X
		F10_0.2-2	0.2-2	X	X	X		X	X	X
		F10_2-4	2-4					X		X

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	F11	F11_0-0.2	0-0.2					X	X	X
		F11_0.2-2	0.2-2	X	X	X		X	X	X
		F11_2-4	2-4					X		X
Western Parcel	F12	F12_0-0.2	0-0.2					X	X	X
		F12_0.2-2	0.2-2	X	X	X		X	X	X
		F12_2-4	2-4					X		
Western Parcel	G01	G1_0-0.2	0-0.2					X	X	X
		G1_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	G02	G2_0-0.2	0-0.2					X	X	X
		G2_0.2-2	0.2-2	X	X	X		X	X	X
		G2_2-4	2-4							X
		G2_4-6	4-6							X
Western Parcel	G03	G3_0-0.2	0-0.2					X	X	X
		G3_0.2-2	0.2-2	X	X	X		X	X	X
		G3_2-4	2-4					X		
		G3_4-6	4-6					X		
Western Parcel	G04	G4_0-0.2	0-0.2					X	X	X
		G4_0.2-2	0.2-2	X	X	X		X	X	X
		G4_2-4	2-4					X		X
		G4_4-6	4-6					X		X
Western Parcel	G05	G5_0-0.2	0-0.2					X	X	X
		G5_0.2-2	0.2-2	X	X	X	X	X	X	X
		G5_13-15	13-15	X	X	X	X	X	X	X
Western Parcel	G06	G6_0-0.2	0-0.2					X	X	X
		G6_0.2-2	0.2-2	X	X	X		X	X	X
		G6_2-4	2-4					X		X
Western Parcel	G07	G7_0-0.2	0-0.2					X	X	X
		G7_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	G08	G8_0-0.2	0-0.2					X	X	X
		G8_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	G09	G9_0-0.2	0-0.2					X	X	X
		G9_0.2-2	0.2-2	X	X			X	X	X
Western Parcel	G10	G10_0-0.2	0-0.2					X	X	X
		G10_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	G11	G11_0-0.2	0-0.2					X	X	X
		G11_0.2-2	0.2-2	X	X	X		X	X	X

Table 1
Remedial Investigation Soil Sample Locations
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	G12	G12_0-0.2	0-0.2					X	X	X
		G12_0.2-2	0.2-2	X	X	X	X	X	X	X
		G12_2-4	2-4					X		
		G12_9-11	9-11	X	X	X	X	X	X	X
Western Parcel	H01	H1_0-0.2	0-0.2					X	X	X
		H1_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	H02	H2_0-0.2	0-0.2					X	X	X
		H2_0.2-2	0.2-2	X	X	X		X	X	X
		H2_2-4	2-4					X		X
Western Parcel	H03	H3_0-0.2	0-0.2					X	X	X
		H3_0.2-2	0.2-2	X	X	X		X	X	X
		H3_2-4	2-4							X
Western Parcel	H04	H4_0-0.2	0-0.2					X	X	X
		H4_0.2-2	0.2-2	X	X	X		X	X	X
		H4_2-4	2-4					X		X
Western Parcel	H05	H5_0-0.2	0-0.2					X	X	X
		H5_0.2-2	0.2-2	X	X	X		X	X	X
		H5_2-4	2-4					X		X
Western Parcel	H06	H6_0-0.2	0-0.2					X	X	X
		H6_0.2-2	0.2-2	X	X	X		X	X	X
		H6_2-4	2-4					X		
Western Parcel	H07	H7_0-0.2	0-0.2					X	X	X
		H7_0.2-2	0.2-2	X	X	X		X	X	X
		H7_2-4	2-4					X		
Western Parcel	H08	H8_0-0.2	0-0.2					X	X	X
		H8_0.2-2	0.2-2	X	X	X		X	X	X
		H8_2-4	2-4					X		
Western Parcel	H09	H9_0-0.2	0-0.2					X	X	X
		H9_0.2-2	0.2-2	X	X	X		X	X	X
		H9_2-4	2-4					X		X
		H9_4-6	4-6					X		X
Western Parcel	H10	H10_0-0.2	0-0.2					X	X	X
		H10_0.2-2	0.2-2	X	X	X		X	X	X
		H10_2-4	2-4					X		
Western Parcel	H11	H11_0-0.2	0-0.2					X	X	X
		H11_0.2-2	0.2-2	X	X	X		X	X	X
		H11_2-4	2-4					X		X

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	I01	I1_0-0.2	0-0.2					X	X	X
		I1_0.2-2	0.2-2	X	X	X	X	X	X	X
		I1_2-4	2-4					X		
Western Parcel	I02	I2_0-0.2	0-0.2					X	X	X
		I2_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	I03	I3_0-0.2	0-0.2					X	X	X
		I3_0.2-2	0.2-2	X	X	X		X	X	X
		I3_2-4	2-4					X		
Western Parcel	I04	I4_0-0.2	0-0.2					X	X	X
		I4_0.2-2	0.2-2	X	X	X		X	X	X
		I4_2-4	2-4					X		X
Western Parcel	I05	I5_0-0.2	0-0.2					X	X	X
		I5_0.2-2	0.2-2	X	X	X		X	X	X
		I5_2-4	2-4							X
Western Parcel	I06	I6_0-0.2	0-0.2					X	X	X
		I6_0.2-2	0.2-2	X	X	X		X	X	X
		I6_2-4	2-4					X		
Western Parcel	I07	I7_0-0.2	0-0.2					X	X	X
		I7_0.2-2	0.2-2	X	X	X		X	X	X
		I7_2-4	2-4							X
Western Parcel	I08	I8_0-0.2	0-0.2					X	X	X
		I8_0.2-2	0.2-2	X	X	X	X	X	X	X
		I8_2-4	2-4					X		X
		I8_6-8	6-8	X	X	X	X	X	X	X
Western Parcel	I09	I9_0-0.2	0-0.2					X	X	X
		I9_0.2-2	0.2-2	X	X	X		X	X	X
		I9_2-4	2-4					X		X
Western Parcel	I10	I10_0-0.2	0-0.2					X	X	X
		I10_0.2-2	0.2-2	X	X	X		X	X	X
		I10_2-4	2-4					X		X
Western Parcel	I11	I11_0-0.2	0-0.2					X	X	X
		I11_0.2-2	0.2-2	X	X	X		X	X	X
Western Parcel	TS-01	TS-01_0-1	0-1	X	X	X		X		X
Western Parcel	TS-02	TS-02_0-1	0-1	X	X	X		X		X
Western Parcel	TS-03	TS-03_0-1	0-1	X	X			X		X
Western Parcel	TS-04	TS-04_0-1	0-1	X	X			X		X
Western Parcel	TS-05	TS-05_0-1	0-1	X	X	X		X		X

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Western Parcel	TS-06	TS-06_0-1	0-1	X	X			X		X
Western Parcel	TS-07	TS-07_0-1	0-1	X	X	X		X		X
Western Parcel	TS-08	TS-08_0-1	0-1	X	X	X		X		X
Western Parcel	TS-09	TS-09_0-1	0-1	X	X	X		X		X
Western Parcel	TS-10	TS-10_0-1	0-1	X	X	X		X		X
Western Parcel	TS-11	TS-11_0-1	0-1	X	X	X		X		X
Western Parcel	TS-12	TS-12_0-1	0-1	X	X	X		X		X
Western Parcel	TS-13	TS-13_0-1	0-1	X	X	X		X		X
Western Parcel	TS-14	TS-14_0-1	0-1	X	X			X		X
Western Parcel	TS-15	TS-15_0-1	0-1	X	X			X		X
Eastern Parcel	C14	C14_0-0.2	0-0.2					X	X	X
		C14_0.2-2	0.2-2	X	X	X		X	X	X
Eastern Parcel	D14	D14_0-0.2	0-0.2					X	X	X
		D14_0.2-2	0.2-2	X	X	X		X	X	X
		D14_2-4	2-4					X		
Eastern Parcel	E14	E14_0-0.2	0-0.2					X	X	X
		E14_0.2-2	0.2-2	X	X	X		X	X	X
Eastern Parcel	F13	F13_0-0.2	0-0.2					X	X	X
		F13_0.2-2	0.2-2	X	X	X		X	X	X
		F13_2-4	2-4					X		
		F13_4-6	4-6					X		
Eastern Parcel	F14	F14_0-0.2	0-0.2					X	X	X
		F14_0.2-2	0.2-2	X	X	X		X	X	X
Eastern Parcel	F15	F15_0-0.2	0-0.2					X	X	X
		F15_0.2-2	0.2-2	X	X	X		X	X	X
		F15_2-4	2-4					X		
Eastern Parcel	G13	G13_0-0.2	0-0.2					X	X	X
		G13_0.2-2	0.2-2	X	X	X		X	X	X
Eastern Parcel	G14	G14_0-0.2	0-0.2					X	X	X
		G14_0.2-2	0.2-2	X	X	X		X	X	X
Eastern Parcel	G15	G15_0-0.2	0-0.2					X	X	X
		G15_0.2-2	0.2-2	X	X	X		X	X	X
		G15_2-4	2-4							X
Eastern Parcel	H12	H12_0-0.2	0-0.2					X	X	X
		H12_0.2-2	0.2-2	X	X	X		X	X	X
		H12_2-4	2-4							X

Table 1

Remedial Investigation Soil Sample Locations

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses						
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**Pesticides**	**Herbicides**	**Metals**
Eastern Parcel	H13	H13_0-0.2	0-0.2					X	X	X
		H13_0.2-2	0.2-2	X	X	X		X	X	X
		H13_2-4	2-4					X		X
Eastern Parcel	H14	H14_0-0.2	0-0.2					X	X	X
		H14_0.2-2	0.2-2	X	X	X		X	X	X
		H14_2-4	2-4					X		
Eastern Parcel	H15	H15_0-0.2	0-0.2					X	X	X
		H15_0.2-2	0.2-2	X	X	X		X	X	X
Eastern Parcel	I12	I12_0-0.2	0-0.2					X	X	X
		I12_0.2-2	0.2-2	X	X	X		X	X	X
		I12_2-4	2-4					X		X
Eastern Parcel	I13	I13_0-0.2	0-0.2					X	X	X
		I13_0.2-2	0.2-2	X	X	X		X	X	X
		I13_2-4	2-4					X		X
Eastern Parcel	I14	I14_0-0.2	0-0.2					X	X	X
		I14_0.2-2	0.2-2	X	X	X		X	X	X
		I14_2-4	2-4					X		
Eastern Parcel	I15	I15_0-0.2	0-0.2					X	X	X
		I15_0.2-2	0.2-2	X	X	X	X	X	X	X
		I15_6-8	6-8	X	X	X	X	X	X	X

Abbreviations:

X - lab analysis run

PCB - polychlorinated biphenyls

PFAS - per- and polyfluoroalkyl substances

SVOC - semi-volatile organic compounds

VOC - volatile organic compounds

Table 2
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Western Parcel	A04R	A04R-0.5-1	0.5-1								X				X			Vertical Refinement - RSCOs Exceedance
		A04R-1-1.5	1-1.5								H				H			
		A04R-1.5-2	1.5-2								H				H			
		A04R-2-4	2-4				X											Vertical Delineation - UUSCOs
		A04R-4-6	4-6				H											
Western Parcel	A05R	A05R-0.2-2	0.2-2				X											Horizontal Delineation - UUSCOs Exceedance
		A05R-2-4	2-4				H											
		A05R-4-6	4-6				H											
Western Parcel	A11R	A11R-0.5-1	0.5-1								X				X			Vertical Refinement - RSCOs Exceedance
		A11R-1-1.5	1-1.5								H				H			
		A11R-1.5-2	1.5-2								H				H			
Western Parcel	A13R	A13R-2-2.5	2-2.5					X							X			Vertical Refinement - RSCOs Exceedance
		A13R-2.5-3	2.5-3					H							H			
		A13R-3-3.5	3-3.5					H							H			
		A13R-3.5-4	3.5-4					H							H			
Western Parcel	B04R	B04R-0.2-2	0.2-2				X											Horizontal Delineation - UUSCOs Exceedance
		B04R-2-4	2-4				H											
		B04R-4-6	4-6				H											
Western Parcel	B05R	B05R-0.2-2	0.2-2				X											Horizontal Delineation - UUSCOs Exceedance
		B05R-2-4	2-4				H											
		B05R-4-6	4-6				H											
Western Parcel	B08R	B08R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		B08R-1-1.5	1-1.5								H							
		B08R-1.5-2	1.5-2								H							
		B08R-6-8	6-8										X					Vertical Delineation - UUSCOs
		B08R-8-10	8-10										H					
Western Parcel	B12R	B12R-6-8	6-8					X										Vertical Delineation - UUSCOs
		B12R-8-10	8-10					H										
Western Parcel	B13R	B13R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		B13R-1-1.5	1-1.5												H			
		B13R-1.5-2	1.5-2												H			
Western Parcel	C03R	C03R-0.5-1	0.5-1					X										Vertical Refinement - RSCOs Exceedance
		C03R-1-1.5	1-1.5					H										
		C03R-1.5-2	1.5-2					H										
Western Parcel	C10R	C10R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		C10R-1-1.5	1-1.5					H			H							
		C10R-1.5-2	1.5-2					H			H							
Western Parcel	C11R	C11R-0.5-1	0.5-1								X				X			Vertical Refinement - RSCOs Exceedance
		C11R-1-1.5	1-1.5								H				H			
		C11R-1.5-2	1.5-2								H				H			
		C11R-6-8	6-8												X			Vertical Delineation - UUSCOs
		C11R-8-10	8-10												H			
Western Parcel	D04R	D04R-2-4	2-4									X						Vertical Delineation - UUSCOs
		D04R-4-6	4-6									H						
Western Parcel	D11R	D11R-0.5-1	0.5-1					X			X	X			X			Vertical Refinement - RSCOs Exceedance
		D11R-1-1.5	1-1.5					H			H	H			H			
		D11R-1.5-2	1.5-2					H			H	H			H			
Western Parcel	D13R	D13R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		D13R-1-1.5	1-1.5								H							
		D13R-1.5-2	1.5-2								H							

Table 2
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Eastern Parcel	D14R	D14R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		D14R-1-1.5	1-1.5					H										
		D14R-1.5-2	1.5-2					H										
Western Parcel	E03R	E03R-0.5-1	0.5-1					X							X			Vertical Refinement - RSCOs Exceedance
		E03R-1-1.5	1-1.5					H							H			
		E03R-1.5-2	1.5-2					H							H			
Western Parcel	E06R	E06R-0.5-1	0.5-1					X			X				X			Vertical Refinement - RSCOs Exceedance
		E06R-1-1.5	1-1.5					H			H				H			
		E06R-1.5-2	1.5-2					H			H				H			
Western Parcel	E07R	E07R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		E07R-1-1.5	1-1.5					H			H							
		E07R-1.5-2	1.5-2					H			H							
		E07R-2-4	2-4					H			H				X			Vertical Delineation - UUSCOs (if needed)
Western Parcel	E08R	E08R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		E08R-1-1.5	1-1.5								H							
		E08R-1.5-2	1.5-2								H							
Western Parcel	E12R	E12R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		E12R-1-1.5	1-1.5								H							
		E12R-1.5-2	1.5-2								H							
Western Parcel	F02R	F02R-0.5-1	0.5-1		X	X												Vertical Refinement - RSCOs Exceedance
		F02R-1-1.5	1-1.5		H	H												
		F02R-1.5-2	1.5-2		H	H												
		F02R-2-2.5	2-2.5		H	H												Vertical Delineation - RSCOs (if needed)
		F02R-2.5-3	2.5-3		H	H												
		F02R-3-3.5	3-3.5		H	H												
		F02R-3.5-4	3.5-4		H	H												
Western Parcel	F03R	F03R-6-8	6-8					X										Vertical Delineation - UUSCOs
		F03R-8-10	8-10					H										
Western Parcel	F07R	F07R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		F07R-1-1.5	1-1.5								H							
		F07R-1.5-2	1.5-2								H							
Western Parcel	F08R	F08R-0.5-1	0.5-1					X			X	X						Vertical Refinement - RSCOs Exceedance
		F08R-1-1.5	1-1.5					H			H	H						
		F08R-1.5-2	1.5-2					H			H	H						
Western Parcel	F10R	F10R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		F10R-1-1.5	1-1.5					H			H							
		F10R-1.5-2	1.5-2					H			H							
Western Parcel	F11R	F11R-0.5-1	0.5-1					X			X	X			X			Vertical Refinement - RSCOs Exceedance
		F11R-1-1.5	1-1.5					H			H	H			H			
		F11R-1.5-2	1.5-2					H			H	H			H			
Eastern Parcel	F13R	F13R-0.5-1	0.5-1					X										Vertical Refinement/Delineation - UUSCOs Exceedance - Resample for Pesticides
		F13R-1-1.5	1-1.5					H										
		F13R-1.5-2	1.5-2					H										
		F13R-2-2.5	2-2.5					H										
		F13R-2.5-3	2.5-3					H										
		F13R-3-3.5	3-3.5					H										
		F13R-3.5-4	3.5-4					H										
		F13R-2-4	2-4					X										
		F13R-4-4.5	4-4.5					H										
		F13R-4.5-5	4.5-5					H										
		F13R-5-5.5	5-5.5					H										
		F13R-5.5-6	5.5-6					H										
		F13R-4-6	4-6					X										
		F13R-6-8	6-8					H										
		F13R-8-10	8-10					H										

Table 2
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses														
											Individual Metal Analyses[1]							
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**TCL Pesticides**	**TCL Herbicides**	**TAL Metals + Hex Chrome**	**Arsenic**	**Total + Hex Chrome**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**Sampling Rationale**
Eastern Parcel	F15R	F15R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		F15R-1-1.5	1-1.5					H										
		F15R-1.5-2	1.5-2					H										
Western Parcel	G02R	G02R-6-8	6-8													X		Vertical Delineation - UUSCOs
		G02R-8-10	8-10													H		
Western Parcel	G03R	G03R-6-8	6-8					X										Vertical Delineation - UUSCOs
		G03R-8-10	8-10					H										
Western Parcel	G04R	G04R-2-2.5	2-2.5												X			Vertical Refinement - RSCOs Exceedance
		G04R-2.5-3	2.5-3												H			
		G04R-3-3.5	3-3.5												H			
		G04R-3.5-4	3.5-4												H			
		G04R-6-8	6-8					X							X			Vertical Delineation - UUSCOs
		G04R-8-10	8-10					H							H			
Western Parcel	G06R	G06R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		G06R-1-1.5	1-1.5												H			
		G06R-1.5-2	1.5-2												H			
Western Parcel	G07R	G07R-2-4	2-4					X										Vertical Delineation - UUSCOs
		G07R-4-6	4-6					H										
Western Parcel	G08R	G08R-2-4	2-4					X				X						Vertical Delineation - UUSCOs
		G08R-4-6	4-6					H				H						
Western Parcel	G09R	G09R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		G09R-1-1.5	1-1.5					H			H							
		G09R-1.5-2	1.5-2					H			H							
		G09R-2-2.5	2-2.5					H			H							Vertical Delineation - RSCOs (if needed)
		G09R-2.5-3	2.5-3					H			H							
		G09R-3-3.5	3-3.5					H			H							
		G09R-3.5-4	3.5-4					H			H							
		G09R-2-4	2-4					H			H				X			Vertical Delineation - UUSCOs
		G09R-4-6	4-6					H			H				H			
Western Parcel	G10R	G10R-2-4	2-4					X										Vertical Delineation - UUSCOs
		G10R-4-6	4-6					H										
Western Parcel	G11R	G11R-2-4	2-4					X										Vertical Delineation - UUSCOs
		G11R-4-6	4-6					H										
Eastern Parcel	G15R	G15R-0.5-1	0.5-1												X			Vertical Refinement - UUSCOs Exceedance
		G15R-1-1.5	1-1.5												H			
		G15R-1.5-2	1.5-2												H			
Western Parcel	H01R	H01R-2-4	2-4					X										Vertical Delineation - UUSCOs
		H01R-4-6	4-6					H										
Western Parcel	H02R	H02R-4-6	4-6														X	Vertical Delineation - UUSCOs
		H02R-6-8	6-8														H	
Western Parcel	H03R	H03R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		H03R-1-1.5	1-1.5								H							
		H03R-1.5-2	1.5-2								H							
Western Parcel	H04R	H04R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		H04R-1-1.5	1-1.5												H			
		H04R-1.5-2	1.5-2												H			
		H04R-4-6	4-6													X	X	Vertical Delineation - UUSCOs
		H04R-6-8	6-8													H	H	
Western Parcel	H05R	H05R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		H05R-1-1.5	1-1.5								H							
		H05R-1.5-2	1.5-2								H							

Table 2

Proposed Supplemental Soil Sampling Plan

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Western Parcel	H06R	H06R-0.5-1	0.5-1					X										Vertical Refinement - RSCOs Exceedance
		H06R-1-1.5	1-1.5					H										
		H06R-1.5-2	1.5-2					H										
		H06R-4-6	4-6					X										Vertical Delineation - UUSCOs
		H06R-6-8	6-8					H										
Western Parcel	H08R	H08R-4-6	4-6					X										Vertical Delineation - UUSCOs
		H08R-6-8	6-8					H										
Western Parcel	H09R	H09R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		H09R-1-1.5	1-1.5												H			
		H09R-1.5-2	1.5-2												H			
		H09R-6-8	6-8					X										Vertical Delineation - UUSCOs
		H09R-8-10	8-10					H										
Eastern Parcel	H12R	H12R-0.5-1	0.5-1												X			Vertical Refinement - UUSCOs Exceedance
		H12R-1-1.5	1-1.5												H			
		H12R-1.5-2	1.5-2												H			
Eastern Parcel	H13R	H13R-0.5-1	0.5-1					X			X	X		X	X			Vertical Refinement - UUSCOs Exceedance
		H13R-1-1.5	1-1.5					H			H	H		H	H			
		H13R-1.5-2	1.5-2					H			H	H		H	H			
Eastern Parcel	H14R	H14R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		H14R-1-1.5	1-1.5					H										
		H14R-1.5-2	1.5-2					H										
Western Parcel	I01R	I01R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I01R-6-8	6-8					H										
Western Parcel	I04R	I04R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		I04R-1-1.5	1-1.5					H			H							
		I04R-1.5-2	1.5-2					H			H							
		I04R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I04R-6-8	6-8					H										
Western Parcel	I06R	I06R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I06R-6-8	6-8					H										
Western Parcel	I09R	I09R-0.5-1	0.5-1					X			X				X			Vertical Refinement - RSCOs Exceedance
		I09R-1-1.5	1-1.5					H			H				H			
		I09R-1.5-2	1.5-2					H			H				H			
		I09R-2-2.5	2-2.5					H										
		I09R-2.5-3	2.5-3					H										
		I09R-3-3.5	3-3.5					H										
		I09R-3.5-4	3.5-4					H										
		I09R-2-4	2-4					X										Vertical Delineation - UUSCOs Exceedance
		I09R-4-6	4-6					H							X			
		I09R-6-8	6-8					H							H			
Western Parcel	I10R	I10R-0.5-1	0.5-1					X			X	X						Vertical Refinement - RSCOs Exceedance
		I10R-1-1.5	1-1.5					H			H	H						
		I10R-1.5-2	1.5-2					H			H	H						
		I10R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I10R-6-8	6-8					H										

Table 2

Proposed Supplemental Soil Sampling Plan

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses														
											Individual Metal Analyses[1]							
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**TCL Pesticides**	**TCL Herbicides**	**TAL Metals + Hex Chrome**	**Arsenic**	**Total + Hex Chrome**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**Sampling Rationale**
Eastern Parcel	I12R	I12R-0.5-1	0.5-1					X			X	X		X	X			Vertical Refinement - UUSCOs Exceedance
		I12R-1-1.5	1-1.5					H			H	H		H	H			
		I12R-1.5-2	1.5-2					H			H	H		H	H			
		I12R-2-2.5	2-2.5					H										
		I12R-2.5-3	2.5-3					H										
		I12R-3-3.5	3-3.5					H										
		I12R-3.5-4	3.5-4					H										
		I12R-2-4	2-4					H										Vertical Delineation - UUSCOs
		I12R-4-6	4-6					H										
		I12R-6-8	6-8					H										
Eastern Parcel	I13R	I13R-0.5-1	0.5-1					X			X	X		X	X			Vertical Refinement - UUSCOs Exceedance
		I13R-1-1.5	1-1.5					H			H	H		H	H			
		I13R-1.5-2	1.5-2					H			H	H		H	H			
		I13R-2-2.5	2-2.5									H				X		
		I13R-2.5-3	2.5-3									H				H		
		I13R-3-3.5	3-3.5									H				H		
		I13R-3.5-4	3.5-4									H				H		
		I13R-4-6	4-6									H				H		Vertical Delineation - UUSCOs
		I13R-6-8	6-8									H				H		
Eastern Parcel	I14R	I14R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		I14R-1-1.5	1-1.5					H										
		I14R-1.5-2	1.5-2					H										
Western Parcel	TS-01R	TS-01R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-01R-1-1.5	1-1.5		X			X		X								
		TS-01R-1.5-2	1.5-2		H			H		H								
		TS-01R-2-2.5	2-2.5		H			H		H								
		TS-01R-2.5-3	2.5-3		H			H		H								
		TS-01R-3-3.5	3-3.5		H			H		H								
		TS-01R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-02R	TS-02R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-02R-1-1.5	1-1.5		X			X		X								
		TS-02R-1.5-2	1.5-2		H			H		H								
		TS-02R-2-2.5	2-2.5		H			H		H								
		TS-02R-2.5-3	2.5-3		H			H		H								
		TS-02R-3-3.5	3-3.5		H			H		H								
		TS-02R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-03R	TS-03R-0-1	0-1	X	X		X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-03R-1-1.5	1-1.5		X		X	X		X								
		TS-03R-1.5-2	1.5-2		H		H	H		H								
		TS-03R-2-2.5	2-2.5		H		H	H		H								
		TS-03R-2.5-3	2.5-3		H		H	H		H								
		TS-03R-3-3.5	3-3.5		H		H	H		H								
		TS-03R-3.5-4	3.5-4		H		H	H		H								
Western Parcel	TS-04R	TS-04R-0-1	0-1	X	X	X		X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-04R-1-1.5	1-1.5		X	H		X		X								
		TS-04R-1.5-2	1.5-2		H	H		H		H								
		TS-04R-2-2.5	2-2.5		H	H		H		H								
		TS-04R-2.5-3	2.5-3		H	H		H		H								
		TS-04R-3-3.5	3-3.5		H	H		H		H								
		TS-04R-3.5-4	3.5-4		H	H		H		H								

Table 2

Proposed Supplemental Soil Sampling Plan

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses							Individual Metal Analyses[1]							
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**TCL Pesticides**	**TCL Herbicides**	**TAL Metals + Hex Chrome**	**Arsenic**	**Total + Hex Chrome**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**Sampling Rationale**
Western Parcel	TS-05R	TS-05R-0-1	0-1	X	X		X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-05R-1-1.5	1-1.5		X		X	X		X								
		TS-05R-1.5-2	1.5-2		H		H	H		H								
		TS-05R-2-2.5	2-2.5		H		H	H		H								
		TS-05R-2.5-3	2.5-3		H		H	H		H								
		TS-05R-3-3.5	3-3.5		H		H	H		H								
		TS-05R-3.5-4	3.5-4		H		H	H		H								
Western Parcel	TS-06R	TS-06R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-06R-1-1.5	1-1.5		X			X		X								
		TS-06R-1.5-2	1.5-2		H			H		H								
		TS-06R-2-2.5	2-2.5		H			H		H								
		TS-06R-2.5-3	2.5-3		H			H		H								
		TS-06R-3-3.5	3-3.5		H			H		H								
		TS-06R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-07R	TS-07R-0-1	0-1	X	X			X		X								Vertical Delineation - UUSCOs Exceedance[2]
		TS-07R-1-1.5	1-1.5		X			X		X								
		TS-07R-1.5-2	1.5-2		H			H		H								
		TS-07R-2-2.5	2-2.5		H			H		H								
		TS-07R-2.5-3	2.5-3		H			H		H								
		TS-07R-3-3.5	3-3.5		H			H		H								
		TS-07R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-08R	TS-08R-0-1	0-1	X	X	X		X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-08R-1-1.5	1-1.5		X	X		X		X								
		TS-08R-1.5-2	1.5-2		H	H		H		H								
		TS-08R-2-2.5	2-2.5		H	H		H		H								
		TS-08R-2.5-3	2.5-3		H	H		H		H								
		TS-08R-3-3.5	3-3.5		H	H		H		H								
		TS-08R-3.5-4	3.5-4		H	H		H		H								
Western Parcel	TS-09R	TS-09R-0-1	0-1	X	X			X		X								Vertical Delineation - UUSCOs Exceedance[2]
		TS-09R-1-1.5	1-1.5		X	H		X		X								
		TS-09R-1.5-2	1.5-2		H	H		H		H								
		TS-09R-2-2.5	2-2.5		H	H		H		H								
		TS-09R-2.5-3	2.5-3		H	H		H		H								
		TS-09R-3-3.5	3-3.5		H	H		H		H								
		TS-09R-3.5-4	3.5-4		H	H		H		H								
Western Parcel	TS-10R	TS-10R-0-1	0-1	X	X	X	X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-10R-1-1.5	1-1.5		X	H	X	X		X								
		TS-10R-1.5-2	1.5-2		H	H	H	H		H								
		TS-10R-2-2.5	2-2.5		H	H	H	H		H								
		TS-10R-2.5-3	2.5-3		H	H	H	H		H								
		TS-10R-3-3.5	3-3.5		H	H	H	H		H								
		TS-10R-3.5-4	3.5-4		H	H	H	H		H								
Western Parcel	TS-11R	TS-11R-0-1	0-1	X	X	X		X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-11R-1-1.5	1-1.5		X	X		X		X								
		TS-11R-1.5-2	1.5-2		H	H		H		H								
		TS-11R-2-2.5	2-2.5		H	H		H		H								
		TS-11R-2.5-3	2.5-3		H	H		H		H								
		TS-11R-3-3.5	3-3.5		H	H		H		H								
		TS-11R-3.5-4	3.5-4		H	H		H		H								

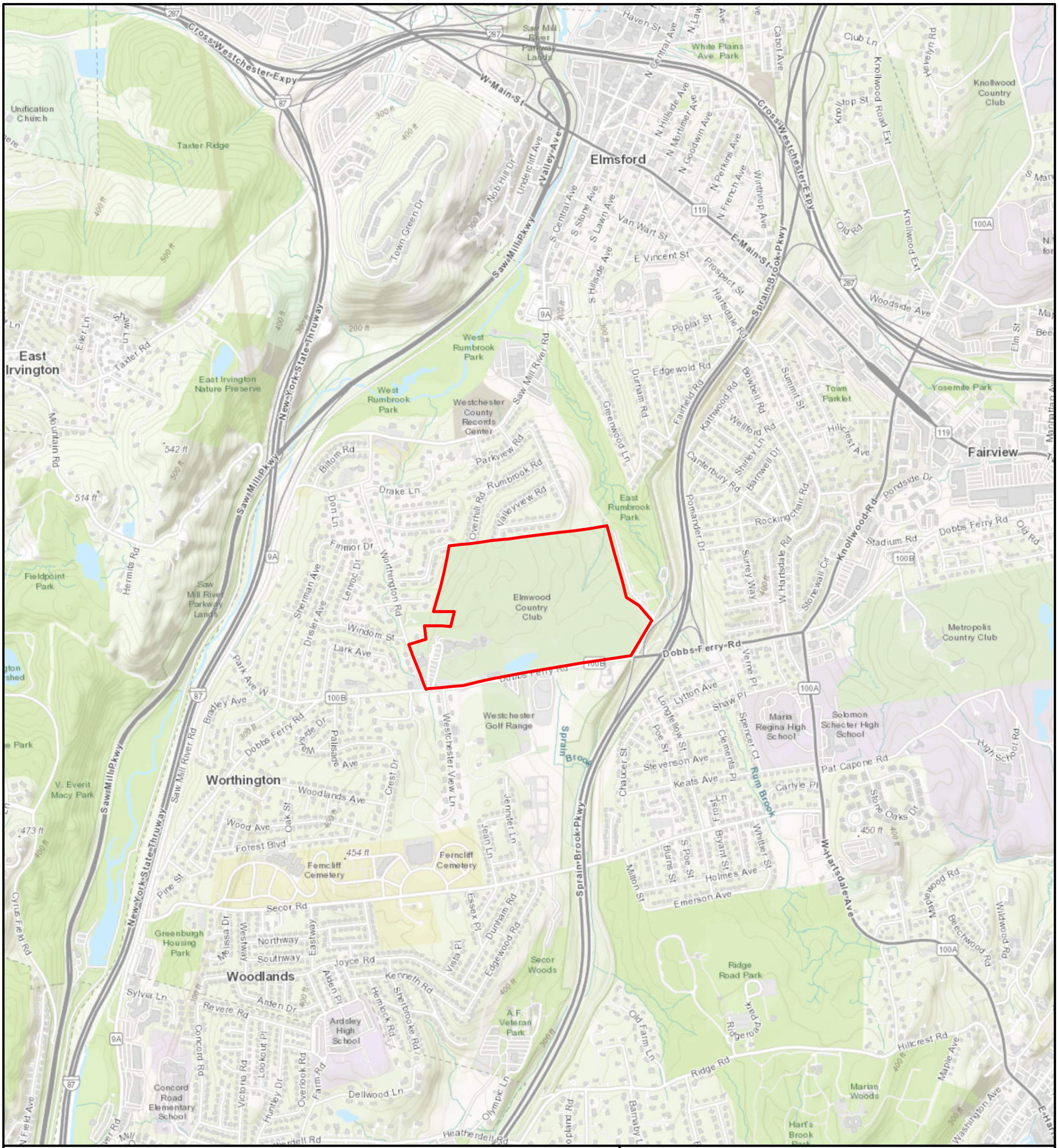
Table 2
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses														
											Individual Metal Analyses[1]							
Area	Location ID	Sample ID	Sample Depth (ft bgs)	VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	Sampling Rationale
Western Parcel	TS-12R	TS-12R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-12R-1-1.5	1-1.5		X			X		X								
		TS-12R-1.5-2	1.5-2		H			H		H								
		TS-12R-2-2.5	2-2.5		H			H		H								
		TS-12R-2.5-3	2.5-3		H			H		H								
		TS-12R-3-3.5	3-3.5		H			H		H								
		TS-12R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-13R	TS-13R-0-1	0-1	X	X			X		X								Vertical Delineation - UUSCOs Exceedance[2]
		TS-13R-1-1.5	1-1.5		X			X		X								
		TS-13R-1.5-2	1.5-2		H			H		H								
		TS-13R-2-2.5	2-2.5		H			H		H								
		TS-13R-2.5-3	2.5-3		H			H		H								
		TS-13R-3-3.5	3-3.5		H			H		H								
		TS-13R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-14R	TS-14R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-14R-1-1.5	1-1.5		X			X		X								
		TS-14R-1.5-2	1.5-2		H			H		H								
		TS-14R-2-2.5	2-2.5		H			H		H								
		TS-14R-2.5-3	2.5-3		H			H		H								
		TS-14R-3-3.5	3-3.5		H			H		H								
		TS-14R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-15R	TS-15R-0-1	0-1	X	X		X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-15R-1-1.5	1-1.5		X		X	X		X								
		TS-15R-1.5-2	1.5-2		H		H	H		H								
		TS-15R-2-2.5	2-2.5		H		H	H		H								
		TS-15R-2.5-3	2.5-3		H		H	H		H								
		TS-15R-3-3.5	3-3.5		H		H	H		H								
		TS-15R-3.5-4	3.5-4		H		H	H		H								
Western Parcel	TEI-SB-01	TEI-SB-01-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-01-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]
Western Parcel	TEI-SB-02	TEI-SB-02-X.X-X.X	X.X-X.X	X	X	X	X	X	X	X								NYSDEC Request - Vicinity of Septic Tank[2]
		TEI-SB-02-X.X-X.X	X.X-X.X	H	H	H	H	H	H	H								NYSDEC Request - Vicinity of Septic Tank[2]
Western Parcel	TEI-SB-03	TEI-SB-03-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-03-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]
Western Parcel	TEI-SB-04	TEI-SB-04-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of AST[2]
		TEI-SB-04-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of AST[2]
Western Parcel	TEI-SB-05	TEI-SB-05-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-05-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]
Western Parcel	TEI-SB-06	TEI-SB-06-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-06-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]

Abbreviations:
X - run analysis
H - hold analysis
AST - aboveground storage tank
ft bgs - feet below ground surface
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances
RSCO - residential use soil cleanup objectives
SVOC - semi-volatile organic compounds
TAL - target analyte list
TCL - target compound list
UST - underground storage tank
UUSCO - unrestricted use soil cleanup objectives
VOC - volatile organic compounds

Note:
1 - As applicable, samples will be analyzed for only the specific metal analytes which exceeded SCOs in the RI Data.
2 - See Section 3.2.3 of the Supplemental Remedial Investigation Work Plan for sampling depth interval rationale.

Figures



0 1,000 2,000 4,000
Feet

1 inch = 2,000 feet

N

Legend

🟥 Approximate Site Boundary

Base Map: ESRI World Topographic Map
(data providers include HERE, Garmin, USGS, et al.)

SAFETY FIRST

CLIENT: Ridgewood Elmwood Owner, LLC

PROJECT:
Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

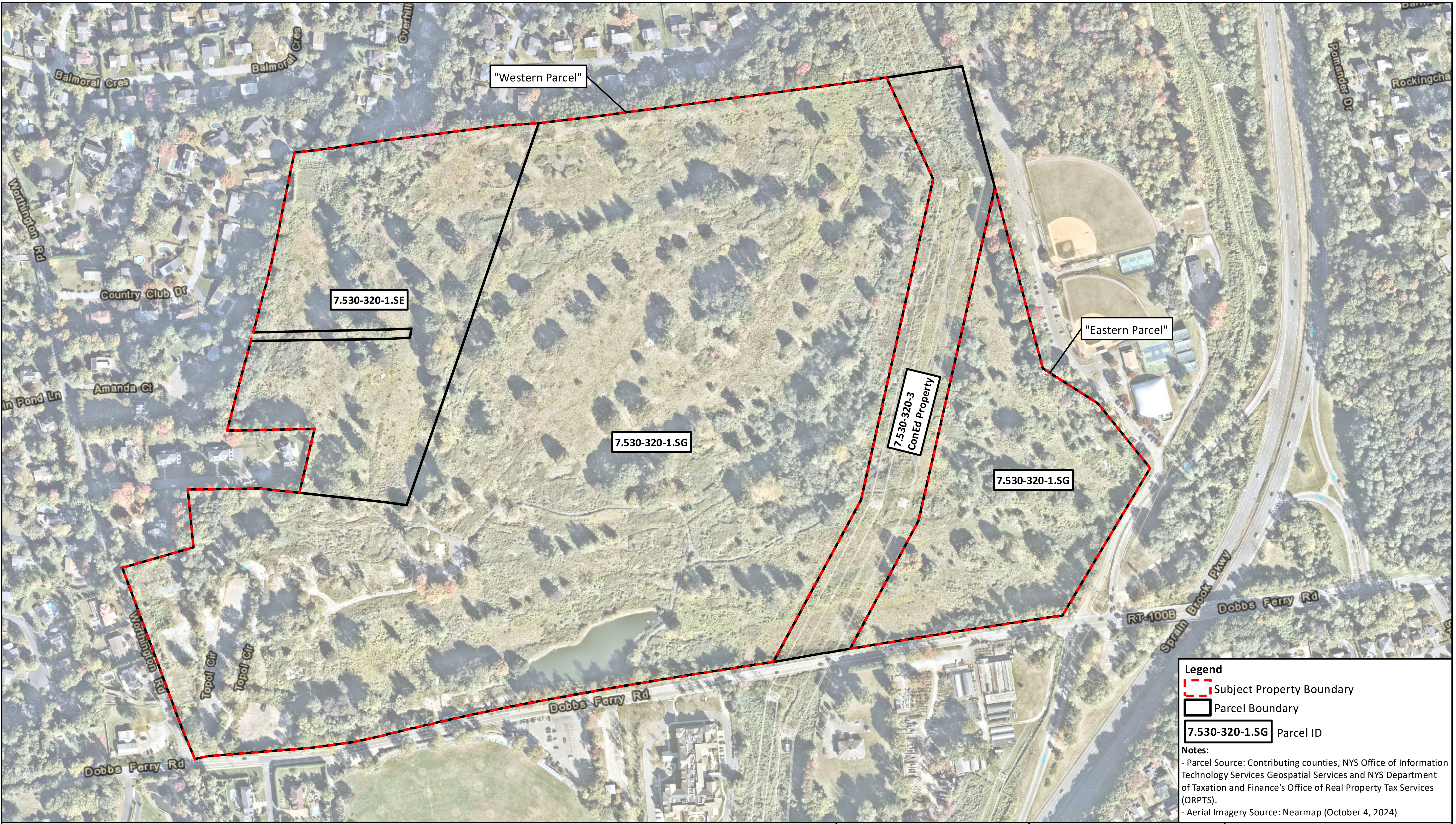
Site Location

FIGURE 1

carsonvoci
engineering and geology dpc
an affiliate of Terraphase Engineering inc.

File: N:\GIS\Prj\105.004_Elmwood Country Club\MXDs\(20241206) Figure 1 - Site Location.mxd 12/9/2024 Created by: S.Lowe Coordinate System: NAD 1983 StatePlane New York East FIPS 3101 Feet

File: N:\GIS\Prj\J105.004_Elmwood Country Club\MXDs\(20241206) Figure 2 - Site Plan and Tax Map.mxd 12/9/2024 Created by: S.Lowe Coordinate System: NAD 1983 StatePlane New York East FIPS 3101 Feet



Notes:

- Parcel Source: Contributing counties, NYS Office of Information Technology Services Geospatial Services and NYS Department of Taxation and Finance's Office of Real Property Tax Services (ORPTS).
- Aerial Imagery Source: Nearmap (October 4, 2024)

DRAFT

0 150 300 600 Feet

1 inch = 300 feet

N

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an affiliate of Terraphase Engineering Inc.

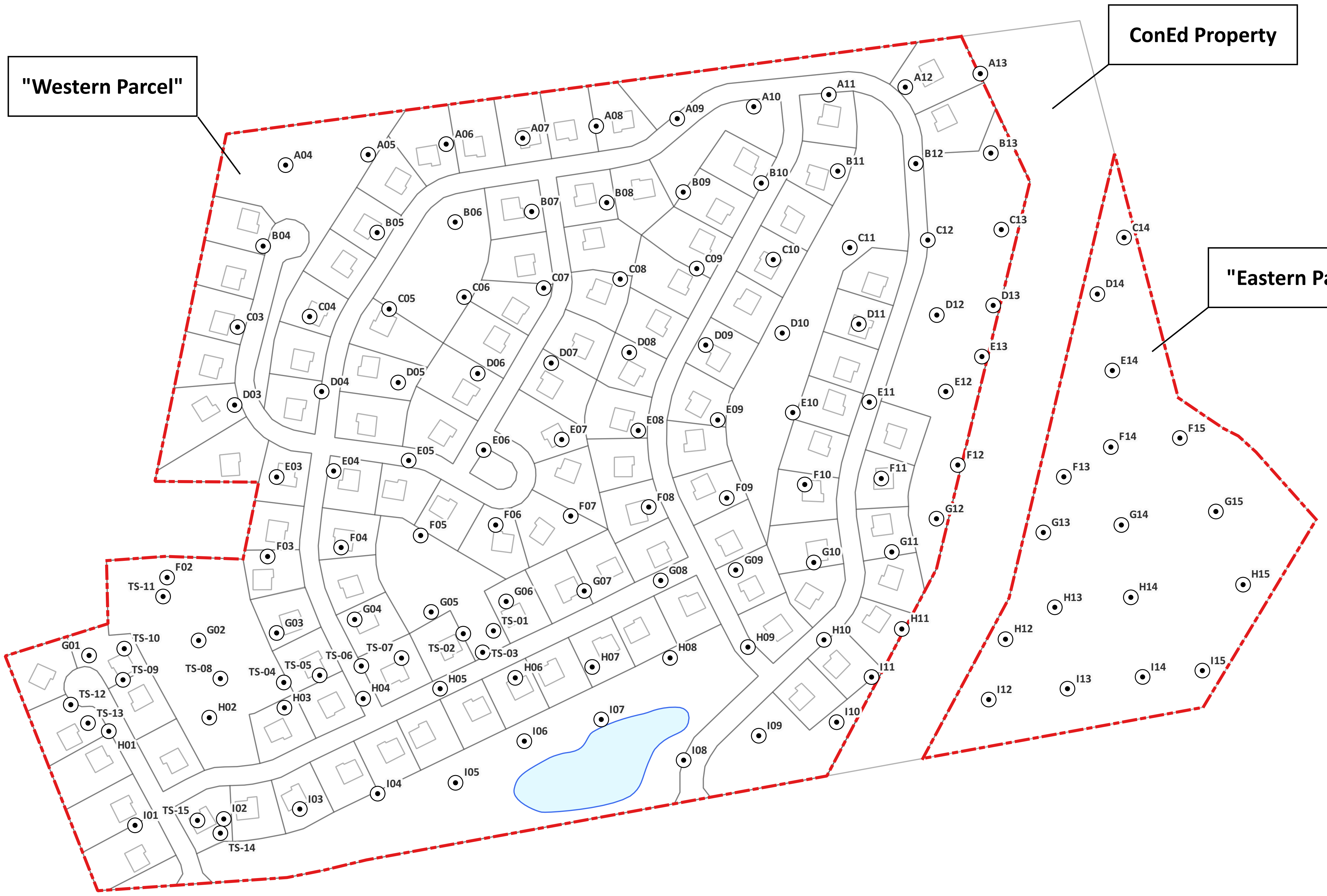
CLIENT: Ridgewood Elmwood Owner, LLC

PROJECT:
Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Site Plan and Tax Map

FIGURE 2



Legend

🟥 Site Boundary

🟦 Pond

☐ Proposed Development Plan

⊙ Remedial Investigation Soil Sample Locations

DRAFT

0 300 600 900 1,200 ft

1 Inch = 300 Feet

N

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an affiliate of Terraphase Engineering Inc

CLIENT: Ridgewood Elmwood Owner, LLC

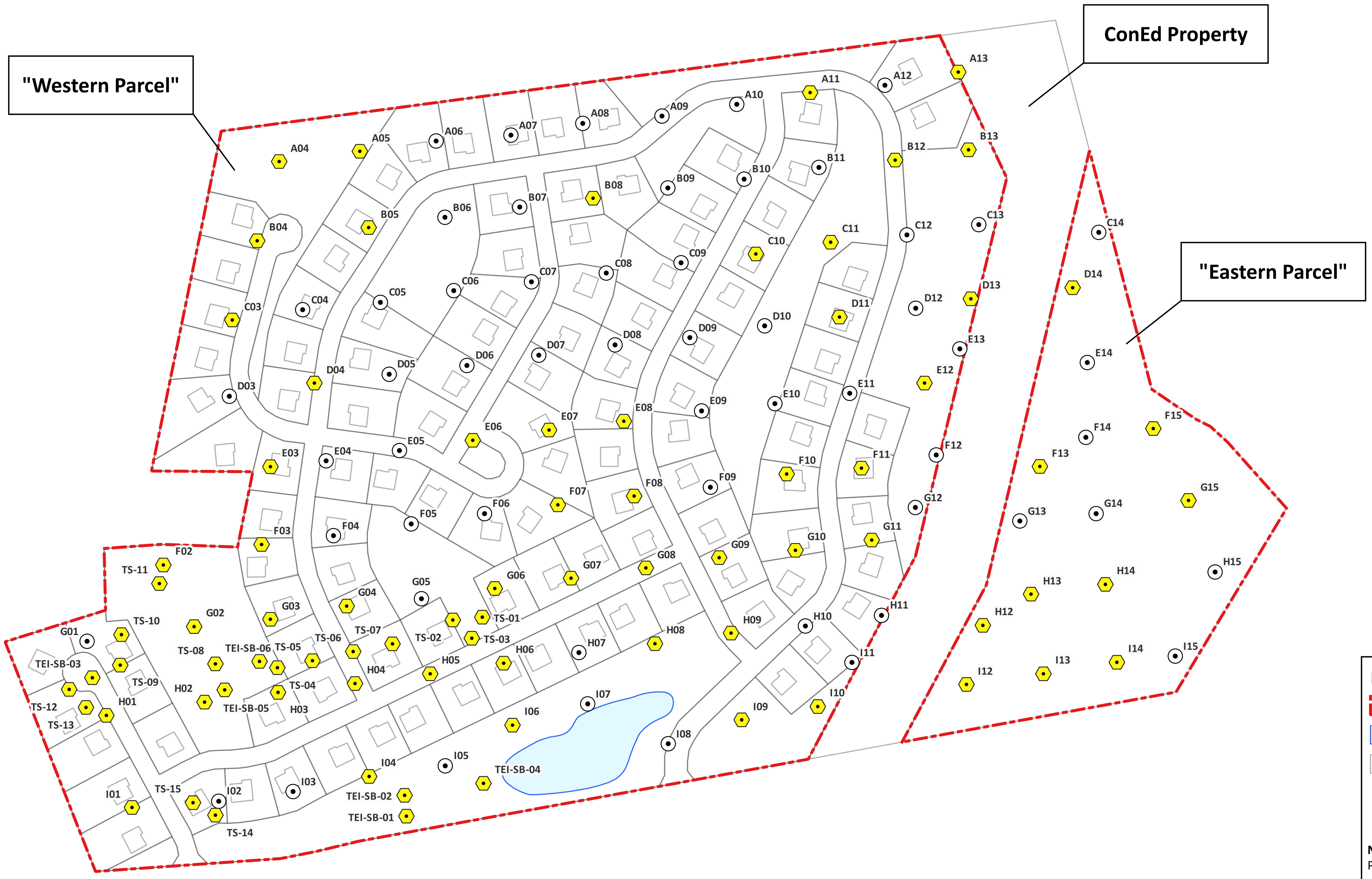
PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Remedial Investigation Soil Sample Locations

Figure 3

N:\GIS\Prj\J105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241206_RISoilSamplingLocations 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

🟥	Site Boundary
🟦	Pond
☐	Proposed Development Plan
⊙	RI Soil Sampling Location
⬢	Proposed Supplemental Soil Sampling Location

Note:
Proposed soil sampling locations are located at the RI sampling locations. See Table 2 for the proposed sampling depths and analyses for each location.

Abbreviation:
RI – Remedial Investigation

DRAFT

0 300 600 900 1,200 ft

1 Inch = 300 Feet

N

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an affiliate of Terraphase Engineering Inc

CLIENT: Ridgewood Elmwood Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Proposed Supplemental Soil Sample Locations

Figure 4

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241204_ProposedSamplingLocations 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

Notes:
Proposed soil sampling locations are located at the RI sampling locations. See Table 2 for the proposed sampling depths and analyses for each location.
Aerial Imagery Source: Nearmap (July 19 ,2017)

Abbreviations:
AST - Aboveground Storage Tank
RI -- Remedial Investigation
UST -- Underground Storage Tank

N:\GIS\Prj\J105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 2025115_ProposedUSTSamplingLocations 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

DRAFT

0 150 300 450 600 ft
1 Inch = 150 Feet

N

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CLIENT: Ridgewood Elmwood Owner, LLC

PROJECT:
Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

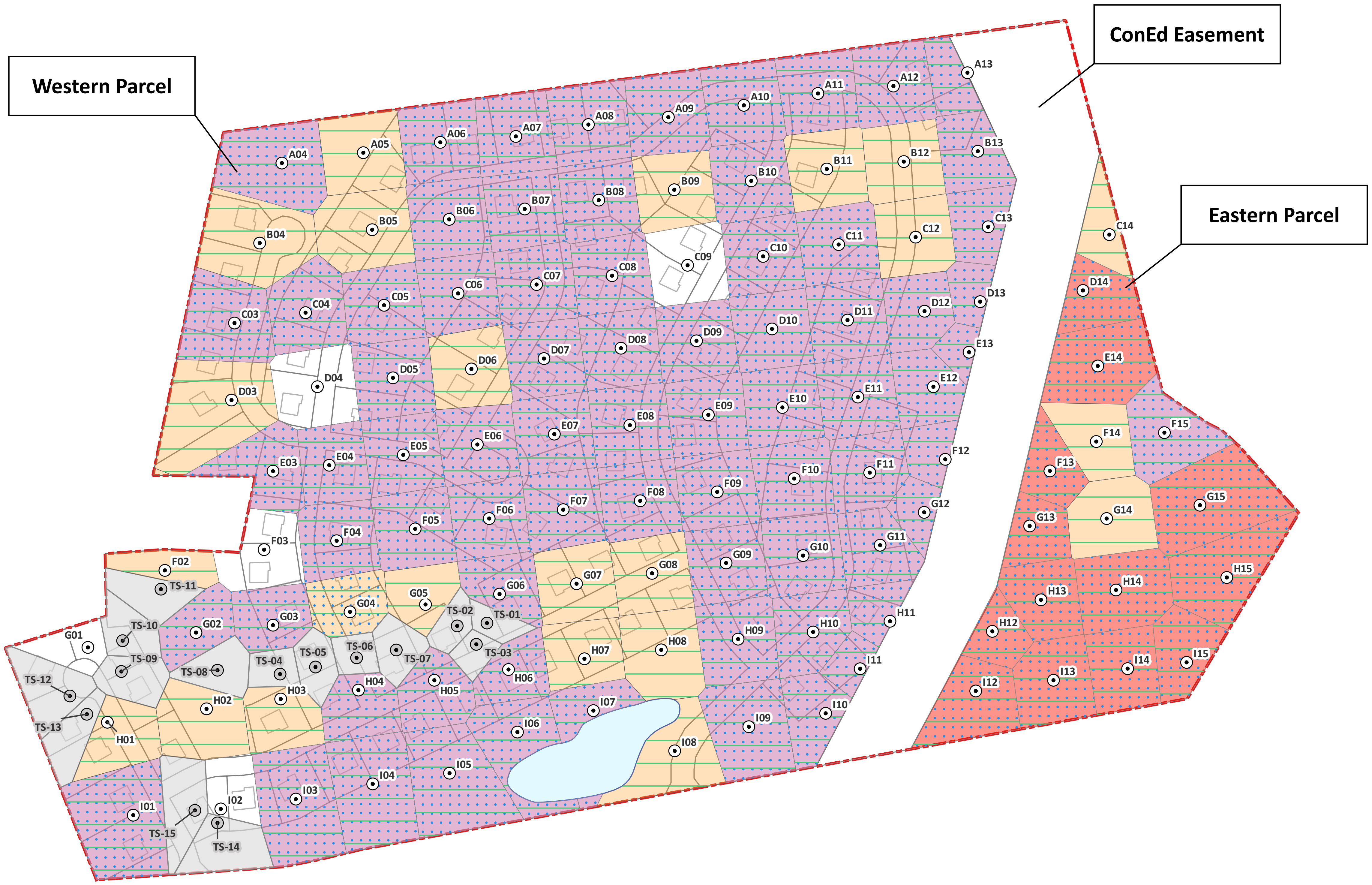
Proposed Supplemental Soil Sample Locations UST/AST and Septic Areas

Figure 5

Appendix A

Remedial Investigation Data Summary Tables and Figures

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth_Overall 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

- 🟥 Site Boundary
- 🟦 Pond
- ☐ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- 🟪 Exceeds Unrestricted Use and Residential SCOs
- 🟥 Exceeds Unrestricted Use, Residential, and Restricted Residential SCOs
- ⁘ Exceeds PGW SCO
- ▤ Exceeds PEco SCO
- ☐ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ● Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (0-0.2 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

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Abbreviations:

SCO - Soil Cleanup Objective
PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

DRAFT

0 300 600 900 1,200 ft

1 Inch = 300 Feet

N

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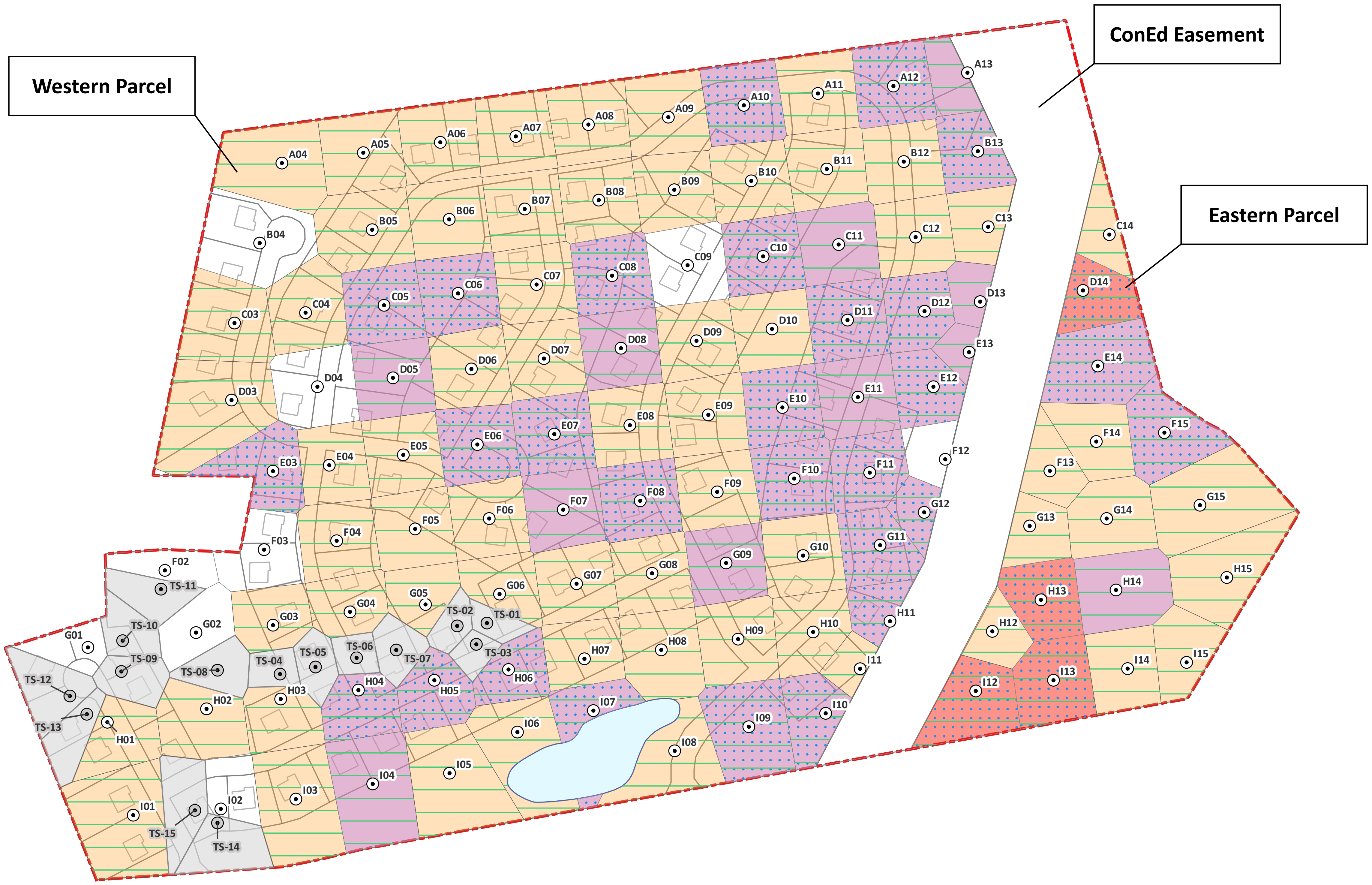
CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
0-0.2 ft bgs

Figure 1



Legend

🟥 Site Boundary

🟦 Pond

☐ Proposed Development Plan

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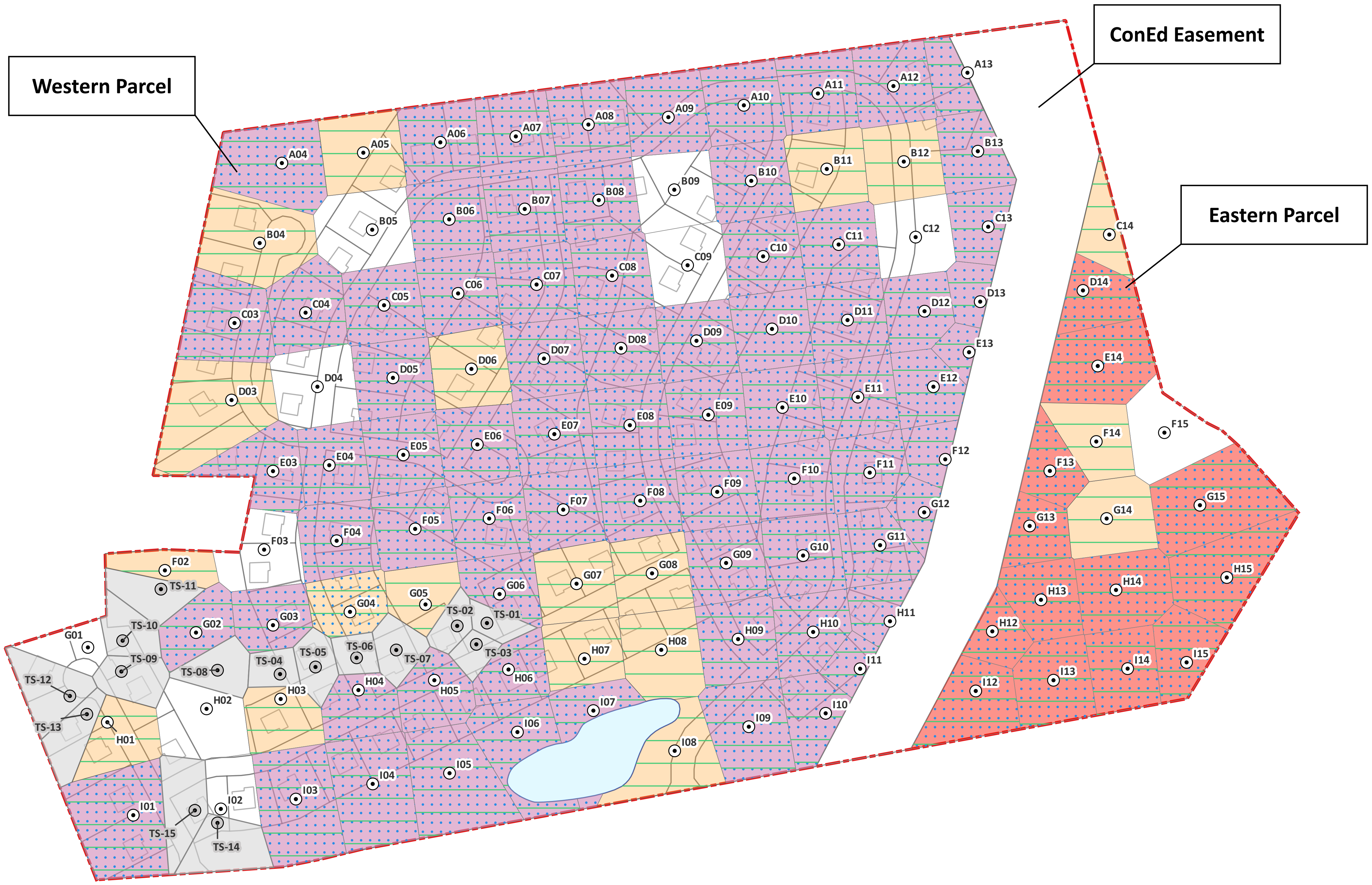
Soil Sampling Results
Pesticides
0-0.2 ft bgs

Figure 1a



Legend

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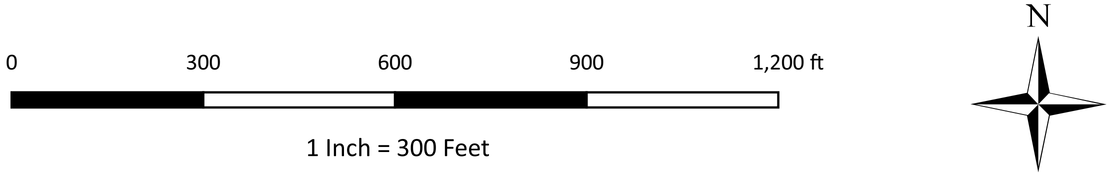
DRAFT



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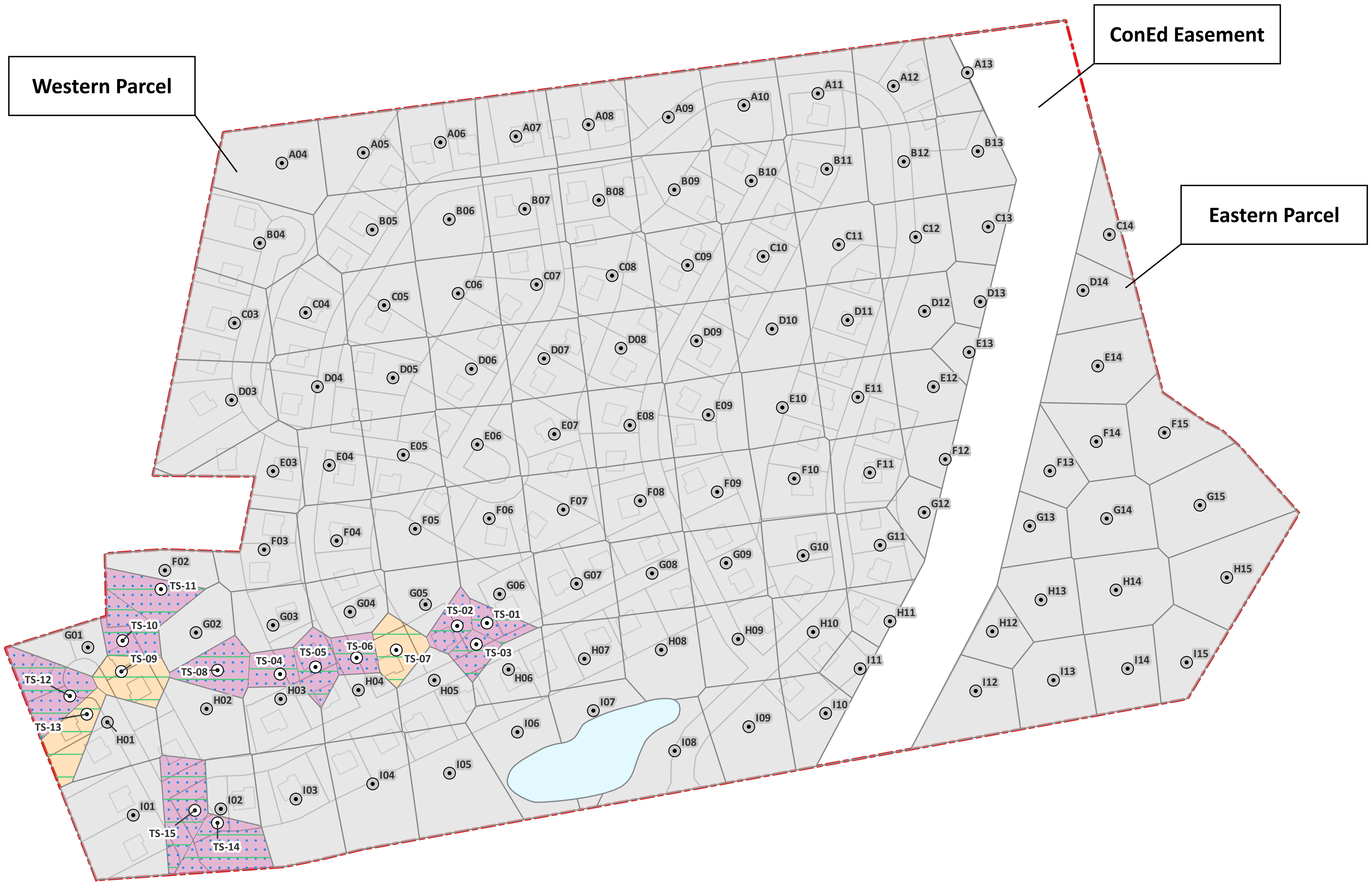
PROJECT NUMBER: CV04.001

Soil Sampling Results
Metals
0-0.2 ft bgs

Figure 1b



Legend

- Site Boundary
- Pond
- Proposed Development Plan
- Exceeds Unrestricted Use SCO Only
- Exceeds Unrestricted Use and Residential SCOs
- Exceeds PGW SCO
- Exceeds PEco SCO
- Not Sampled/ Not Analyzed

Soil Sampling Location

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Notes:

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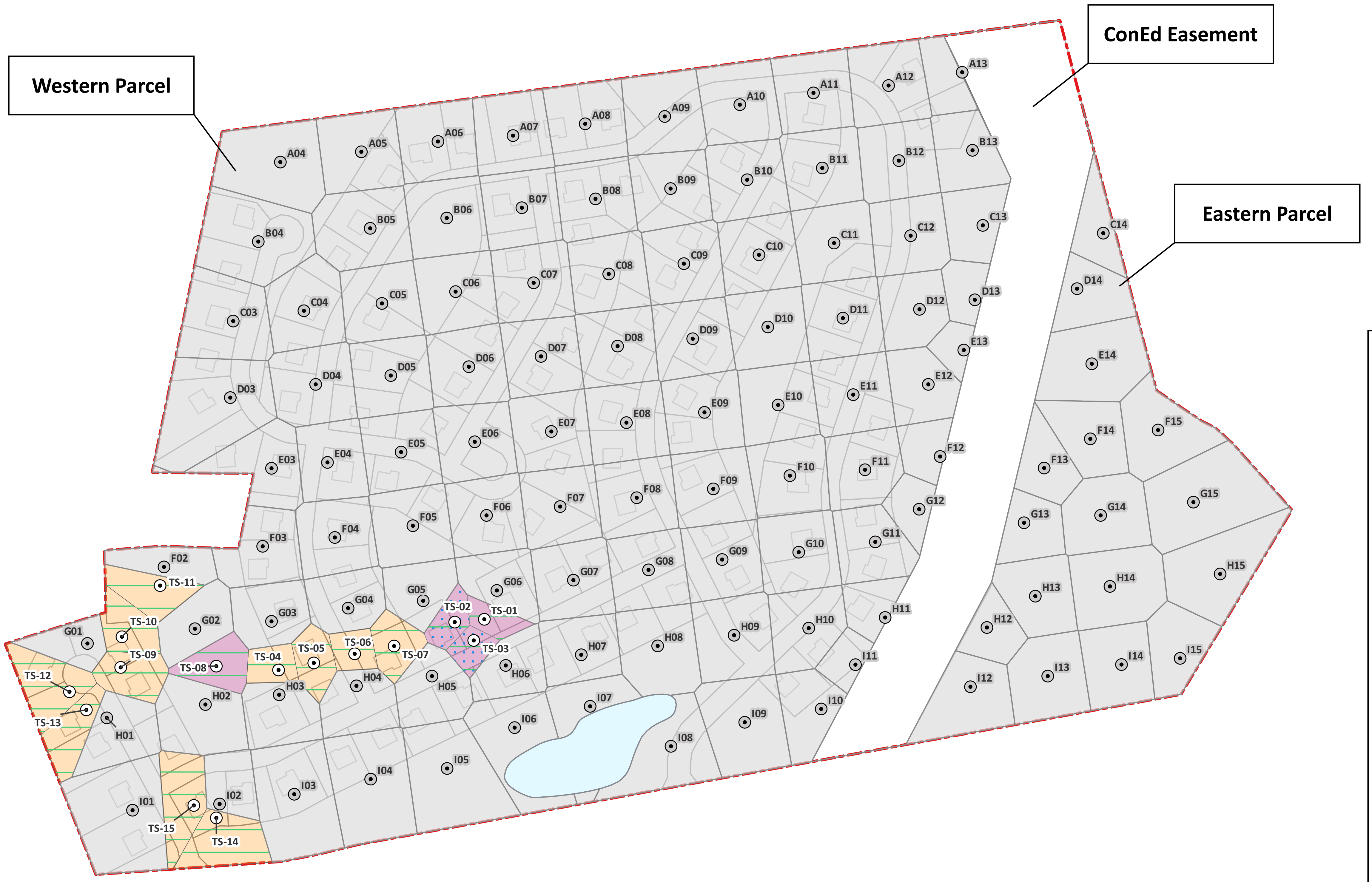
Soil Sampling Results
0-1 ft bgs

Figure 2

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth_Overall 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

⬚	Site Boundary
🟦	Pond
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🟧	Exceeds Unrestricted Use SCO Only
🟪	Exceeds Unrestricted Use and Residential SCOs
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⬜	Not Sampled/ Not Analyzed

Soil Sampling Location

⊙	Sampled at Designated Depth
●	Not Sampled

Notes:

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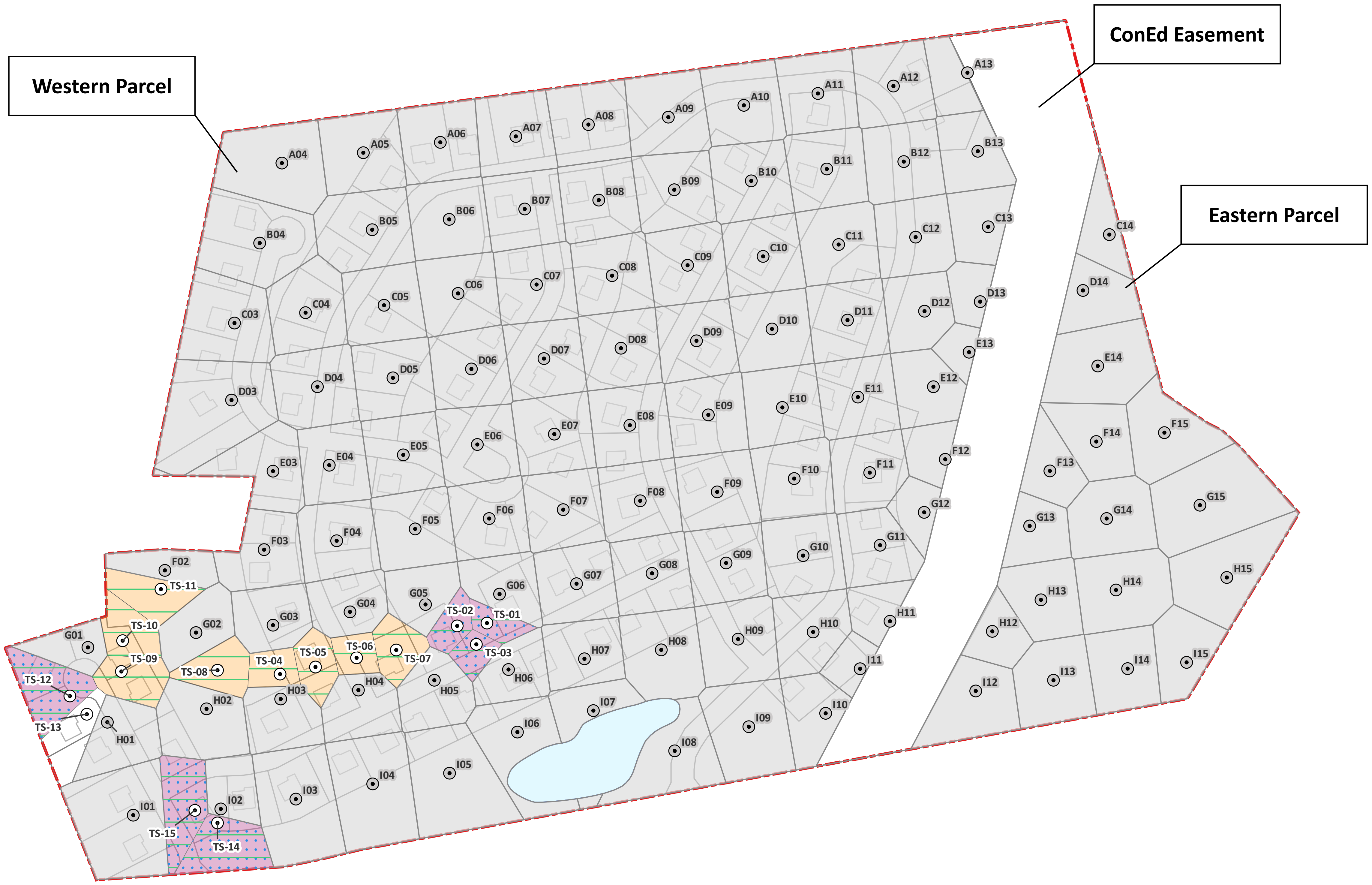
Soil Sampling Results
Pesticides
0-1 ft bgs

Figure 2a

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

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Soil Sampling Location

- ⊙ Sampled at Designated Depth
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Soil Sampling Results
Metals
0-1 ft bgs

Figure 2b

N:\GIS\Prj\J105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

Legend

- 🟥 Site Boundary
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- ☐ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- ⋯ Exceeds PGW SCO
- ☐ No Exceedances
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Soil Sampling Location

- ⊙ Sampled at Designated Depth
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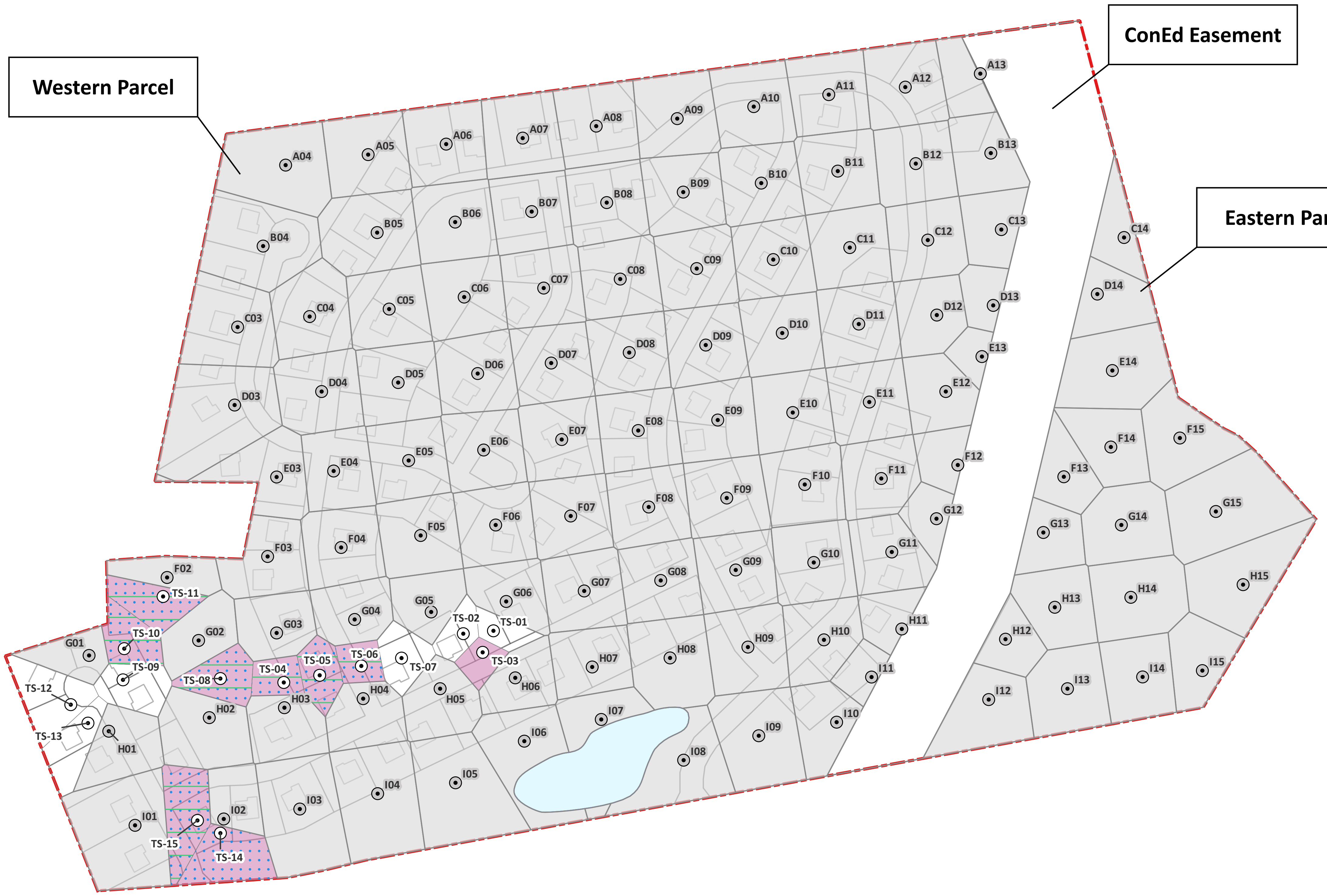
Soil Sampling Results
VOCs
0-1 ft bgs

Figure 2c

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

- 🟥 Site Boundary
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- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ⊙ Not Sampled

Notes:

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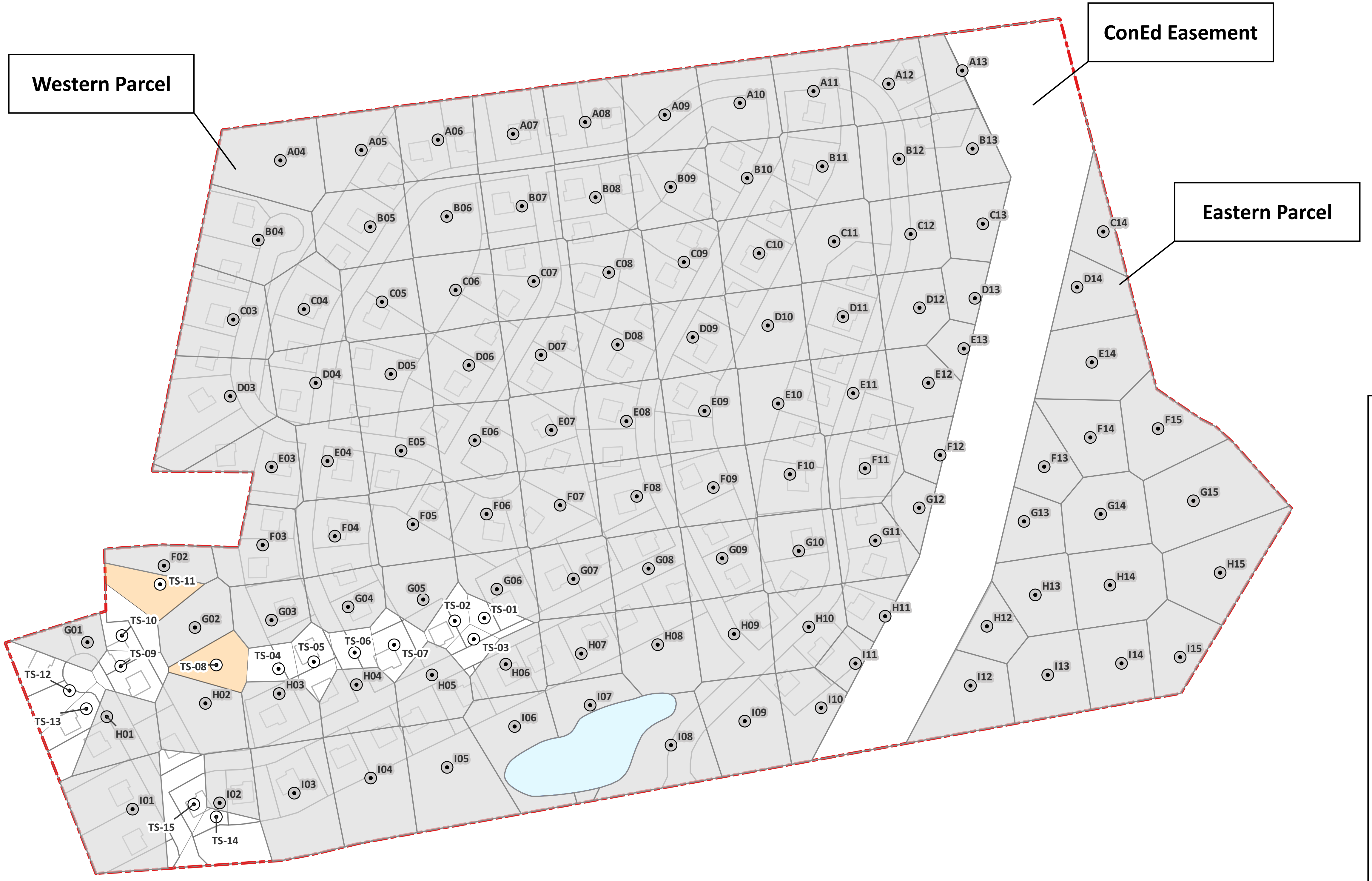
Soil Sampling Results
SVOCs
0-1 ft bgs

Figure 2d

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

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- 🟦 Pond
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- ☐ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
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Notes:

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CLIENT:	Ridgewood Briarcliff Owner, LLC
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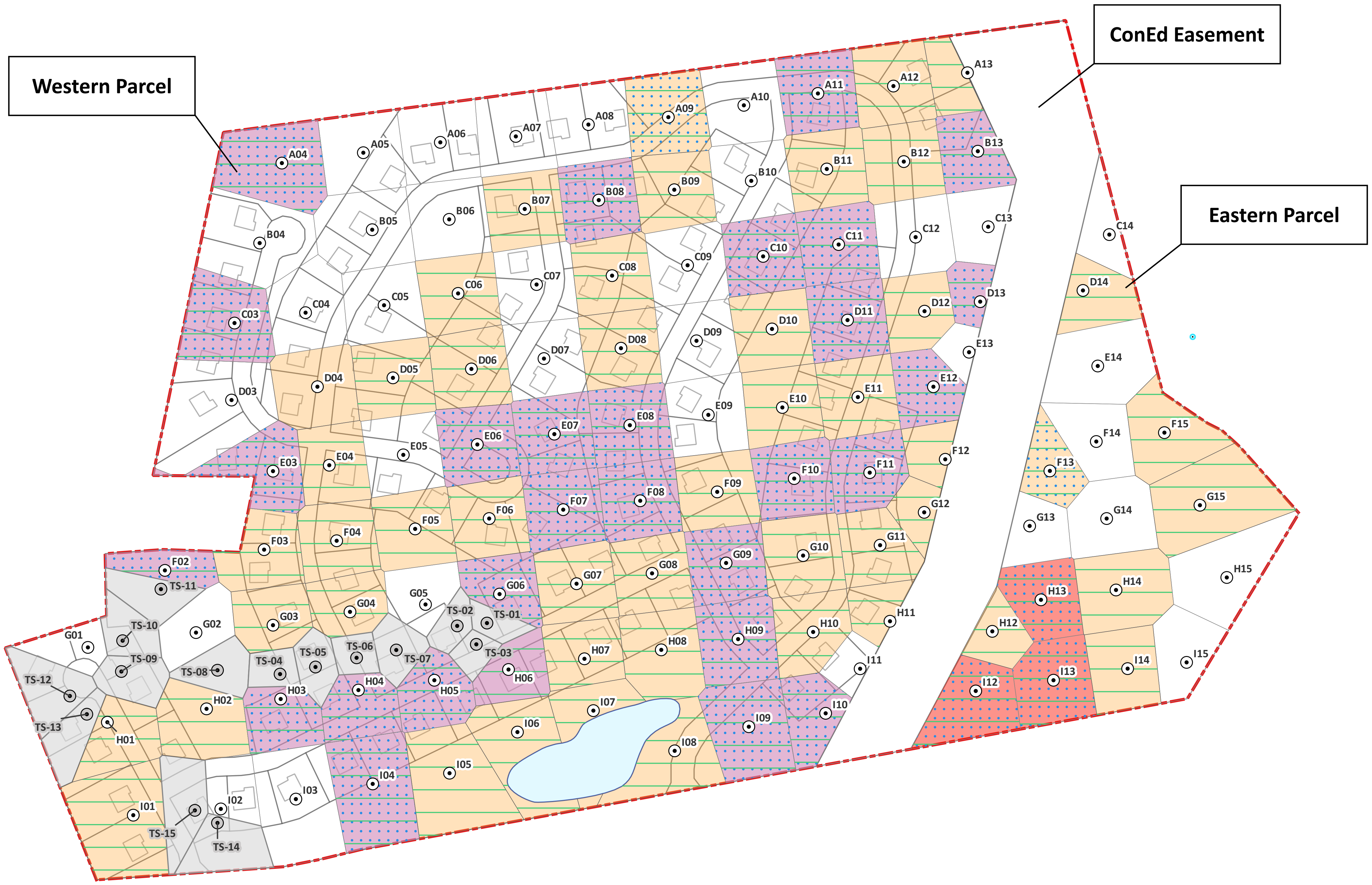
PROJECT NUMBER:	CV04.001

Soil Sampling Results
PCBs
0-1 ft bgs

Figure 2e

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



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Soil Sampling Location

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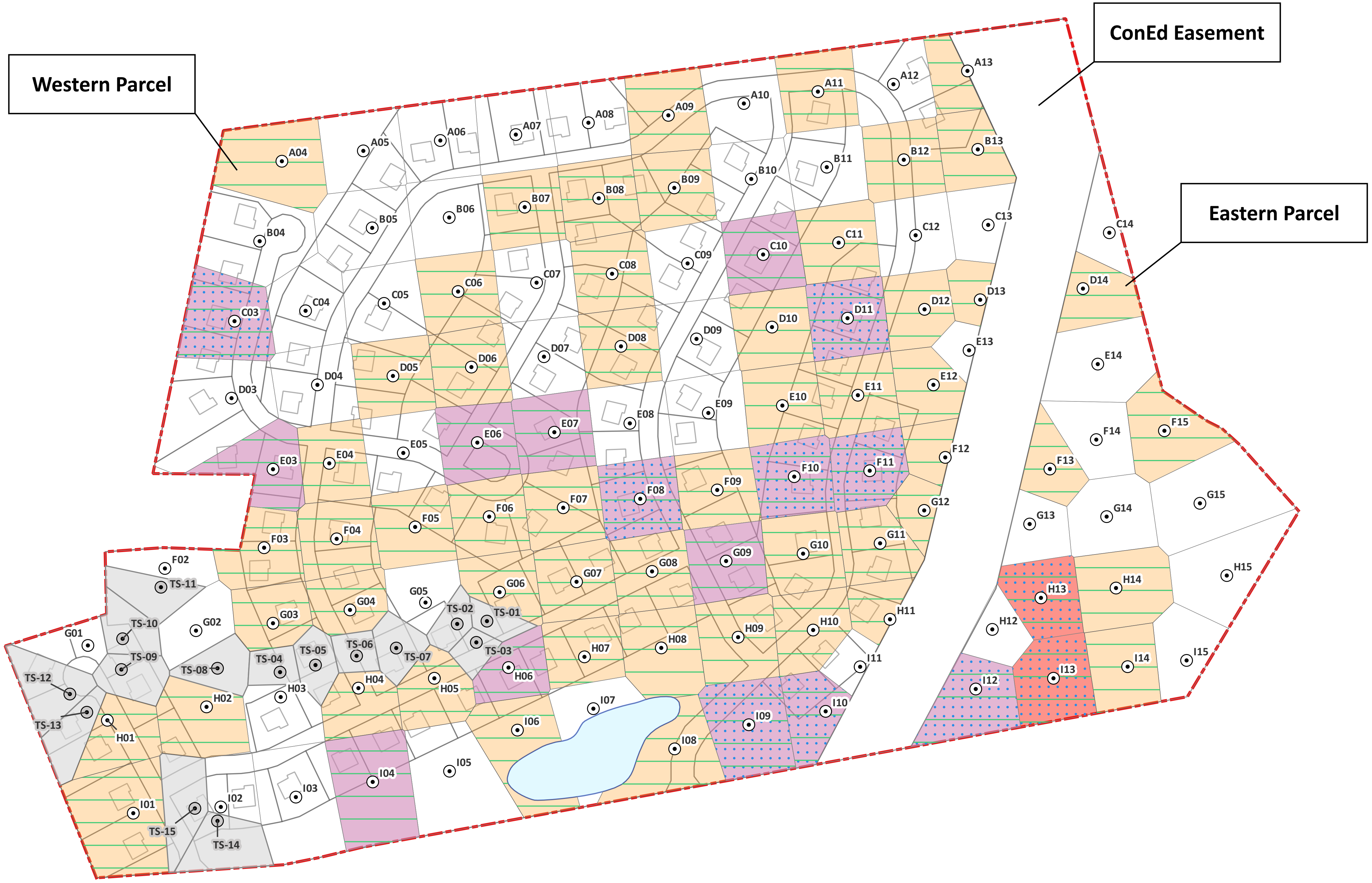
Soil Sampling Results
0.2-2 ft bgs

Figure 3

N:\GIS\Prj\V105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth_Overall 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



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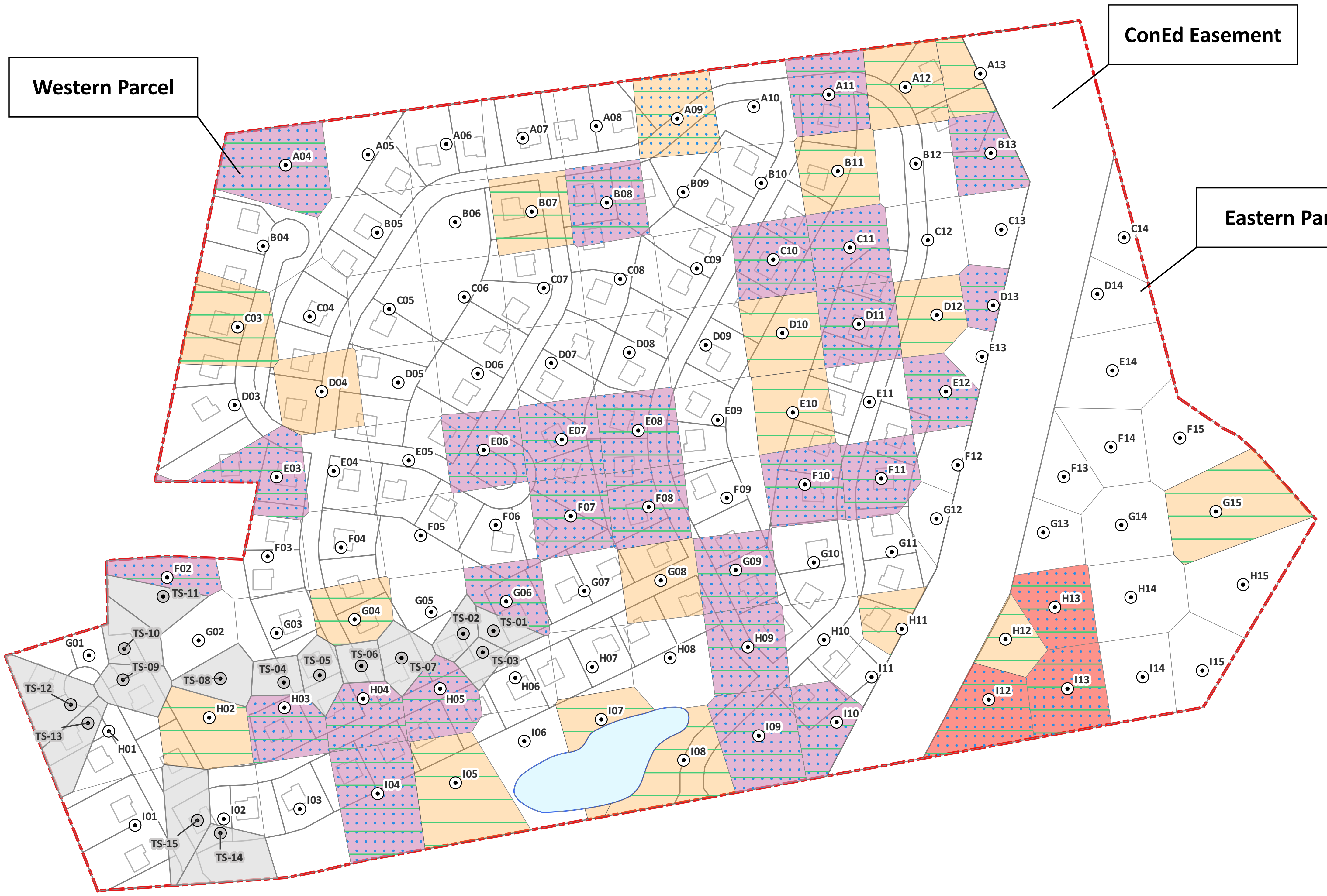
PROJECT NUMBER:	CV04.001

Soil Sampling Results
Pesticides
0.2-2 ft bgs

Figure 3a

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



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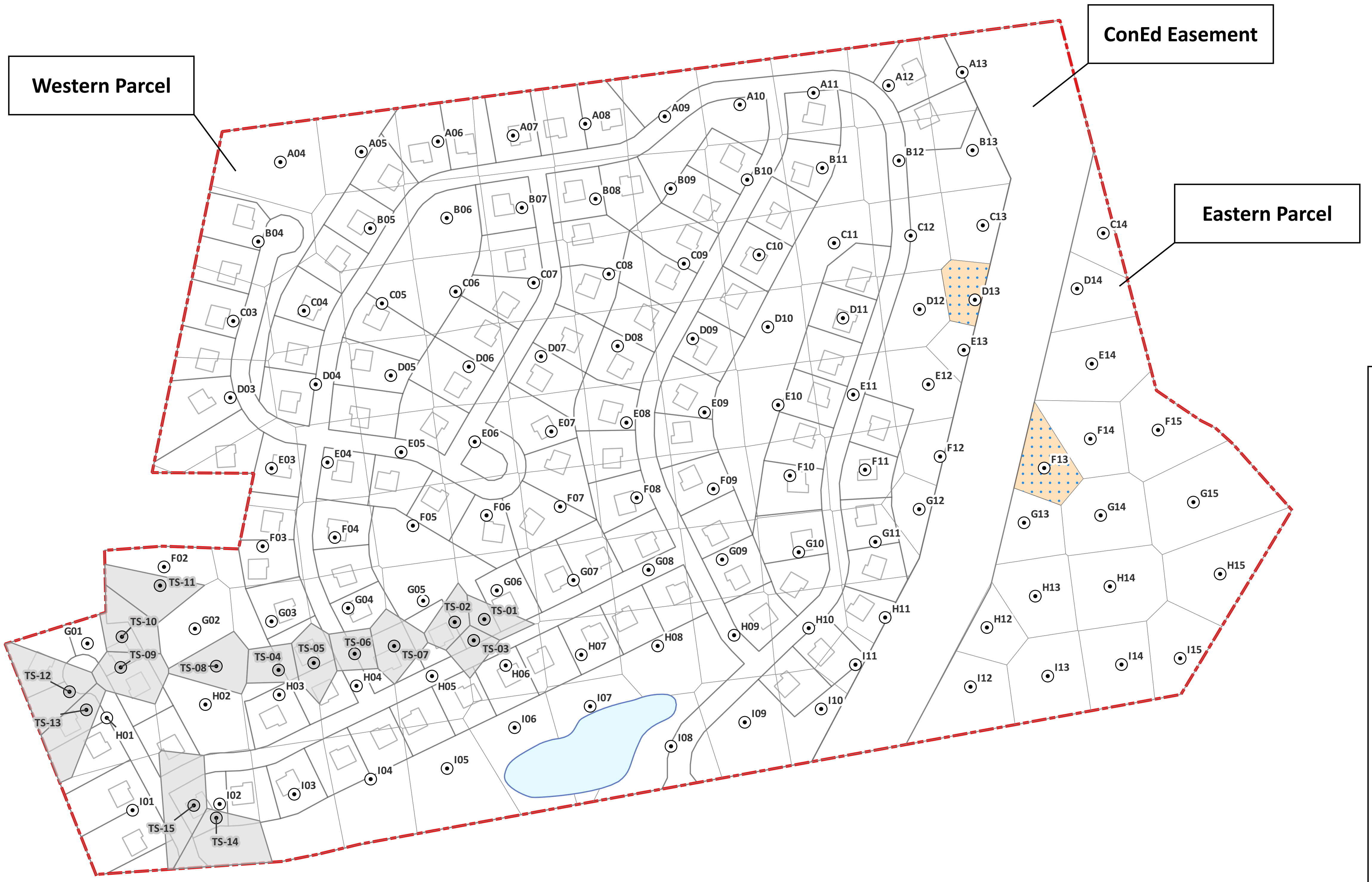
Soil Sampling Results
Metals
0.2-2 ft bgs

Figure 3b

N:\GIS\Prj\1105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M Ingling Checked by: NK



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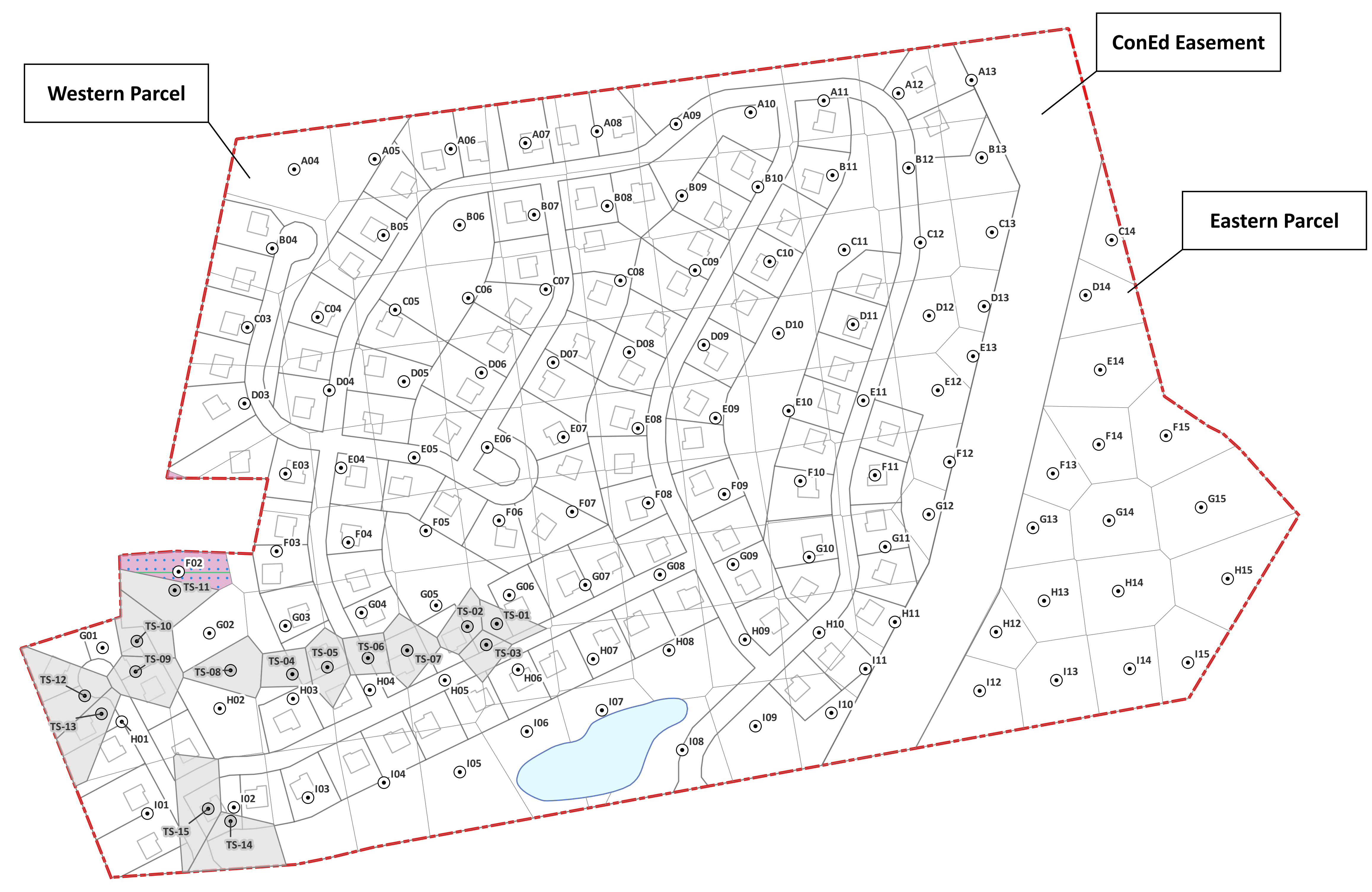
PROJECT NUMBER: CV04.001

Soil Sampling Results
VOCs
0.2-2 ft bgs

Figure 3c



Legend

🟥 Site Boundary

🟦 Pond

☐ Proposed Development Plan

🟪 Exceeds Unrestricted Use and Residential SCOs

▨ Exceeds PGW SCO

🟩 Exceeds PEco SCO

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Soil Sampling Location

⊙ Sampled at Designated Depth

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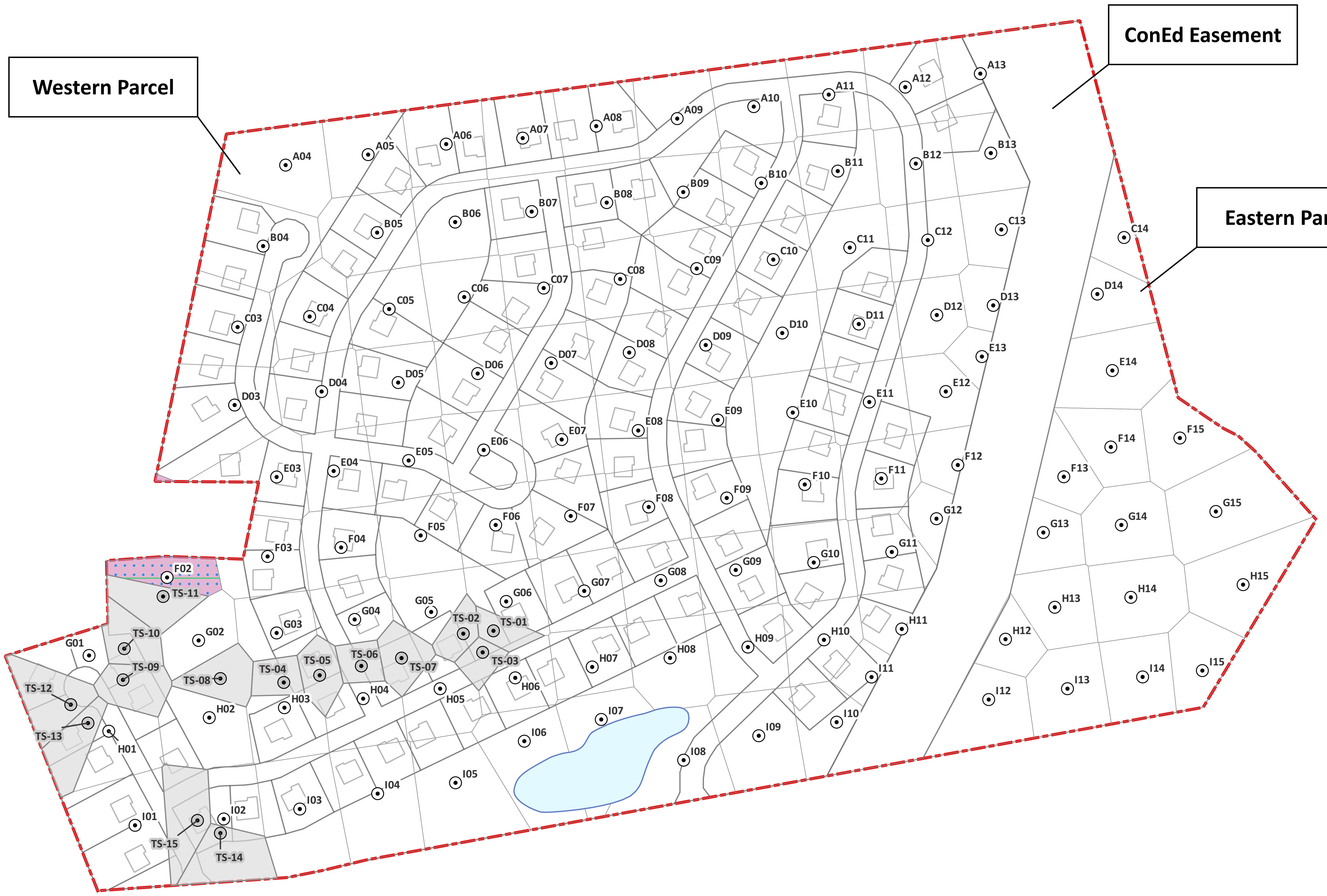
CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
SVOCs
0.2-2 ft bgs

Figure 3d



Legend

- ⬚ Site Boundary
- 🟦 Pond
- ☐ Proposed Development Plan
- 🟪 Exceeds Unrestricted Use and Residential SCOs
- ⋯ Exceeds PGW SCO
- ☰ Exceeds PEco SCO
- ☐ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ◉ Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (0.2-2 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective

PGW - Protection of Groundwater

PEco - Protection of Ecological Resources

DRAFT

0 300 600 900 1,200 ft

1 Inch = 300 Feet

N

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CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
PCBs
0.2-2 ft bgs

Figure 3e

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

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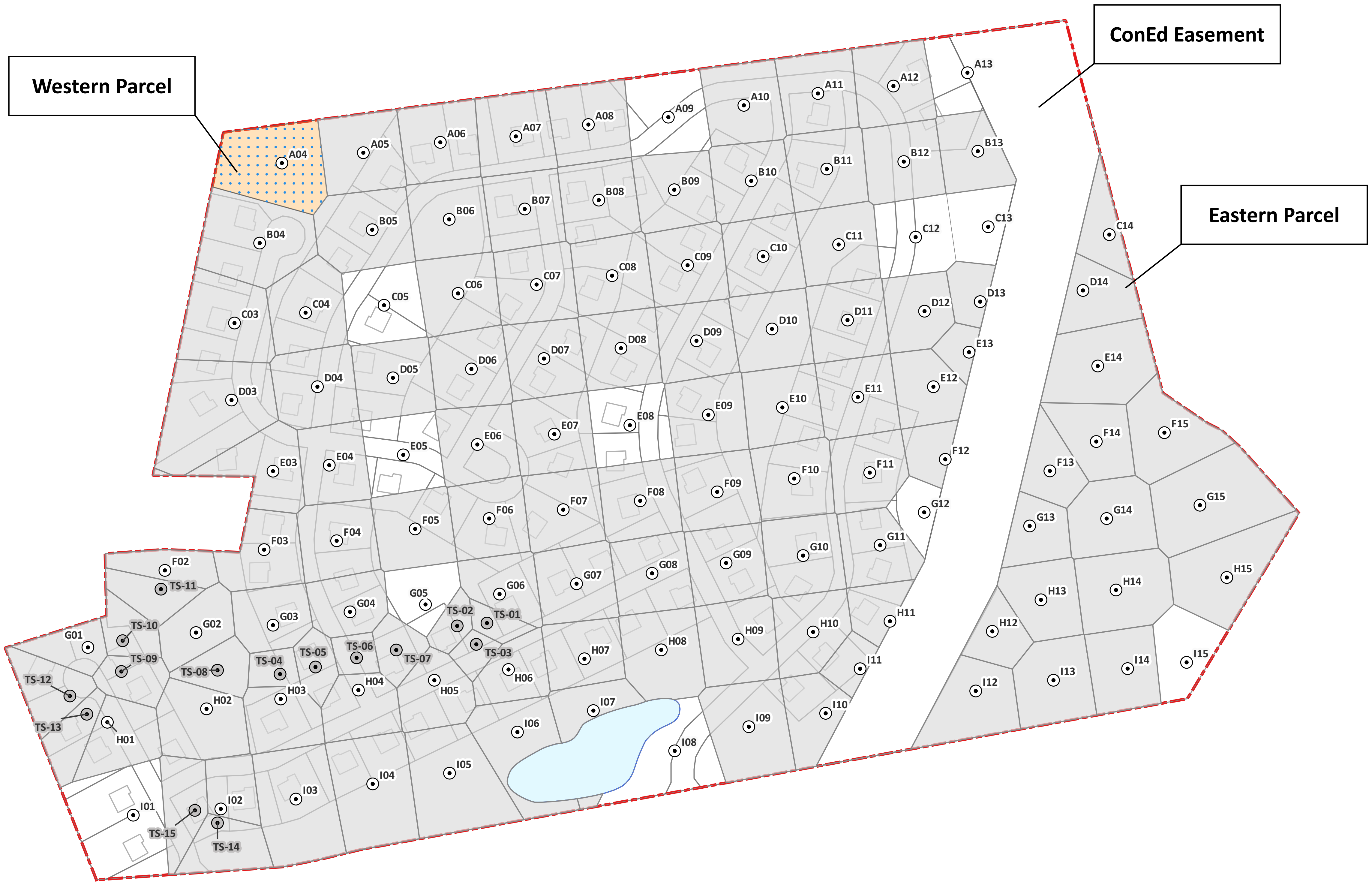

Legend

- ⬚ Site Boundary
- 🟦 Pond
- ⬜ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- ⁘ Exceeds PGW SCO
- ⬜ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ● Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (0.2-2 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective
PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

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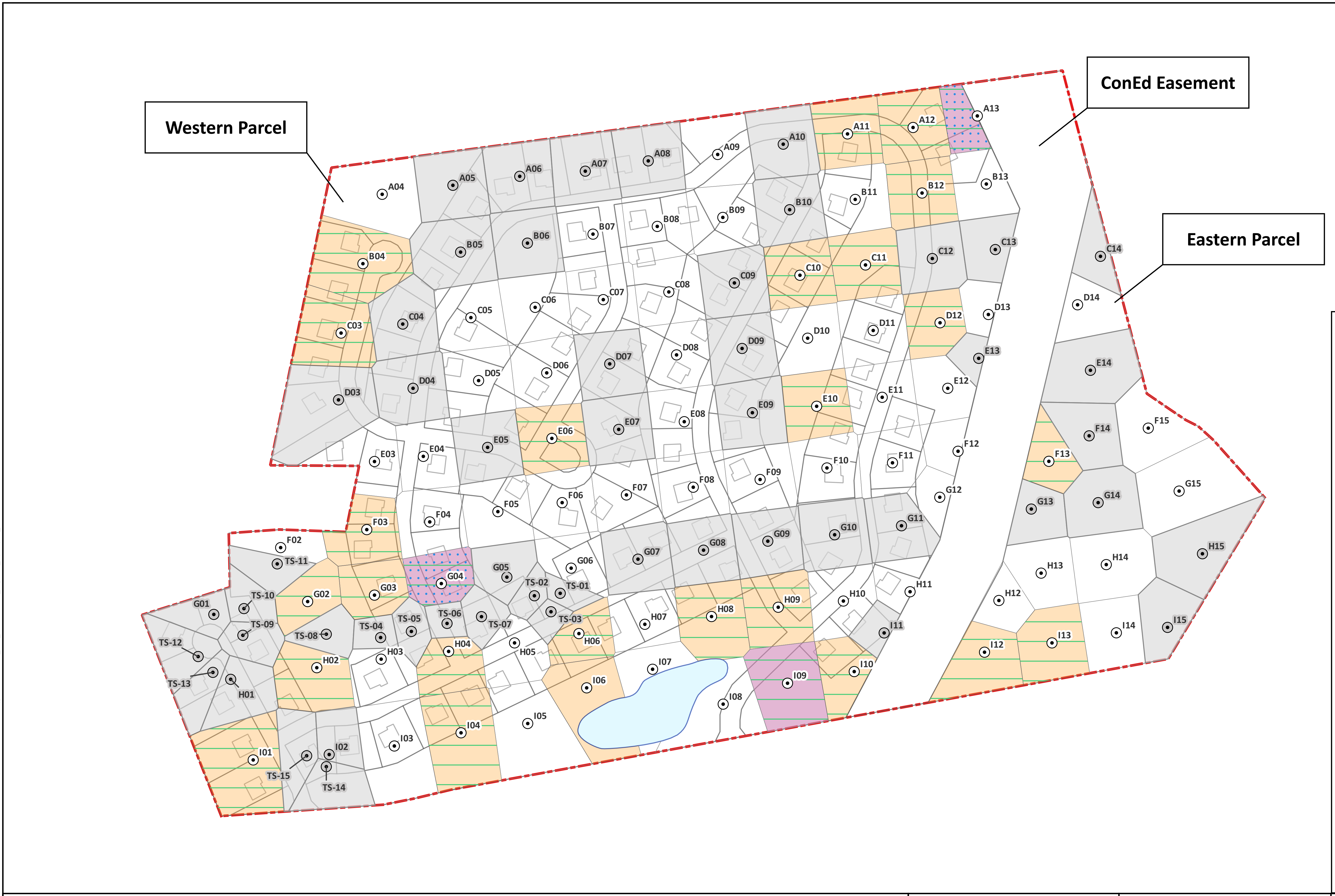
CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
PFAS
0.2-2 ft bgs

Figure 3f



Legend

⬚	Site Boundary
🟦	Pond
☐	Proposed Development Plan
🟧	Exceeds Unrestricted Use SCO Only
🟪	Exceeds Unrestricted Use and Residential SCOs
⁚	Exceeds PGW SCO
☰	Exceeds PEco SCO
☐	No Exceedances
▩	Not Sampled/ Not Analyzed

Soil Sampling Location

⊙	Sampled at Designated Depth
⊙	Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (2-4 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective
PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

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0 300 600 900 1,200 ft

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CLIENT: Ridgewood Briarcliff Owner, LLC

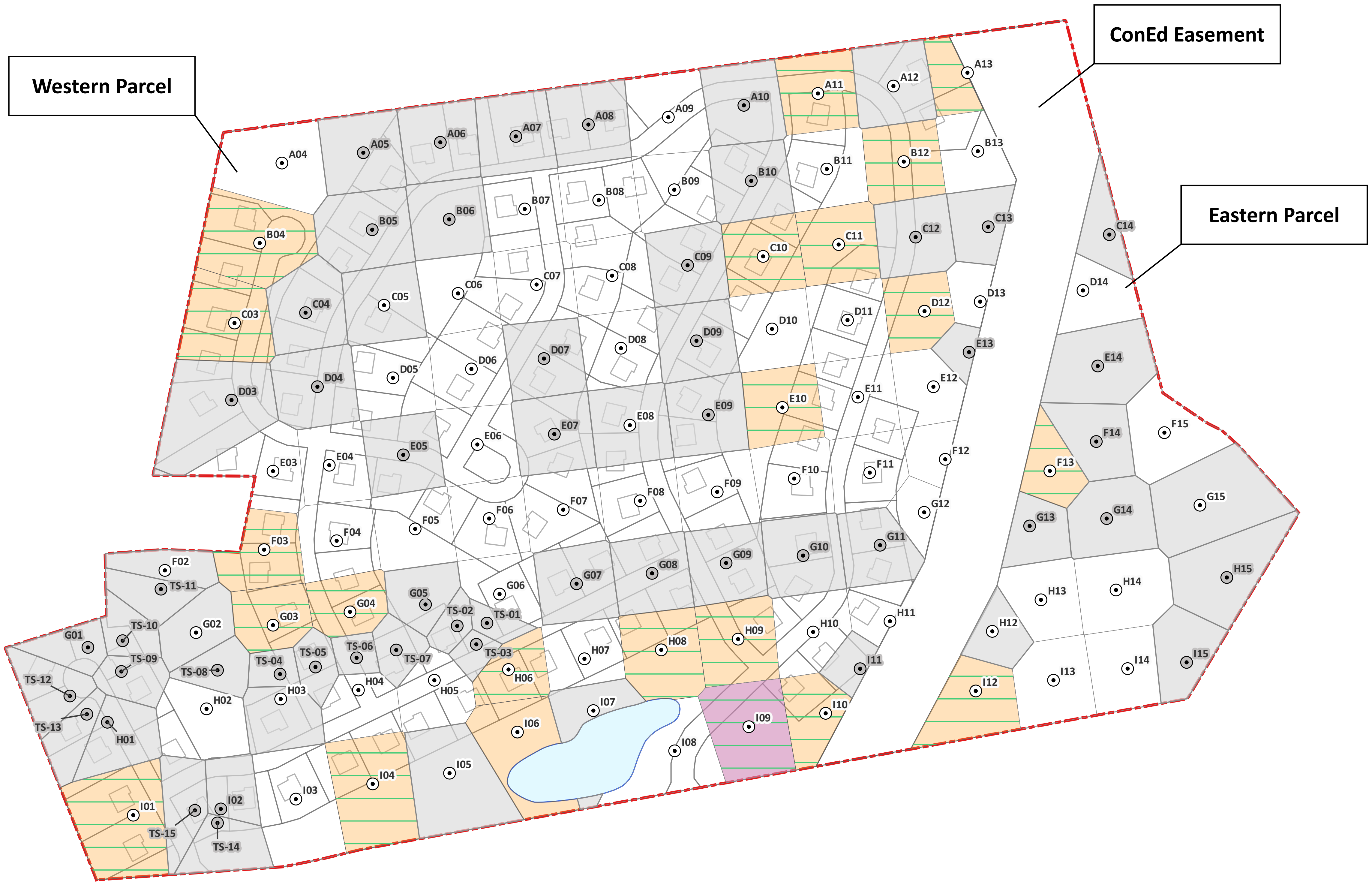
PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
2-4 ft bgs

Figure 4

N:\GIS\Prj\J105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth_Overall 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

- ⬚ Site Boundary
- 🟦 Pond
- ☐ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- 🟪 Exceeds Unrestricted Use and Residential SCOs
- ▤ Exceeds PEco SCO
- ☐ No Exceedances
- ▩ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ◉ Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (2-4 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

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PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

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1 Inch = 300 Feet

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CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

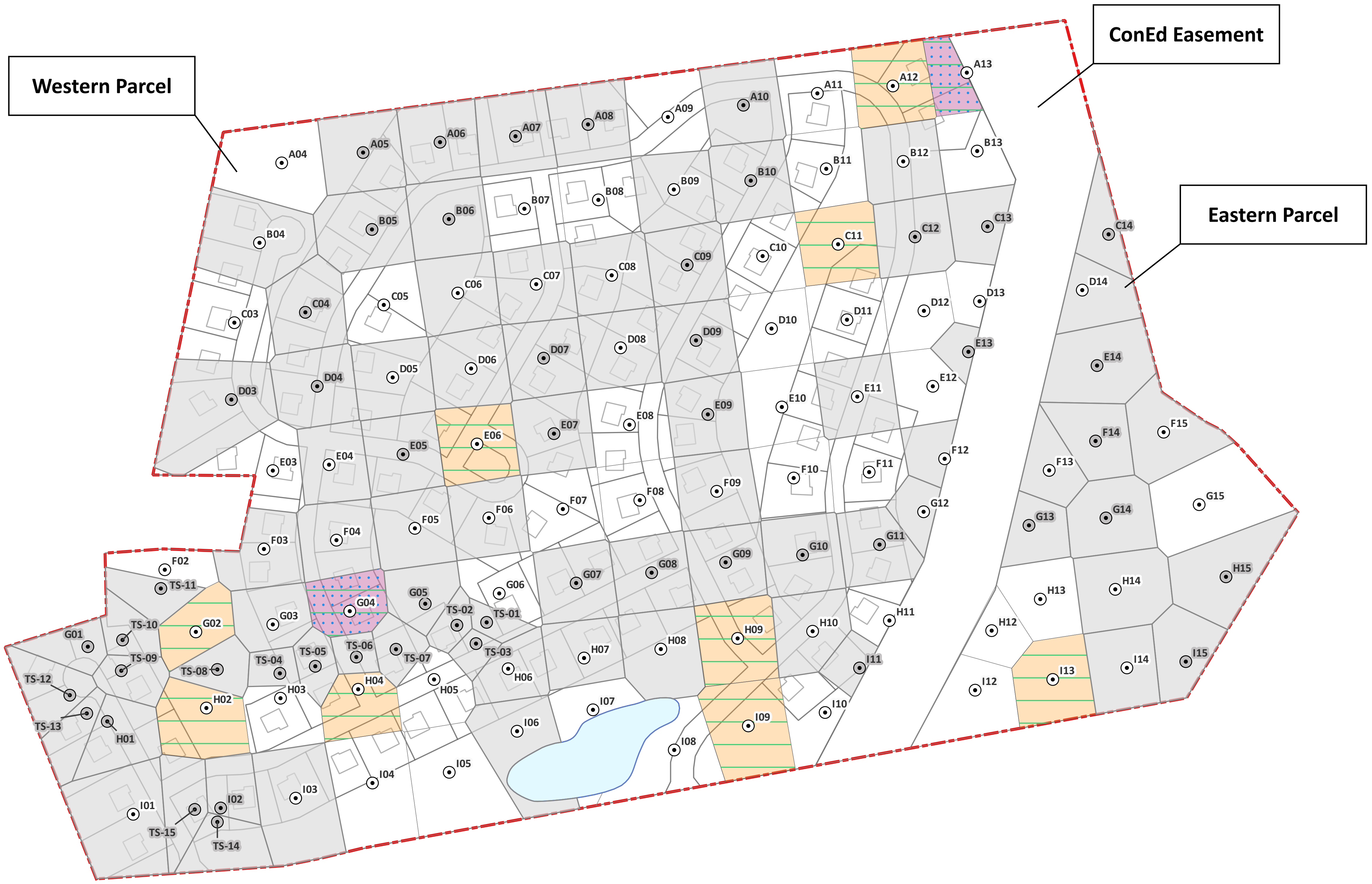
PROJECT NUMBER: CV04.001

Soil Sampling Results
Pesticides
2-4 ft bgs

Figure 4a

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

- ⬚ Site Boundary
- 🟦 Pond
- ⬜ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- 🟪 Exceeds Unrestricted Use and Residential SCOs
- ⁙ Exceeds PGW SCO
- ☰ Exceeds PEco SCO
- ⬜ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ◉ Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (2-4 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective
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PEco - Protection of Ecological Resources

DRAFT

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1 Inch = 300 Feet

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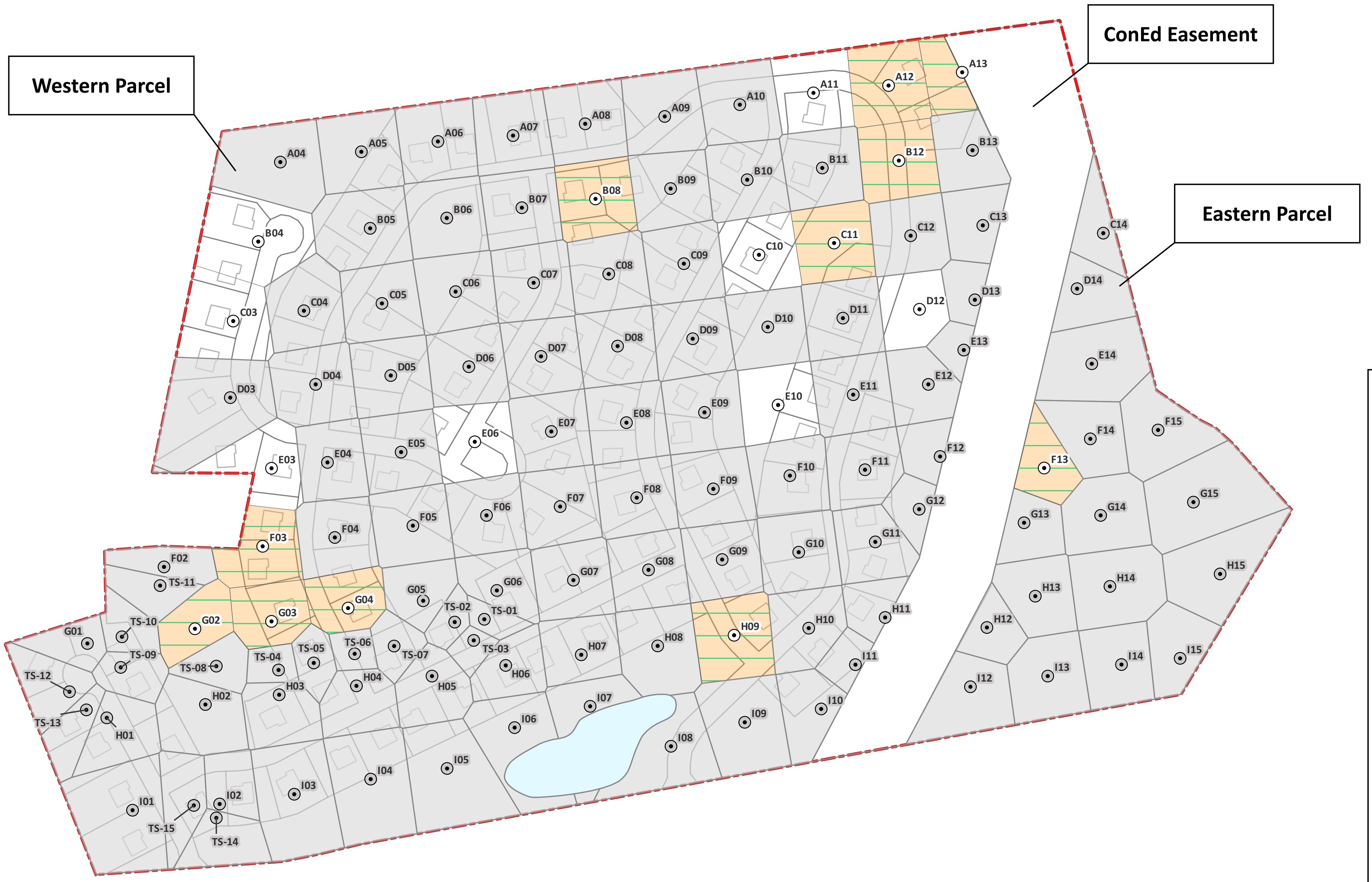
PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
Metals
2-4 ft bgs

Figure 4b

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth_Overall 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

- ▭ Site Boundary
- 🟦 Pond
- ⬜ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- ▤ Exceeds PEco SCO
- ⬜ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ◉ Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (4-6 ft bgs) at the sampling location shown.

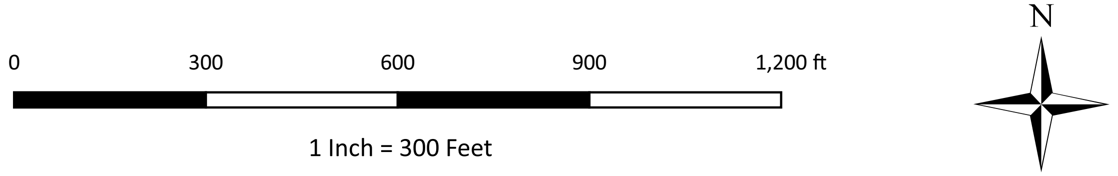
Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective
PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

DRAFT



1 Inch = 300 Feet

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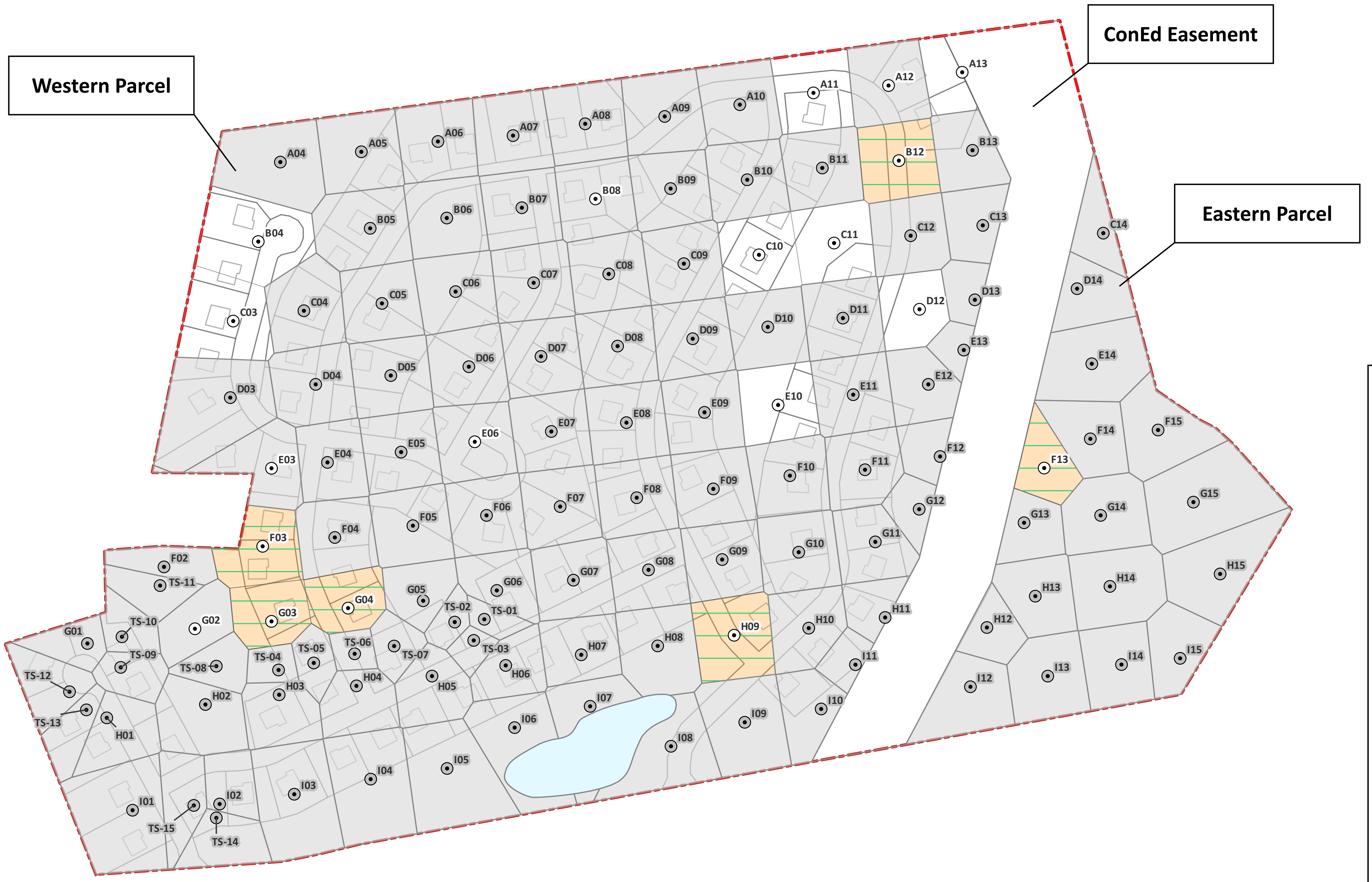
CLIENT:	Ridgewood Briarcliff Owner, LLC
PROJECT:	Elmwood Preserve Site NYSDEC Site No. C360239 850 Dobbs Ferry Road, White Plains, New York
PROJECT NUMBER:	CV04.001

Soil Sampling Results
4-6 ft bgs

Figure 5

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK



Legend

- ⬚ Site Boundary
- ▭ Pond
- ☐ Proposed Development Plan
- ▨ Exceeds Unrestricted Use SCO Only
- ▤ Exceeds PEco SCO
- ☐ No Exceedances
- ■ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ● Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (4-6 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

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PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

DRAFT

0 300 600 900 1,200 ft

1 Inch = 300 Feet

N

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CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT:
Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
Pesticides
4-6 ft bgs

Figure 5a

Legend

- ▭ Site Boundary
- 🟦 Pond
- ☐ Proposed Development Plan
- 🟧 Exceeds Unrestricted Use SCO Only
- ▤ Exceeds PEco SCO
- ☐ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ◉ Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (4-6 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective
PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

DRAFT

0 300 600 900 1,200 ft
1 Inch = 300 Feet

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PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
Metals
4-6 ft bgs

Figure 5b

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

Legend

- 🟥 Site Boundary
- 🟦 Pond
- ☐ Proposed Development Plan
- ☐ No Exceedances
- ▨ Not Sampled/ Not Analyzed

Soil Sampling Location

- ⊙ Sampled at Designated Depth
- ⊙ Not Sampled

Notes:

Data utilized for the presented SCO comparisons is from the sample collected from the associated sampling interval (≥ 6 ft bgs) at the sampling location shown.

Soil sampling results within the Western Parcel are compared against the Unrestricted, Residential, PGW, and PEco SCOs.

Soil sampling results within the Eastern Parcel are compared against the Unrestricted, Residential, Restricted Residential, PGW, and PEco SCOs.

Abbreviations:

SCO - Soil Cleanup Objective
PGW - Protection of Groundwater
PEco - Protection of Ecological Resources

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241119_Soil_Exceedance_Figures_ByDepth_Overall 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

DRAFT

0 300 600 900 1,200 ft

1 Inch = 300 Feet

N

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CLIENT: Ridgewood Briarcliff Owner, LLC

PROJECT:
Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Soil Sampling Results
≥ 6 ft bgs

Figure 6

Table 1

Soil Screening Summary (0-0.2 ft bgs)

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

Area	Chem Group	Chemical	CASRN	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	Unrestricted Use Soil Cleanup Objectives (mg/kg)	# UUSCO Exceeds	Residential Soil Cleanup Objectives (mg/kg)	# Res SCO Exceeds	Restricted Residential Soil Cleanup Objectives (mg/kg)	# Restricted Res SCO Exceeds	Protection of Groundwater Soil Cleanup Objectives (mg/kg)	# PGW SCO Exceeds	Protection of Ecological Resources Soil Cleanup Objectives (mg/kg)	# PEco SCO Exceeds
Western Parcel	PEST	Chlordane (total)	57-74-9	0.0017	0.78	E6_0-0.2	98	0.094	**19**	0.91	0	4.2	NA	2.9	0	1.3	0
Western Parcel	PEST	4,4'-DDD	72-54-8	0.00075	0.019	C11_0-0.2	98	0.0033	**12**	2.6	0	13	NA	14	0	0.0033	**12**
Western Parcel	PEST	4,4'-DDE	72-55-9	0.00062	1.5	F8_0-0.2	98	0.0033	**89**	1.8	0	8.9	NA	17	0	0.0033	**89**
Western Parcel	PEST	4,4'-DDT	50-29-3	0.0025	3.0	F7_0-0.2	98	0.0033	**85**	1.7	**1**	7.9	NA	136	0	0.0033	**85**
Western Parcel	PEST	Dieldrin	60-57-1	0.00074	1.1	G11_0-0.2	98	0.0050	**53**	0.039	**36**	0.20	NA	0.10	**26**	0.0060	**50**
Western Parcel	PEST	Endrin	72-20-8	0.0046	0.044	I7_0-0.2	98	0.014	**1**	2.2	0	11	NA	0.060	0	0.014	**1**
Western Parcel	PEST	Heptachlor epoxide	1024-57-3	0.0013	0.40	F11_0-0.2	98	0.042	**28**	0.42	0	2.1	NA	0.38	**1**	0.14	**11**
Western Parcel	INORG	Arsenic	7440-38-2	0.27	218	C10_0-0.2	98	13	**73**	16	**67**	16	NA	16	**67**	13	**73**
Western Parcel	INORG	Cadmium	7440-43-9	0.10	3.3	G11_0-0.2	98	2.5	**2**	2.5	**2**	4.3	NA	7.5	0	4.0	0
Western Parcel	INORG	Chromium III	16065-83-1	2.6	140	C10_0-0.2	98	30	**45**	36	**33**	180	NA		0	41	**30**
Western Parcel	INORG	Chromium VI	18540-29-9	0.23	1.5	G2_0-0.2	98	1.0	**1**	22	0	110	NA	19	0	1.0	**1**
Western Parcel	INORG	Lead	7439-92-1	1.0	287	B10_0-0.2	98	63	**53**	400	0	400	NA	450	0	63	**53**
Western Parcel	INORG	Mercury	7439-97-6	0.057	76	E6_0-0.2	98	0.18	**78**	0.81	**39**	0.81	NA	0.73	**41**	0.18	**78**
Western Parcel	INORG	Nickel	7440-02-0	0.21	32	A12_0-0.2	98	30	**1**	140	0	310	NA	130	0	30	**1**
Western Parcel	INORG	Zinc	7440-66-6	5.2	214	H5_0-0.2	98	109	**7**	2200	0	10000	NA	2480	0	109	**7**
Eastern Parcel	PEST	Chlordane (total)	57-74-9	0.0026	0.41	F13_0-0.2	17	0.094	**3**	0.91	0	4.2	0	2.9	0	1.3	0
Eastern Parcel	PEST	4,4'-DDD	72-54-8	0.0071	0.017	F13_0-0.2	17	0.0033	**2**	2.6	0	13	0	14	0	0.0033	**2**
Eastern Parcel	PEST	4,4'-DDE	72-55-9	0.0012	0.29	I13_0-0.2	17	0.0033	**15**	1.8	0	8.9	0	17	0	0.0033	**15**
Eastern Parcel	PEST	4,4'-DDT	50-29-3	0.0025	0.079	I13_0-0.2	17	0.0033	**13**	1.7	0	7.9	0	136	0	0.0033	**13**
Eastern Parcel	PEST	Dieldrin	60-57-1	0.0018	0.52	I13_0-0.2	17	0.0050	**13**	0.039	**7**	0.20	**4**	0.10	**6**	0.0060	**13**
Eastern Parcel	PEST	Heptachlor epoxide	1024-57-3	0.0011	0.12	E14_0-0.2	17	0.042	**7**	0.42	0	2.1	0	0.38	0	0.14	0
Eastern Parcel	INORG	Arsenic	7440-38-2	4.7	193	I13_0-0.2	17	13	**12**	16	**12**	16	**12**	16	**12**	13	**12**
Eastern Parcel	INORG	Chromium III	16065-83-1	18	126	H13_0-0.2	17	30	**6**	36	**6**	180	0		0	41	**6**
Eastern Parcel	INORG	Lead	7439-92-1	6.4	203	I13_0-0.2	17	63	**7**	400	0	400	0	450	0	63	**7**
Eastern Parcel	INORG	Mercury	7439-97-6	0.062	3.9	F13_0-0.2	17	0.18	**14**	0.81	**7**	0.81	**7**	0.73	**7**	0.18	**14**
Eastern Parcel	INORG	Zinc	7440-66-6	30	294	H14_0-0.2	17	109	**1**	2200	0	10000	0	2480	0	109	**1**

Notes:

Only constituents detected at concentrations above the unrestricted use SCOs in each area are shown.

The criteria for heptachlor epoxide are the criteria provided by the agency for heptachlor.

The criteria for chlordane (total) are the criteria provided by the agency for chlordance (alpha).

Chem Group - chemical group; INORG - metals; PEST - pesticides

NA - Soil sampling results within the Western Parcel are compared against the residential SCOs.

SCO - soil cleanup objective

Table 2
Soil Screening Summary (0-1 ft bgs)
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Chem Group	Chemical	CASRN	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	Unrestricted Use Soil Cleanup Objectives (mg/kg)	# UUSCO Exceeds	Residential Soil Cleanup Objectives (mg/kg)	# Res SCO Exceeds	Restricted Residential Soil Cleanup Objectives (mg/kg)	# Restricted Res SCO Exceeds	Protection of Groundwater Soil Cleanup Objectives (mg/kg)	# PGW SCO Exceeds	Protection of Ecological Resources Soil Cleanup Objectives (mg/kg)	# PEco SCO Exceeds
Western Parcel	VOC	Acetone	67-64-1	0.0093	0.16	TS-10_0-1	15	0.050	**1**	100	0	100	NA	0.050	**1**	2.2	0
Western Parcel	SVOC	Benzo(a)anthracene	56-55-3	0.057	14	TS-10_0-1	15	1.0	**8**	1.0	**8**	1.0	NA	1.0	**8**		0
Western Parcel	SVOC	Benzo(a)pyrene	50-32-8	0.061	11	TS-10_0-1	15	1.0	**8**	1.0	**8**	1.0	NA	22	0	2.6	**7**
Western Parcel	SVOC	Benzo(b)fluoranthene	205-99-2	0.082	13	TS-10_0-1	15	1.0	**9**	1.0	**9**	1.0	NA	1.7	**8**		0
Western Parcel	SVOC	Benzo(k)fluoranthene	207-08-9	0.040	4.6	TS-10_0-1	15	0.80	**8**	1.0	**7**	3.9	NA	1.7	**5**		0
Western Parcel	SVOC	Chrysene	218-01-9	0.057	11	TS-10_0-1	15	1.0	**8**	1.0	**8**	3.9	NA	1.0	**8**		0
Western Parcel	SVOC	Dibenz(a,h)anthracene	53-70-3	0.038	1.5	TS-10_0-1	15	0.33	**8**	0.33	**8**	0.33	NA	1000	0		0
Western Parcel	SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	0.031	6.5	TS-10_0-1	15	0.50	**8**	0.50	**8**	0.50	NA	8.2	0		0
Western Parcel	PEST	Aldrin	309-00-2	0.0017	0.024	TS-08_0-1	15	0.0050	**1**	0.019	**1**	0.10	NA	0.19	0	0.14	0
Western Parcel	PEST	Chlordane (total)	57-74-9	0.0042	0.13	TS-01_0-1	15	0.094	**4**	0.91	0	4.2	NA	2.9	0	1.3	0
Western Parcel	PEST	4,4'-DDD	72-54-8	0.0015	0.047	TS-01_0-1	15	0.0033	**6**	2.6	0	13	NA	14	0	0.0033	**6**
Western Parcel	PEST	4,4'-DDE	72-55-9	0.0046	0.45	TS-01_0-1	15	0.0033	**15**	1.8	0	8.9	NA	17	0	0.0033	**15**
Western Parcel	PEST	4,4'-DDT	50-29-3	0.0065	0.12	TS-06_0-1	15	0.0033	**15**	1.7	0	7.9	NA	136	0	0.0033	**15**
Western Parcel	PEST	Dieldrin	60-57-1	0.0017	0.48	TS-02_0-1	15	0.0050	**6**	0.039	**3**	0.20	NA	0.10	**2**	0.0060	**5**
Western Parcel	PEST	Heptachlor epoxide	1024-57-3	0.0049	0.073	TS-02_0-1	15	0.042	**1**	0.42	0	2.1	NA	0.38	0	0.14	0
Western Parcel	PCB	PCBs (total)	1336-36-3	0.016	0.79	TS-11_0-1	10	0.10	**2**	1.0	0	1.0	NA	3.2	0	1.0	0
Western Parcel	INORG	Arsenic	7440-38-2	3.9	81	TS-02_0-1	15	13	**4**	16	**4**	16	NA	16	**4**	13	**4**
Western Parcel	INORG	Lead	7439-92-1	32	209	TS-05_0-1	15	63	**10**	400	0	400	NA	450	0	63	**10**
Western Parcel	INORG	Mercury	7439-97-6	0.11	3.3	TS-01_0-1	15	0.18	**10**	0.81	**6**	0.81	NA	0.73	**6**	0.18	**10**
Western Parcel	INORG	Zinc	7440-66-6	62	312	TS-10_0-1	15	109	**9**	2200	0	10000	NA	2480	0	109	**9**

Notes:
Only constituents detected at concentrations above the unrestricted use SCOs in each area are shown.
The criteria for heptachlor epoxide are the criteria provided by the agency for heptachlor.
The criteria for chlordane (total) are the criteria provided by the agency for chlordance (alpha).
Chem Group - chemical group; INORG - metals; PCB - polychlorinated biphenyls; PEST - pesticides; SVOC - semi-volatile organic compounds; VOC - volatile organic compounds
NA - Soil sampling results within the Western Parcel are compared against the residential SCOs.
SCO - soil cleanup objective

Table 3
Soil Screening Summary (0.2-2 ft bgs)
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Chem Group	Chemical	CASRN	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	Unrestricted Use Soil Cleanup Objectives (mg/kg)	# UUSCO Exceeds	Residential Soil Cleanup Objectives (mg/kg)	# Res SCO Exceeds	Restricted Residential Soil Cleanup Objectives (mg/kg)	# Restricted Res SCO Exceeds	Protection of Groundwater Soil Cleanup Objectives (mg/kg)	# PGW SCO Exceeds	Protection of Ecological Resources Soil Cleanup Objectives (mg/kg)	# PEco SCO Exceeds
Western Parcel	VOC	Acetone	67-64-1	0.0058	0.12	D13_0.2-2	98	0.050	**1**	100	0	100	NA	0.050	**1**	2.2	0
Western Parcel	SVOC	Benzo(a)anthracene	56-55-3	0.022	15	F2_0.2-2	98	1.0	**1**	1.0	**1**	1.0	NA	1.0	**1**		0
Western Parcel	SVOC	Benzo(a)pyrene	50-32-8	0.057	16	F2_0.2-2	98	1.0	**1**	1.0	**1**	1.0	NA	22	0	2.6	**1**
Western Parcel	SVOC	Benzo(b)fluoranthene	205-99-2	0.033	20	F2_0.2-2	98	1.0	**1**	1.0	**1**	1.0	NA	1.7	**1**		0
Western Parcel	SVOC	Benzo(k)fluoranthene	207-08-9	0.036	5.6	F2_0.2-2	98	0.80	**1**	1.0	**1**	3.9	NA	1.7	**1**		0
Western Parcel	SVOC	Chrysene	218-01-9	0.020	14	F2_0.2-2	98	1.0	**1**	1.0	**1**	3.9	NA	1.0	**1**		0
Western Parcel	SVOC	Dibenz(a,h)anthracene	53-70-3	0.074	2.2	F2_0.2-2	98	0.33	**1**	0.33	**1**	0.33	NA	1000	0		0
Western Parcel	SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	0.026	9	F2_0.2-2	98	0.50	**1**	0.50	**1**	0.50	NA	8.2	**1**		0
Western Parcel	PFAS	Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	0.000090	0.0011	A4_0.2-2	12	0.00088	**1**	0.0088	0	0.044	NA	0.0010	**1**		0
Western Parcel	PEST	Chlordane (total)	57-74-9	0.0016	0.50	E6_0.2-2	98	0.094	**6**	0.91	0	4.2	NA	2.9	0	1.3	0
Western Parcel	PEST	4,4'-DDD	72-54-8	0.00063	0.032	H8_0.2-2	98	0.0033	**4**	2.6	0	13	NA	14	0	0.0033	**4**
Western Parcel	PEST	4,4'-DDE	72-55-9	0.00047	0.71	G3_0.2-2	98	0.0033	**61**	1.8	0	8.9	NA	17	0	0.0033	**61**
Western Parcel	PEST	4,4'-DDT	50-29-3	0.0015	0.422	G3_0.2-2	98	0.0033	**46**	1.7	0	7.9	NA	136	0	0.0033	**46**
Western Parcel	PEST	Dieldrin	60-57-1	0.00056	0.42	I10_0.2-2	98	0.0050	**35**	0.039	**14**	0.20	NA	0.10	**7**	0.0060	**34**
Western Parcel	PEST	Heptachlor epoxide	1024-57-3	0.0011	0.42	F11_0.2-2	98	0.042	**11**	0.42	0	2.1	NA	0.38	**1**	0.14	**3**
Western Parcel	PCB	PCBs (total)	1336-36-3	0.023	3.7	F2_0.2-2	97	0.10	**1**	1.0	**1**	1.0	NA	3.2	**1**	1.0	**1**
Western Parcel	INORG	Arsenic	7440-38-2	0.33	121	D11_0.2-2	98	13	**31**	16	**21**	16	NA	16	**21**	13	**31**
Western Parcel	INORG	Chromium III	16065-83-1	3.0	177	F11_0.2-2	98	30	**10**	36	**4**	180	NA		0	41	**3**
Western Parcel	INORG	Lead	7439-92-1	1.3	130	D11_0.2-2	98	63	**9**	400	0	400	NA	450	0	63	**9**
Western Parcel	INORG	Mercury	7439-97-6	0.049	50	E6_0.2-2	98	0.18	**30**	0.81	**11**	0.81	NA	0.73	**13**	0.18	**30**
Western Parcel	INORG	Nickel	7440-02-0	0.30	39	A12_0.2-2	98	30	**1**	140	0	310	NA	130	0	30	**1**
Western Parcel	INORG	Zinc	7440-66-6	5.1	136	F2_0.2-2	98	109	**1**	2200	0	10000	NA	2480	0	109	**1**
Eastern Parcel	VOC	Acetone	67-64-1	0.0065	0.11	F13_0.2-2	17	0.050	**1**	100	0	100	0	0.050	**1**	2.2	0
Eastern Parcel	PEST	4,4'-DDE	72-55-9	0.00051	0.22	I13_0.2-2	17	0.0033	**7**	1.8	0	8.9	0	17	0	0.0033	**7**
Eastern Parcel	PEST	4,4'-DDT	50-29-3	0.0014	0.069	I13_0.2-2	17	0.0033	**3**	1.7	0	7.9	0	136	0	0.0033	**3**
Eastern Parcel	PEST	Dieldrin	60-57-1	0.0010	0.68	H13_0.2-2	17	0.0050	**5**	0.039	**3**	0.20	**2**	0.10	**3**	0.0060	**5**
Eastern Parcel	PEST	Heptachlor epoxide	1024-57-3	0.0010	0.10	H13_0.2-2	17	0.042	**2**	0.42	0	2.1	0	0.38	0	0.14	0
Eastern Parcel	INORG	Arsenic	7440-38-2	1.4	134	I13_0.2-2	17	13	**3**	16	**3**	16	**3**	16	**3**	13	**3**
Eastern Parcel	INORG	Chromium III	16065-83-1	13	105	H13_0.2-2	17	30	**3**	36	**3**	180	0		0	41	**3**
Eastern Parcel	INORG	Lead	7439-92-1	4.4	144	I13_0.2-2	17	63	**3**	400	0	400	0	450	0	63	**3**
Eastern Parcel	INORG	Mercury	7439-97-6	0.058	1.0	H13_0.2-2	17	0.18	**5**	0.81	**1**	0.81	**1**	0.73	**2**	0.18	**5**

Notes:
Only constituents detected at concentrations above the unrestricted use SCOs in each area are shown.
The criteria for heptachlor epoxide are the criteria provided by the agency for heptachlor.
Chem Group - chemical group; INORG - metals; PCB - polychlorinated biphenyls; PEST - pesticides; PFAS - per- and polyfluoroalkyl substances; SVOC - semi-volatile organic compounds; VOC - volatile organic compounds
NA - Soil sampling results within the Western Parcel are compared against the residential SCOs.
SCO - soil cleanup objective

Table 4
Soil Screening Summary (2-4 ft bgs)
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Chem Group	Chemical	CASRN	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	Unrestricted Use Soil Cleanup Objectives (mg/kg)	# UUSCO Exceeds	Residential Soil Cleanup Objectives (mg/kg)	# Res SCO Exceeds	Restricted Residential Soil Cleanup Objectives (mg/kg)	# Restricted Res SCO Exceeds	Protection of Groundwater Soil Cleanup Objectives (mg/kg)	# PGW SCO Exceeds	Protection of Ecological Resources Soil Cleanup Objectives (mg/kg)	# PEco SCO Exceeds
Western Parcel	PEST	4,4'-DDD	72-54-8	0.00073	0.12	G4_2-4	60	0.0033	**3**	2.6	0	13	NA	14	0	0.0033	**3**
Western Parcel	PEST	4,4'-DDE	72-55-9	0.00041	0.28	B12_2-4	60	0.0033	**19**	1.8	0	8.9	NA	17	0	0.0033	**19**
Western Parcel	PEST	4,4'-DDT	50-29-3	0.0018	0.062	G3_2-4	60	0.0033	**8**	1.7	0	7.9	NA	136	0	0.0033	**8**
Western Parcel	PEST	Dieldrin	60-57-1	0.00071	0.051	I9_2-4	60	0.0050	**5**	0.039	**1**	0.20	NA	0.10	0	0.0060	**4**
Western Parcel	INORG	Mercury	7439-97-6	0.047	3.2	A13_2-4	42	0.18	**7**	0.81	**2**	0.81	NA	0.73	**2**	0.18	**7**
Western Parcel	INORG	Nickel	7440-02-0	5.7	45	H4_2-4	42	30	**3**	140	0	310	NA	130	0	30	**3**
Western Parcel	INORG	Zinc	7440-66-6	26	283	H2_2-4	42	109	**3**	2200	0	10000	NA	2480	0	109	**3**
Eastern Parcel	PEST	4,4'-DDE	72-55-9	0.00047	0.0067	I12_2-4	8	0.0033	**1**	1.8	0	8.9	0	17	0	0.0033	**1**
Eastern Parcel	PEST	Dieldrin	60-57-1	0.00059	0.0073	I12_2-4	8	0.0050	**2**	0.039	0	0.20	0	0.10	0	0.0060	**2**
Eastern Parcel	INORG	Nickel	7440-02-0	6.7	110	I13_2-4	5	30	**1**	140	0	310	0	130	0	30	**1**

Notes:
Only constituents detected at concentrations above the unrestricted use SCOs in each area are shown.
Chem Group - chemical group; PEST - pesticides; INORG - inorganics
NA - Soil sampling results within the Western Parcel are compared against the residential SCOs.
SCO - soil cleanup objective

Table 5
Soil Screening Summary (4-6 ft bgs)

Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Chem Group	Chemical	CASRN	Min Detected (mg/kg)	Max Detected (mg/kg)	Location of Max Detect	# Analyzed	Unrestricted Use Soil Cleanup Objectives (mg/kg)	# UUSCO Exceeds	Residential Soil Cleanup Objectives (mg/kg)	# Res SCO Exceeds	Restricted Residential Soil Cleanup Objectives (mg/kg)	# Restricted Res SCO Exceeds	Protection of Groundwater Soil Cleanup Objectives (mg/kg)	# PGW SCO Exceeds	Protection of Ecological Resources Soil Cleanup Objectives (mg/kg)	# PEco SCO Exceeds
Western Parcel	PEST	4,4'-DDD	72-54-8	0.0053	0.018	G4_4-6	13	0.0033	**3**	2.6	0	13	NA	14	0	0.0033	**3**
Western Parcel	PEST	4,4'-DDE	72-55-9	0.00057	0.12	B12_4-6	13	0.0033	**5**	1.8	0	8.9	NA	17	0	0.0033	**5**
Western Parcel	PEST	4,4'-DDT	50-29-3	0.0027	0.021	B12_4-6	13	0.0033	**4**	1.7	0	7.9	NA	136	0	0.0033	**4**
Western Parcel	INORG	Copper	7440-50-8	11	63	B8_4-6	9	50	**1**	270	0	270	NA	1720	0	50	**1**
Western Parcel	INORG	Mercury	7439-97-6	0.055	0.69	G4_4-6	9	0.18	**3**	0.8	0	0.8	NA	0.73	0	0.18	**3**
Western Parcel	INORG	Nickel	7440-02-0	13	39	A12_4-6	9	30	**2**	140	0	310	NA	130	0	30	**2**
Eastern Parcel	PEST	Dieldrin	60-57-1	0.016	0.016	F13_4-6	1	0.0050	**1**	0.039	0	0.20	0	0.10	0	0.0060	**1**

Notes:
Only constituents detected at concentrations above the unrestricted use SCOs in each area are shown.
Chem Group - chemical group; PEST - pesticides; INORG - metals
NA - Soil sampling results within the Western Parcel are compared against the residential SCOs.
SCO - soil cleanup objective

Table 6

Soil Screening Summary (≥ 6 ft bgs)

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

Area	Chem Group	# Analyzed	Unrestricted Use Soil Cleanup Objectives (mg/kg)	# UUSCO Exceeds	Residential Soil Cleanup Objectives (mg/kg)	# Res SCO Exceeds	Restricted Residential Soil Cleanup Objectives (mg/kg)	# Restricted Res SCO Exceeds	Protection of Groundwater Soil Cleanup Objectives (mg/kg)	# PGW SCO Exceeds	Protection of Ecological Resources Soil Cleanup Objectives (mg/kg)	# PEco SCO Exceeds
Western Parcel	VOC	5	-	0	-	0	-	0	-	0	-	0
Western Parcel	PFAS	5	-	0	-	0	-	0	-	0	-	0
Western Parcel	PEST	5	-	0	-	0	-	0	-	0	-	0
Western Parcel	PCB	5	-	0	-	0	-	0	-	0	-	0
Western Parcel	INORG	5	-	0	-	0	-	0	-	0	-	0
Eastern Parcel	VOC	1	-	0	-	0	-	0	-	0	-	0
Eastern Parcel	INORG	1	-	0	-	0	-	0	-	0	-	0

Notes:

No constituents were detected in soil at concentrations above the SCOs.

Chem Group - chemical group; INORG - metals; PCB - polychlorinated biphenyls; PEST - pesticides; PFAS - per- and polyfluoroalkyl substances; VOC - volatile organic compounds

SCO - soil cleanup objective

Appendix B

Quality Assurance Project Plan

Quality Assurance Project Plan

Elmwood Preserve

NYSDEC BCP Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

Prepared for

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Prepared by

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January 31, 2025

Project Number CV04.001.003

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APPENDICES

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D	Analytical Laboratory PFAS Standard Operation Procedures and Reporting Limits

ACRONYMS AND ABBREVIATIONS

ASP	analytical services protocol
AWQS	ambient water quality standards
BCP	Brownfield Cleanup Program
bgs	below ground surface
Carson Voci	Carson Voci Engineering and Geology, D.P.C.
COCs	chain of custody
ConEd	Consolidated Edison
DER	Division of Environmental Remediation
DER-10	*DER 10 / Technical Requirements for Site Investigation and Remediation*
DKQP	Data of Known Quality Protocols
DQO	data quality objectives
DUSR	data usability summary report
EPA	United States Environmental Protection Agency
g	grams
GC/MS	gas chromatography/mass spectrometry
L	liters
mL	milliliters
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSWER	Office of Solid Waste and Emergency Response
PCBs	Polychlorinated Biphenyls
PFAS	per- and polyfluoroalkyl substances
PFAS Guidance	*Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS)*
PID	photo-ionization detector
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RI	remedial investigation
RIWP	remedial investigation work plan
SCOs	soil criteria objectives
SV	soil vapor

SVI Guidance	*Guidance for Evaluating Soil Vapor Intrusion in the State of New York*
SV/IA	Soil Vapor/Indoor Air (Decision Matrices)
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TO-15	EPA Air Method, Toxic Organics - 15
TOGS	Technical and Operational Guidance Series
Terraphase	Terraphase Engineering Inc.
USGS	United States Geological Survey
VOC	volatile organic compound

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is prepared on behalf of Ridgewood Elmwood Owner, L.L.C. (the "Applicant and "Participant") to support the supplemental remedial investigation work plan (SRIWP) activities for the New York State (NYS) Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) Site No. C360239 identified as Elmwood Preserve at 850 Dobbs Ferry Road, White Plains, New York (Site). The SRIWP will be conducted in support of compliance with NYSDEC requirements related to the BCP.

This QAPP presents the analytical methods and procedures to be followed during implementation of the field activities to ensure that samples are representative of the actual environment from which they were collected and are of sufficient quality and quantity to meet the project objectives.

1.1 Project Scope

The purpose of the supplemental remedial investigation (RI) is to delineate the nature and extent of contamination and allow for effective evaluation of multiple BCP cleanup track alternatives. Data collected during the supplemental RI will determine the basis for future remedial actions for the Site.

All sampling activities will also be conducted in accordance with United States Environmental Protection Agency (EPA) regulations and NYSDEC guidance documents, including but not limited to:

- *DER-10, Technical Guidance for Site Investigation and Remediation.* New York State Department of Environmental Conservation. *May 3, 2010 (DER-10).*
- *Analytical Service Protocol,* New York State Department of Environmental Conservation*. July 2005.*
- *US EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R-5, March 2001).*
- *Guidance for Quality Assurance Project Plans (EPA QA/G-5, December 2002).*

1.2 Site Description and Conceptual Site Model Summary

The Site is currently owned by the Applicant, a Participant in the BCP. The approximately 106.8-acre Site consists of two parcels identified as 7.530-320.1..SG and 7.530-320-1..SE in the Town of Greenburgh, New York, Geographic Information System tax map. The Site is bisected by parcel 7.530-320-3, owned by Consolidated Edison Company of New York, Inc. (ConEd). The Site is improved by a former 18-hole golf course and country club that included several buildings for the main clubhouse and maintenance and storage shops. The buildings were located on the southwest portion of the Site and have since been demolished. The Site also included several tennis courts and a pool area. The buildings were accessed by a paved parking lot and two small roads that lead to Dobbs Ferry Road.

The planned redevelopment of the Site consists of the construction of approximately 113 private (single-family) residential homes.

The Site is currently zoned as an R-30 one-family residence and is in an urban area surrounded by residential and commercial properties. The immediate surrounding properties consist of residential homes to the north, a municipal park to the east, commercial properties to the south, and residential homes and a fire department to the west.

According to the Unites States Geological Survey's Central Park, New York, 7.5 Minute Series topographic map, the Site is located approximately 360 feet above average mean sea level. The highest elevation is located in the central portion of the Site and the Site generally slopes downward towards the property boundaries. A pond is located north of Dobbs Ferry Road along the southern property line and a small stream/drainage ditch runs through the Site to the northeast.

According to the Natural Resources Conservation Service Web Soil Survey website,[1] the dominant soil composition in the vicinity of the Site is classified as Charlton fine sandy loam, Charlton-Chatfield complex, and Paxton fine sandy loam.

Depth to groundwater at the Site was estimated to be 8 feet bgs during previous investigations. The direction of groundwater flow is inferred to be west-northwest (GZA 2017); however, surveyed monitoring wells are not yet installed at the Site to confirm groundwater flow direction.

Additional information on the geology and hydrogeology at the site will be added to the conceptual site model following as part of the RI report.

1.3 Field Sampling Plan Design

In accordance with the aforementioned regulations and guidance documents, Carson Voci prepared the SRIWP scope of work to refine the vertical extent of contaminated soils at the Site based on the evaluation of the data collected during the RI activities. The intent of the supplemental RI sampling plan is to collect sufficient data to determine the basis for future remedial actions for the Site, based on known and potentially unknown impacts to the Site.

The SRIWP program will include:

- Groundwater monitoring well installations
- Groundwater analytical sampling
- Soil borings
- Soil field screening and logging
- Soil analytical sampling

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[1] http://websoilsurvey.nrcs.usda.gov/app/

The location of the proposed field samples and a detailed summary of the samples to be collected are provided within Appendix A. Currently, only additional soil sampling is being proposed as part of the initial SRIWP scope.

2.0 DATA EVALUATION

2.1 Data Quality Objectives

Data quality objectives (DQOs) are qualitative specifications designed to ensure that data of known quality are obtained during investigative activities to support decisions regarding the selection of an appropriate remedial action. The overall DQOs for all samples to be obtained through the work encompassed by this QAPP will be to ensure that collection techniques and analyses generate results that are accurate, precise and representative of site conditions, and sufficiently sensitive to meet the most stringent standards and other applicable criteria (see Section 2.2). To further this objective, Terraphase will use the sampling methods and procedures set forth in the DER-10 and applicable Field Sampling Procedures Manual(s). Additionally, the selected NY-accredited laboratory (see Section 3) will perform all analyses in conformance with the Environmental Laboratory Approval Program (ELAP), Contract Laboratory Protocol (CLP), NYSDEC July 2005 ASP, and other applicable industry standards. As such, general DQO information is provided below but does not include all information related to the data quality assessment.

DQOs for this project are established as follows:

2.1.1 Sensitivity DQOs and Data Evaluation

These DQOs relate to the standards and criteria to which the RIWP analytical results will be evaluated. In this regard, the laboratory will be informed of the specific objectives so that the detection and reporting limits will be less than these standards and criteria to the extent feasible, and where such levels cannot be achieved, the basis for that non-conformance will be documented.

Analytical results generated during the RIWP activities addressed herein will be evaluated relative to NYSDEC standards, screening levels and other appropriate criteria applicable to each specific environmental medium, as indicated below.

Soil

- Soil analytical results will be evaluated relative to NYSDEC Standards, Criteria, and Guidance Soil Cleanup Objectives (SCOs), published in 6 NYCCR 375-6.8

Groundwater

- Groundwater analytical results will be compared to Technical Operations and Guidance Memorandum 1.1.1 (TOGS 1.1.1) Ambient Water Quality Standards (AWQS)

Soil Vapor

- Soil vapor analytical results will be compared to the NYS Department of Health (NYSDOH) "Soil Vapor/Indoor Air (SV/IA) Decision Matrices" from the Guidance for Evaluating Soil Vapor Intrusion in the State of New York.

2.1.2 Accuracy DQOs

Accuracy is the degree of difference between measured and calculated or true values. In laboratory conditions, accuracy is measured in terms of blank results, the average percent recovery of surrogate compounds or spiked compounds (matrix spike/matrix spike duplicates), and/or laboratory control samples. The acceptable level of accuracy for this project will be based on the acceptable percent recovery/difference of laboratory control spikes for each method. The laboratory will evaluate this DQO for its own laboratory data.

2.1.3 Precision DQOs

Precision expresses the closeness of agreement between data as a measure of the reproducibility of sample results. Precision DQOs are established by defining acceptance criteria for precision between duplicate results for both field duplicates and laboratory duplicates. In general, solid matrices have a greater amount of heterogeneity than liquid and gas matrices. When the RPD for detected constituents is greater than or equal to 50 percent for nonaqueous matrices, greater than or equal to 30 percent for aqueous matrices, or greater than or equal to 25 percent for gaseous matrices the representativeness of the sample results will be evaluated to assess the acceptability and usability of the analytical results.

2.1.4 Representativeness DQOs

These DQOs are established through definition of the field sampling plan, and related procedures for the collection, preservation and transport of samples, as well as through definition of appropriate analytical methodologies. The procedures that will be used to obtain representative samples are documented in Section 6 of this QAPP. The field sampling plan is presented in the RIWP.

2.1.5 Completeness DQOs

These DQOs are those used to determine the quantity of data needed for project decisions as well as the degree to which the data are appropriate for use based on the data quality assessment. For this project, the specific quantity of sampling to be conducted at the site will include the generation of soil, groundwater, and soil vapor needed to fully characterize and delineate site contamination for purposes of designing any appropriate remedial actions. The completeness of the analytical results will be assessed on an ongoing basis until the NYSDEC concludes that the standards of characterization, delineation and data quality have been met.

2.1.6 Comparability

Comparability is the degree to which one set of data can be accurately compared to another set of data that were collected by a different means or analyzed by a different entity. The objectives of the analytical laboratory for comparability are to:

1. Demonstrate traceability of standards to USEPA or NYSDEC-approved sources;
2. Use standard methodology;
3. Report results from similar matrices in standard units;
4. Apply appropriate levels of quality control within the context of the laboratory QA program, (Level III, USEPA Data Objectives for Remedial Response Activities, 1987, or equivalent); and,
5. Participate in inter-laboratory studies to document laboratory performance.

3.0 LABORATORY

The laboratory to be retained for sample analysis include the following:

Pace Analytical Services
8 Walkup Drive
Westborough, MA 01581

AND

320 Forbes Boulevard
Mansfield, MA 02048

Contact: Cynthia Pagut, Project Manager

It is possible that additional laboratories may be retained as subcontractors by the above. Information regarding contract laboratories, if utilized, will be provided within the laboratory data deliverables generated for the analytical work.

4.0 SITE CONTACTS

The following individuals will be responsible for work conducted at this property, including overall project management and coordination, sampling activities, and laboratory activities:

Remedial/Professional Engineer: Nick Krasnecky, PE
Associate Engineer
Carson Voci Engineering and Geology, D.P.C.
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Project Manager: Chris Voci
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Data/Database Manager: Madison Ingling
Senior Staff I Scientist
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Princeton, NJ 08540
973-769-8699
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Health and Safety: Daren Roth
Associate Health and Safety Director
Terraphase Engineering Inc.
7901 Stoneridge Drive, Suite 528
Pleasanton, CA 94588
925-719-5496
daren.roth@terraphase.com

On-site compliance with the required health and safety protocols to be determined based on determination on field sampler(s)

Laboratory Project Manager: Cynthia Pagut
Project Manager
Pace Analytical Sevices.
201-812-9072
Cynthia.Pagut@pacelabs.com

Third Party Data Validator: Chris Taylor
Principal
EQA, Inc.
845-239-0132
eqainc.1@gmail.com

Changes to the project team, if any, will be annotated to this QAPP.

Resumes of the pertinent project participants are included in Appendix B.

5.0 FIELD AND ANALYTICAL METHODS/QUALITY ASSURANCE

5.1 Quality Assurance/Quality Control Sampling

Quality Assurance/Quality Control (QAQC) samples will be collected in accordance with the ASP and DER-10, as shown in Table 1. The procedures to obtain the field QAQC samples are discussed below. All samples will be properly labeled, immediately placed in a cooler with ice, and submitted to the laboratory within 48 hours using standard chain-of-custody procedures. Encore soil samples will be received by the laboratory and preserved within 48 hours of collection.

Table 1: QAQC Sampling Frequency

Sample Type	Frequency
Duplicate	One per 20 samples, per matrix
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One per 20 samples, per matrix (soil and groundwater only)
Trip Blank	One per cooler when VOC samples are submitted
Equipment Blank	Once per day for aqueous matrix; 5% of the total number of samples for non-aqueous matrix, not applicable for gaseous matrix

5.1.1 Duplicate Samples

To provide an indication of analytical precision and accuracy, a minimum of 5 percent of all samples, or at least one sample of every 20 samples collected, are to be collected in duplicate. Duplicate samples will be analyzed for the same parameters as the samples. The duplicate samples will receive a sample identification number different from the actual sample location. The Chain-of-Custody Record will note the unique number and describe the sample as "duplicate", without revealing the actual sampling location.

Duplicate soil samples will be collected by dividing sampled material before placing in duplicate sample containers. Duplicate groundwater and soil vapor samples will be sent for laboratory analysis to evaluate the reproducibility of the sampling technique used.

5.1.2 Matrix Spike and Matrix Spike Duplicate Samples

To provide an indication of analytical precision and accuracy, a minimum of 5 percent of all samples, or at least one sample of every 20 samples collected, are to be collected in triplicate for a matrix spike and matrix spike duplicate (MS/MSD) analysis. The site-specific MS/MSD samples will be prepared and analyzed by the analytical laboratory by spiking an aliquot of the submitted sample volume with analytes of interest. The MS/MSD samples will be labeled with the sample ID with a -MS or -MSD added on to the end of the sample.

MS/MSD soil samples will be collected by dividing sampled material before placing in duplicate sample containers. MS/MSD groundwater samples will be collected by filling one sample jar after the other for each analysis until samples in triplicate are obtained, and then move on to the next sample jar/analysis and repeat. MS/MSD samples are only required for soil and groundwater samples.

5.1.3 Trip Blanks

Trip blanks will be used to assess whether site samples have been exposed to non-site-related volatile constituents during storage and transport. Trip blanks will be analyzed at a frequency of once per cooler containing samples to be analyzed for volatile organic constituents. A trip blank will consist of a container filled with analyte-free water (supplied by the laboratory) which remains unopened with field samples throughout the sampling event.

Trip blanks will be analyzed for VOCs only to evaluate the potential occurrence of contamination of samples during sample shipment or as a result of laboratory handling. Trip blanks will be prepared for aqueous samples preserved with hydrochloric acid at a rate of one per sample shipment (not to exceed 2 consecutive field days). These samples consist of laboratory-prepared glass bottles (40 milliliters [mL]) with an open-top screw cap and a Teflon septa or other similar sample container. The trip blanks will accompany sample containers to the field and back to the laboratory with the collected samples for analysis, remaining sealed until this time, thus ensuring similar exposure as the collected samples. No trip blanks are required for soil vapor sampling.

5.1.4 Equipment Blanks

Equipment blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Equipment blanks will be prepared and submitted for analysis at a frequency of one per day (when sample equipment cleaning occurs) or once for every 20 samples collected, whichever is more. Equipment blanks will be prepared by filling sample containers with deionized water, specifically PFAS free water if a PFAS sample is to be collected, (supplied by the laboratory) which has been routed through a cleaned sampling device. It is anticipated that some of the sampling devices and sample containers used at the site will be dedicated, including dedicated sample tubing. When dedicated sampling devices are used, or sample containers are used to collect the samples, equipment blanks will not be necessary.

Equipment blanks will be prepared by pouring analyte-free water, specifically PFAS free water if a PFAS sample and equipment blank is to be collected with that equipment, over decontaminated sampling equipment as a check that the decontamination procedure has been adequately performed and that cross contamination of samples will not occur due to the equipment. One equipment blank will be collected for each type of equipment used each day a decontamination event occurs. Equipment blanks will be performed on sampling equipment and other equipment such as water level sensors during groundwater monitoring. The same aliquot of field water may be used on all equipment coming in contact with a particular matrix for analysis for inorganic constituents. A separate equipment blank must be collected for each piece of decontaminated equipment used for a particular sample matrix. Equipment blanks will be collected at the beginning of the day before the sampling event and must accompany the samples collected that day. No equipment blanks are required for soil vapor sampling.

All equipment blanks and trip blanks will be shipped to the laboratory with the sample containers. Blanks and the associated samples will be held onsite in sample coolers with ice (water and/or reusable ice packs) and delivered to the laboratory daily (via laboratory courier pickup at the site) within one day of shipment from the field. All blanks and samples will be maintained at 4°C while stored onsite and during shipment. Sample bottles and blanks will be handled in the same manner prior to their return to the laboratory.

5.2 Analytical Methods

An Analytical Methods / Quality Assurance Summary Table is included below as per DER-10-2.4(a)2.v.. This table includes for each proposed analysis/matrix the analytical method, required sample volume, sample container size and preservative (if any), and analytical holding time. Further, the table provides anticipated sample quantities per analysis and matrix, as well as associated number and frequency of field and trip blanks, as well as for duplicate samples.

Table 2a: Soil Methods

Analysis	Mass Required (g)	Bottleware	Laboratory Method (EPA)	Preservation Required	Hold Time
TCL VOCs	15	Three EnCore samplers	8260C/D	EnCore	48 hours for lab to prep. 14 days for analysis
TCL SVOCs + 1,4-Dioxane	100	8 oz glass	8270C	None	14 days to extract, 40 days for analysis from extraction
Total Solids Analysis	50	8 oz glass	SM2540G	None	7 days to extract, 40 days for analysis from extraction
TCL Pesticides/Herbicides	100	8 oz glass	8081B/8151A	None	14 days to extract, 40 days for analysis from extraction

Table 2a: Soil Methods

Analysis	Mass Required (g)	Bottleware	Laboratory Method (EPA)	Preservation Required	Hold Time
TAL Metals	25	8 oz glass	6010C / 7471B	None	Mercury 26 days, other elements 180 days
TCL PCBs	100	8 oz glass	8082A	None	7 days to extract, 40 days for analysis from extraction
Per- and Polyfluoroalkyl Substances (PFAS)	100	8-oz HDPE	EPA Method 1633	None	14 days to extract, 40 days for analysis from extraction

Table 2b: Aqueous Methods

Analysis	Volume Required (mL)	Bottleware	Laboratory Method (EPA)	Preservation Required	Hold Time
TCL VOCs	120	Three 40 ml Vials	8260C/D	HCL < 2	48 hours for lab to prep. 14 days for analysis
TCL SVOC	2,000	Two 1 L Amber Glass	8270E	None	7 days to extract, 40 days for analysis from extraction
TCL Pesticides/Herbicides	2,000	Two 1 L Amber Glass	8081B/8151A	None	7 days to extract, 40 days for analysis from extraction
TAL Total/Dissolved Metals	500	One 500 mL Amber Glass	200.7/7470A	$HNO_3 < 2$	Mercury 26 days, other elements 180 days
TCL PCBs	300	Two 300 ml Amber Glass	8082A	None	7 days to extract, 40 days for analysis from extraction

Table 2b: Aqueous Methods

Analysis	Volume Required (mL)	Bottleware	Laboratory Method (EPA)	Preservation Required	Hold Time
Per- and Polyfluoroalkyl Substances (PFAS)	500	HDPE – 500 ml	1633	None	14 days to extract, 40 days for analysis from extraction

Table 2c: Gaseous Methods

Analysis	Volume Required (L)	Bottleware	Laboratory Method	Preservation Required	Hold Time
Toxic Organics in Air - 15	6	Batch Certified Clean Summa Canisters, laboratory calibrated 8-hour flow controllers	USEPA Method TO-15	None	Analyzed within 14 days of collection

The project compounds summary, pursuant to DER-10, is included in Table 3 below.

Table 3: Project Compounds Summary

Matrix	Project Action Limits / Project Quantitative Limits	Applicable Analytical Parameters
Soil	New York State Department of Environmental Conservation Standards, Criteria, and Guidance Soil Cleanup Objectives (SCOs), published in 6 NYCCR Part 375-6.8	VOCs; SVOCs; PCBs; Herbicides/Pesticides; Metals; Total Solids
	NYSDEC Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS). April 2023	PFAS
Groundwater	NYSDEC, Division of Water, Technical and Operational Guidance Series (TOGS) Memorandum 1.1.1, “Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations”	VOCs; SVOCs; PCBs; Herbicides/Pesticides; Total/Dissolved Metals:
	NYSDEC Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS). April 2023	PFAS

Table 3: Project Compounds Summary

Matrix	Project Action Limits / Project Quantitative Limits	Applicable Analytical Parameters
Air	New York State Department of Health May 2017 Updates to Soil Vapor/Indoor Air Decision Matrices	VOCs

Abbreviations:

VOC -- Volatile Organic Compound

SVOC -- Semi-Volatile Organic Compound.

PCB -- Polychlorinated Biphenyls.

PFAS – Per- and polyfluoroalkyl substances

TAL – Target Analyte List

TCL – Target Compound List

5.2.1 PFAS Specific Analytical Methods and Information

Environmental samples collected during the Remedial Investigation to be analyzed for PFAS, will be analyzed via EPA Method 1633. Reporting limits for Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS) in aqueous samples should not exceed 2 nanograms per liter (ng/L). Reporting limits for PFOA and PFOS in solid samples should not exceed 0.5 micrograms per kilogram (µg/kg). Reporting limits for all other PFAS in aqueous and solid media should be as close to these limits as possible. If laboratories indicate that they are not able to achieve these reporting limits for the entire PFAS Analyte List, site-specific decisions regarding acceptance of elevated reporting limits for specific PFAS can be made by the DER project manager in consultation with the DER chemist. A comprehensive list of the 40 PFAS compounds to be analyses via EPA Method 1633 is provided in Table 4 below.

Table 4: PFAS Analyte List – EPA Method 1633

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonic acids	Perfluorobutanesulfonic acid	PFBS	375-73-5
	Perfluoropentanesulfonic acid	PFPeS	2706-91-4
	Perfluorohexanesulfonic acid	PFHxS	355-46-4
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluoroalkyl sulfonic acids	Perfluorononanesulfonic acid	PFNS	68259-12-1
	Perfluorodecanesulfonic acid	PFDS	335-77-3
	Perfluorododecanesulfonic acid	PFDoS	79780-39-5
Perfluoroalkyl carboxylic acids	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	PFHpA	375-85-9

Group	Chemical Name	Abbreviation	CAS Number
	Perfluorooctanoic acid	PFOA	335-67-1
	Perfluorononanoic acid	PFNA	375-95-1
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUnA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTeDA	376-06-7
Per- and Polyfluoroether carboxylic acids	Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
	4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
	Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
	Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5
	Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6
Fluorotelomer sulfonic acids	4:2 Fluorotelomer sulfonic acid	4:2-FTS	757124-72-4
	6:2 Fluorotelomer sulfonic acid	6:2-FTS	27619-97-2
	8:2 Fluorotelomer sulfonic acid	8:2-FTS	39108-34-4
Fluorotelomer carboxylic acids	3:3 Fluorotelomer carboxylic acid	3:3 FTCA	356-02-5
	5:3 Fluorotelomer carboxylic acid	5:3 FTCA	914637-49-3
	7:3 Fluorotelomer carboxylic acid	7:3 FTCA	812-70-4
Perfluorooctane sulfonamides	Perfluorooctane sulfonamide	PFOSA	754-91-6
	N-methylperfluorooctane sulfonamide	NMeFOSA	31506-32-8
	N-ethylperfluorooctane sulfonamide	NEtFOSA	4151-50-2
Perfluorooctane sulfonamidoacetic acids	N-methylperfluorooctane sulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethylperfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6
Perfluorooctane sulfonamide ethanols	N-methylperfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7
	N-ethylperfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2
Ether sulfonic acids	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F-53B Major)	9Cl-PF3ONS	756426-58-1
	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	11Cl-PF3OUdS	763051-92-9
	Perfluoro(2-ethoxyethane) sulfonic acid	PFEESA	113507-82-7

6.0 FIELD SAMPLING METHODS

Clean sample containers will be obtained from the laboratory performing the analyses. The container type and cleaning procedure will depend upon the sample matrix, potential contaminants to be encountered, analytical methods requested, and the laboratory's quality assurance protocols. In selecting the proper container, the following will also be considered: (a) reactivity of container material with sample; (b) volume of container; (c) color of container, and (d) container closure.

An adhesive label will be attached to each bottle. Each label will have the following information written with a waterproof, non-volatile marker: (a) date of sample; (b) time of sample; (c) sample identification; (d) sampler initials; and (e) analytical parameters.

6.1 Decontamination of Sampling Equipment

6.1.1 Decontamination – General Sample Collection

To avoid cross contamination, all sampling equipment shall be clean and free from the residue of any previous samples. The use of new, dedicated sampling equipment and materials is preferred whenever possible. If equipment or materials are re-used, they should be decontaminated using, at a minimum, the following procedure:

- Clean equipment initially and following use with low phosphate detergent;
- Rinse with tap water;
- Rinse with de-ionized (DI) water; and
- Air dry

Decontamination water will be captured and collected in containers for proper off-site disposal pursuant to local and federal regulations. Heavily contaminated materials may require multiple washes and rinses, as well as rinsing in dilute hydrochloric acid.

Field instruments shall be cleaned as per the manufacturer's instructions. Avoid bringing field instruments into contact with heavily contaminated media.

6.1.2 Decontamination – PFAS Sample Collection

In addition to the general decontamination procedures outlined in Section 6.1.1, the following PFAS specific sample non-dedicated equipment decontamination procedures are to be conducted prior to the collection of a PFAS sample:

- Non-dedicated sampling equipment to be cleaned with low phosphate detergent solution consisting of Alconox or Liquinox and DI water.
- The equipment will then be rinsed once with DI water.
- A final rinse will be conducted with laboratory verified PFAS-free water.
- Powderless nitrile (non-latex) gloves will be donned during the handling and decontamination procedures.

- The SDS of detergents used in decontamination will be reviewed to ensure fluoro-surfactants are not listed as ingredients.

6.2 Sampling Methods

All procedures and sampling techniques will be conducted in accordance with the protocols outlined in the SRIWP, applicable guidance documents, in accordance with industry practices in effect at the time the sampling is completed, and site conditions. General information pertaining to the field methods to be used is provided in the subsections below.

6.2.1 Soil Sampling

Subsurface soil samplings will be collected using a hand auger or Geoprobe® direct push drilling method operated by a to-be-determined environmental drilling company. The depth, location, and number of soil borings are specified in the SRIWP, and samples will be collected and submitted for laboratory analysis in accordance with the SRIWP and this QAPP.

Samples for PFAS will be collected in accordance with the *April 2023 Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) NYSDEC* guidance provided as Appendix C and per Section 6.2.5.

The soil samples will be transferred to the sample containers with a minimum of handling. Following sample collection, the soil borings will be abandoned by backfilling with soil cuttings and bentonite to within 3 inches of the ground surface. The surface will be completed with material to match existing surface conditions.

6.2.2 Monitoring Well Installation

Monitoring well installation activities will be completed by a to-be-determined New York-licensed well driller. Monitoring wells will be installed in accordance with the SRIWP, and construction details will be logged during and upon completion of the well installations.

6.2.3 Groundwater Sampling

Groundwater samples will be collected from permanent wells no sooner than 2 weeks after installation to allow the groundwater to equilibrate. Temporary wells will be sampled within 48 hours of installation. The wells will be sampled following EPA low-flow sampling techniques,[2] and in accordance with the procedure outlined in the SRIWP.

Samples will be collected and placed in laboratory provided bottles, preserved as appropriate, and sent to the laboratory under proper chain of custody procedures. Purged groundwater will be containerized, characterized, and properly disposed. Field log entries including ground water equivalent heads, well depths, field water quality parameters, samples collected, the time of

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[2] The EPA low-flow sampling techniques can be access at: https://www.epa.gov/sites/default/files/2017-10/documents/eqasop-gw4.pdf

sample collection, odors, water color and clarity or other pertinent information will be recorded at the time of sampling.

Samples for PFAS will be collected separately in accordance with the *April 2023 Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) NYSDEC* guidance provided as Appendix C and per Section 6.2.5.

6.2.4 Air Sampling

Soil vapor samples will be collected and submitted for laboratory analysis in general accordance with the SRIWP and the *Guidance for Evaluating Soil Vapor Intrusion in the State of New York.*

6.2.5 PFAS and Emerging Contaminant Sampling

Soil and groundwater samples collected for analysis of PFAS and 1,4-Dioxane will be collected in accordance with the *April 2023 Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) NYSDEC* guidance provided as Appendix C. Soil and groundwater samples collected from select sample locations will be analyzed for 1,4-Dioxane by EPA Method 8270 SIM and for PFAS by EPA Method 1633.

The following general special considerations apply to the collection of samples for PFAS analysis:

- Food and beverages are prohibited near sampling equipment;
- No cosmetics, moisturizers, hand cream, sun screen, or clothing materials containing Gore-Tex or Tyvek to be work during sampling;
- Gloves to be nitrile (i.e. not latex);
- Field equipment will not contain Teflon®;
- All sampling material will be made from stainless steel, HDPE, acetate, silicon, or polypropylene;
- No waterproof field books;
- No plastic clipboards, binders, or spiral hard cover notebooks;
- No adhesives;
- No sharpies or permanent markers; ball point pens are acceptable;
- No aluminum;
- PFAS samples will be kept in a separate cooler from other sampling containers; and
- Coolers will be filled only with regular ice (No “Blue Ice”).

Soil samples will be homogenized in acetate and/or stainless steel bowls and placed into laboratory provided glass jars via unused acetate spoons and/or decontaminated stainless steel spoons.

Groundwater samples will be collected using a peristaltic pump or submersible stainless steel pump fitted with dedicated, non-Teflon HDPE tubing. Groundwater samples collected for PFAS will be conducted during a separate “event” at least 24 hours prior to the sampling of the monitoring well for additional analytical parameters.

6.3 Sample Labeling

The analytical laboratory will supply appropriate, pre-cleaned sample containers and preservatives, as necessary. A coding system is to be used to identify each sample taken during the sampling program. This coding system will allow for retrieval of information about a particular sample and assure that each sample is uniquely identified.

For soil samples, each sample identification number is to be composed of the soil boring location, as designated in sampling plans, as well as an additional unique field denoting the sampling interval. For groundwater, each sample identification includes a four-character location designation (e.g., MW-01) and an eight-digit date designation. Proposed sample IDs are included in Appendix A. For soil vapor sampling, each sample identification number is to be composed of the soil vapor sample location followed by the date of the sampling (e.g., SV01-YYMMDD).

6.4 Sample Handling

One member of the field sampling crew will be designated as sample manager. It will be the responsibility of this person to perform sample labeling, packaging, and shipping. The sample manager will also be responsible for ensuring that samples are handled and preserved in the proper manner.

Sample containers will be separated from any potential outside source of contamination between the time they are received from the laboratory, and the time the samples are delivered to the laboratory for analysis. Sample handling will be performed so as to guard against outside contamination being introduced to the sample containers before and after sample collection. If the containers are not used immediately, they will be stored in a suitable area, and kept cool. Following sample collection, the outer surfaces of the containers will undergo any necessary non-submersive decontamination. The samples will then be preserved on ice until they are shipped to the laboratory.

6.5 Sample Packaging

Samples that will be collected as part of this project are anticipated to be "low hazard" samples, based on a review of the analytical results for samples already collected. Therefore, no special packaging requirements are anticipated to be necessary. The samples will be packaged in coolers and appropriately cushioned during transport. The samples will be cooled to approximately 4 degrees Centigrade, using bagged ice.

6.6 Field Analytical Equipment and Associated Calibration and Maintenance Procedures

Field monitoring equipment being used by personnel during the supplemental RI will include a MiniRAE 3000 photo-ionization detector (PID), or equivalent instrumentation, both to assess the presence of any zones of potential soil contamination, as identified through readings materially above background, and in accordance with the Health & Safety Plan for the site work.

Terraphase will also use a Solinst depth to water meter (or equivalent instrumentation) to determine the depth to groundwater at temporary and permanent wells being installed. Groundwater indicator parameters will be collected using a property calibrated Horiba U-52 water quality meter equipped with a flow-through cell or equivalent instrumentation. The use of other monitoring equipment is not anticipated.

Field sampling equipment will be procured for rent as needed from Pine Environmental, Inc. of Windsor, New Jersey (or similar company). Each piece of equipment will be calibrated prior to delivery. When a PID will be on-site for more than one day, it will be calibrated daily according to instrument instructions. Records of the time, results, and ambient conditions (i.e., weather, temperature) of calibration will be kept in the project field notebook by the sampling personnel for each instrument. Calibration of the water level meter is not required.

Monitoring equipment is generally delicate and if there are any concerns identified during use of equipment as to the accuracy of the readings being collected, use of that equipment will cease and a maintenance request made with the rental provider. On-site maintenance of field monitoring equipment will not be conducted.

6.7 Duplicate Sample Collection

Duplicate samples collected for soil and groundwater will be obtained by alternately filling sample containers from the same sampling device. Soil vapor sample duplicates will be taken by utilizing a “T-Splitter” and filling the sample and duplicate sample at the same time. Ambient air duplicate cannisters will be opened and closed at the same time over their respective sampling period.

7.0 DOCUMENTATION

Proper documentation of all site activities will be maintained to trace the possession and handling of samples from the time of collection through analysis and disposition. The following procedures will be used for documentation purpose.

7.1 Field Log Books

Rainproof field logbooks will be used to record all pertinent information regarding the site and sampling procedures. Information recorded in the log books will include, but is not limited to: name and exact location of site; date and time of arrival and departure; name of person keeping log; names of all persons on site; all available information on site; composition and concentration of substance; description of sampling plan; field instrument calibration information; location of sampling points; number of samples taken; volume of samples taken; date, time and methods of sample collection and any factors that may affect its quality; name of collector; all sample identification numbers; and weather conditions on the day of sampling. Summary worksheets may also be used to confirm that all pertinent information is recorded.

7.2 Sampling Locations

Sampling points will be documented as to their exact location using GPS and field measurements. All permanent well groundwater sampling points will be surveyed by a licensed professional surveyor.

7.3 Chain of Custody

The custody record for each sample will be documented using a Chain of Custody Form (“COC”). This form will be accompanying the sample containers to the site and will remain with the samples at all times, including during sample collection, transport, and analysis. The COC bears the name of the person(s) assuming responsibility for the samples and the person who collected the sample. The COC will also specify the following information: project name; project client; laboratory conducting analyses; sample matrix; sample identification number; sample time and date; number of containers; analyses to be performed; sampler’s name; dates, name, and signatures, printed names and times of personnel relinquishing samples; signature, printed name, date, and time of personnel receiving samples.

When collecting a sample, if applicable, personnel will record the seal number associated with each sample cooler and record whether the seal was intact upon arrival in the field. This assures that the sample containers were not tampered with in the time between their preparation and their arrival on-site. After sample collection, the bottles will again be placed in the cooler. The cooler will be sealed on-site (if such seal is provided by the laboratory) and the number will be recorded in the field book.

7.4 Document Management and Archive Procedures

All field documentation discussed herein, all laboratory deliverables and any other documentation regarding the sampling programs encompassed by this QAPP will be maintained in the original electronic and paper (e.g., field notebooks) formats. Electronic files will be maintained on Carson Voci’s network servers, with backup files stored at a secure off-site location.

8.0 LABORATORY SAMPLE STORAGE PROCEDURES

Sample containers will be laboratory-cleaned and provided by the laboratory performing the analysis. Samples will be collected directly into the bottles supplied by the laboratory. Samples will be stored in the laboratory in a manner consistent with the required preservation requirements for each sample matrix and analytical methodology. The laboratory selected to perform analyses of the samples will be NYSDEC-certified and thereafter is expected to follow USEPA and NYSDEC sample storage requirements.

9.0 ANALYTICAL AND OTHER DATA REQUIREMENTS

The analytical and sampling and analysis requirements for the Site are presented in the supplemental RIWP and provided in more detail in the following sections.

9.1 Laboratory Deliverables

The laboratory will provide all soil analytical results in electronic, Category B deliverable format unless otherwise requested. The analytical data package will be accompanied by an electronic data deliverable (EDD). Data for this site will be evaluated and qualified in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, USEPA-540-R-07-003, July 2007 and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540-R-04-004, October 2004, as appropriate for the analytical methods employed.

Data generated will be uploaded to the NYSDEC's Environmental Information Management System in accordance with the NYSDEC Electronic Data Deliverable Manual, V. 4 (NYSDEC, 2018). The EDD format required is current format Earthsoft EQuIS® Environmental Data Management Software. Each EDD must be formatted and copied using an MS-DOS operating system. To avoid transcription errors, data will be loaded directly into the ASCII format from the laboratory information management system (LIMS). The laboratory will perform a QC check on the EDD before delivery. The original data, tabulations, and electronic media must be stored in a secure and retrievable fashion.

9.2 Data Records Management

All field information will be recorded in bound field books using permanent ink and recorded in electronic format on the corporate server. Paper records will be archived at the Site Team's office location.

Errors discovered in records will be corrected by entering a single line through the error and writing the corrected information above the error. The person correcting a record will initial the correction and place the date of correction next to the initial. If the person correcting the record is not the person who made the initial record, then the correcting person shall explain the correction in a permanent memo in the project file.

9.3 Data Verification and Validation

Field records and data will be provided to a Project Team member for review as soon as possible after collection or generation. The Project Team member will review field records and data deliverables for legibility, usability, and completeness within 1 week of receipt. Any noted deficiencies will be corrected as soon as possible thereafter.

Field records will conform to the specifications and requirements of the QAPP and referenced documents herein. Data will be compared to the DQOs to evaluate data usability.

An independent third-party quality assurance chemist will review the laboratory data package and prepare a data usability summary report (DUSR). The validation will conform to the USEPA

Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, USEPA-540-R-07-003, July 2007 and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540-R-04-004, October 2004, as appropriate for the analytical methods employed.

The DUSR will present the results of data validation, including a summary assessment of laboratory data packages, sample preservation, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method. A detailed assessment of each sample delivery group will be presented in the data validation report. At least 10% of the data in a data set should receive a full validation.

The validated analytical results reported by the laboratory and validated by the third-party validator will be assigned one of the following USEPA-defined data usability qualifiers:

- U – Not detected at given value
- UJ – Estimated not detected at given value (applied by third party validator)
- J – Estimated value
- N – Presumptive evidence at the value given (applied by third party validator)
- R – Result not useable (applied by third party validator)
- No Flag – Result accepted without qualification

9.4 Data Usability Summary Report

The analytical data review will be summarized by a third-party validator in a DUSR, which will include a review and evaluation of all the analytical results. The following parameters will be reviewed to ensure compliance with the analytical method protocols:

- Initial and continuing calibrations
- Blanks
- Laboratory control standards and matrix spikes
- Surrogate recoveries
- Matrix interference checks
- Field and laboratory duplicates
- Sample data
- Chain-of-custody forms
- Holding times

The report will describe the samples and parameters reviewed. Any deficiencies identified during the review will be noted and the effect on the generated data will be discussed. If warranted, the report will include recommendations for re-sampling or re-analysis.

9.5 Data Precision and Assessment Procedures

9.5.1 Field Precision

Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the measurement system.

9.5.2 Laboratory Precision

Laboratory data precision for organic analyses will be monitored through the use of surrogate spikes and laboratory duplicates. The precision of data will be measured by calculating the relative percent difference (RPD) by the following equation:

$RPD = 100*(A-B) /((A+B)/2)$

Where:

A = Analytical result from one of two duplicate measurements

B = Analytical result from the second measurement

Precision objectives for laboratory duplicate analyses are identified in the NYSDEC ASP Revision 2016.

9.5.3 Data Accuracy Assessment Procedures

Experienced field personnel, properly calibrated field meters, and adherence to established protocols will control the accuracy of field measurements. The accuracy of field meters will be assessed by review of calibration and maintenance logs.

Laboratory accuracy will be assessed via the use of surrogate spikes, internal standards, and reference standards. Where available and appropriate, quality assurance performance standards will be analyzed periodically to assess laboratory accuracy.

Accuracy will be calculated in terms of percent recovery as follows:

$\% \text{ Recovery} = 100*(A-X)/B$

Where:

A = Value measured in spiked sample or standard

X = Value measured in original sample

B = True value of amount added to sample or true value of standard

This formula is derived under the assumption of constant accuracy over the original and spiked measurements. If any accuracy calculated by this formula is outside of the acceptable levels, data will be evaluated to determine whether the deviation represents unacceptable accuracy, or variable, but acceptable accuracy. Accuracy objectives for surrogate recovery objectives are identified in the NYSDEC ASP 2016 Revision.

9.5.4 Data Completeness Assessment Procedures

The laboratory will calculate the completeness of laboratory data sets by comparing the number of valid sample results generated to the total number of results generated.

Completeness = 100*(Number valid results/Total number of results generated)

As a general guideline, overall project completeness is expected to be at least 90%.

9.6 Corrective Actions

The corrective actions typically taken by the laboratory are described below. If the calibration, instrument performance, or blank criteria are not met, the cause of the problem will be investigated and corrected. The analytical system then will be recalibrated. As part of the laboratory's operating protocol, sample analysis does not begin until calibration, instrument performance, and blank criteria are met. If matrix spike, reference standard, or duplicate analyses are found to be out of acceptable limits, the cause of the issue must be researched. Then, depending on the results of the overall QC program for the sample set, the data may be accepted, accepted with qualification, or determined to be unusable. If deemed unusable, the samples either must be reanalyzed, or a new set of samples collected and analyzed.

Deviations from the QAPP will be identified by the QA Coordinator and corrected, to the extent practicable. If the QAPP requires amending, a QAPP amendment will be attached and distributed to affected persons.

9.7 Distribution

A copy of this QAPP and any amendments will be provided to all Team Members and field personnel.

10.0 REFERENCES

GZA GeoEnvironmental, Inc. (GZA). 2017. *Phase I and Limited Phase II Environmental Site Assessment*. July 28.

New York State Department of Environmental Conservation (NYSDEC). 2018. NYSDEC Electronic Data Deliverable Manual. November. https://www.dec.ny.gov/chemical/62440.html

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NYSDEC, Division of Environmental Remediation (DER). 2010. *DER-10 / Technical Guidance for Site Investigation and Remediation (DER-10).* May 3. https://www.dec.ny.gov/regulations/67386.html.

New York State Department of Health (NYSDOH). 2006. *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*. October 26; updated May 2017. https://www.health.ny.gov/environmental/investigations/soil_gas/svi_guidance/docs/svig_final2006_complete.pdf.

United States Environmental Protection Agency (EPA). 2022. *Standard Operating Procedure for Low-Stress (Low Flow) / Minimal Drawdown Ground-Water Sample Collection.* https://www.epa.gov/sites/default/files/2015-06/documents/finalsopls1217.pdf. November 22.

APPENDIX A

PROPOSED SAMPLE LOCATION FIGURES AND SAMPLE SUMMARY TABLES

Appendix A
Table A-1
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses														
											Individual Metal Analyses[1]							
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**TCL Pesticides**	**TCL Herbicides**	**TAL Metals + Hex Chrome**	**Arsenic**	**Total + Hex Chrome**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**Sampling Rationale**
Western Parcel	A04R	A04R-0.5-1	0.5-1								X				X			Vertical Refinement - RSCOs Exceedance
		A04R-1-1.5	1-1.5								H				H			
		A04R-1.5-2	1.5-2								H				H			
		A04R-2-4	2-4				X											Vertical Delineation - UUSCOs
		A04R-4-6	4-6				H											
Western Parcel	A05R	A05R-0.2-2	0.2-2				X											Horizontal Delineation - UUSCOs Exceedance
		A05R-2-4	2-4				H											
		A05R-4-6	4-6				H											
Western Parcel	A11R	A11R-0.5-1	0.5-1								X				X			Vertical Refinement - RSCOs Exceedance
		A11R-1-1.5	1-1.5								H				H			
		A11R-1.5-2	1.5-2								H				H			
Western Parcel	A13R	A13R-2-2.5	2-2.5					X							X			Vertical Refinement - RSCOs Exceedance
		A13R-2.5-3	2.5-3					H							H			
		A13R-3-3.5	3-3.5					H							H			
		A13R-3.5-4	3.5-4					H							H			
Western Parcel	B04R	B04R-0.2-2	0.2-2				X											Horizontal Delineation - UUSCOs Exceedance
		B04R-2-4	2-4				H											
		B04R-4-6	4-6				H											
Western Parcel	B05R	B05R-0.2-2	0.2-2				X											Horizontal Delineation - UUSCOs Exceedance
		B05R-2-4	2-4				H											
		B05R-4-6	4-6				H											
Western Parcel	B08R	B08R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		B08R-1-1.5	1-1.5								H							
		B08R-1.5-2	1.5-2								H							
		B08R-6-8	6-8										X					Vertical Delineation - UUSCOs
		B08R-8-10	8-10										H					
Western Parcel	B12R	B12R-6-8	6-8					X										Vertical Delineation - UUSCOs
		B12R-8-10	8-10					H										
Western Parcel	B13R	B13R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		B13R-1-1.5	1-1.5												H			
		B13R-1.5-2	1.5-2												H			
Western Parcel	C03R	C03R-0.5-1	0.5-1					X										Vertical Refinement - RSCOs Exceedance
		C03R-1-1.5	1-1.5					H										
		C03R-1.5-2	1.5-2					H										
Western Parcel	C10R	C10R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		C10R-1-1.5	1-1.5					H			H							
		C10R-1.5-2	1.5-2					H			H							
Western Parcel	C11R	C11R-0.5-1	0.5-1								X				X			Vertical Refinement - RSCOs Exceedance
		C11R-1-1.5	1-1.5								H				H			
		C11R-1.5-2	1.5-2								H				H			
		C11R-6-8	6-8												X			Vertical Delineation - UUSCOs
		C11R-8-10	8-10												H			
Western Parcel	D04R	D04R-2-4	2-4									X						Vertical Delineation - UUSCOs
		D04R-4-6	4-6									H						
Western Parcel	D11R	D11R-0.5-1	0.5-1					X			X	X			X			Vertical Refinement - RSCOs Exceedance
		D11R-1-1.5	1-1.5					H			H	H			H			
		D11R-1.5-2	1.5-2					H			H	H			H			
Western Parcel	D13R	D13R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		D13R-1-1.5	1-1.5								H							
		D13R-1.5-2	1.5-2								H							

Table A-1
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Eastern Parcel	D14R	D14R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		D14R-1-1.5	1-1.5					H										
		D14R-1.5-2	1.5-2					H										
Western Parcel	E03R	E03R-0.5-1	0.5-1					X							X			Vertical Refinement - RSCOs Exceedance
		E03R-1-1.5	1-1.5					H							H			
		E03R-1.5-2	1.5-2					H							H			
Western Parcel	E06R	E06R-0.5-1	0.5-1					X			X				X			Vertical Refinement - RSCOs Exceedance
		E06R-1-1.5	1-1.5					H			H				H			
		E06R-1.5-2	1.5-2					H			H				H			
Western Parcel	E07R	E07R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		E07R-1-1.5	1-1.5					H			H							
		E07R-1.5-2	1.5-2					H			H							
		E07R-2-4	2-4					H			H				X			Vertical Delineation - UUSCOs (if needed)
Western Parcel	E08R	E08R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		E08R-1-1.5	1-1.5								H							
		E08R-1.5-2	1.5-2								H							
Western Parcel	E12R	E12R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		E12R-1-1.5	1-1.5								H							
		E12R-1.5-2	1.5-2								H							
Western Parcel	F02R	F02R-0.5-1	0.5-1		X	X												Vertical Refinement - RSCOs Exceedance
		F02R-1-1.5	1-1.5		H	H												
		F02R-1.5-2	1.5-2		H	H												
		F02R-2-2.5	2-2.5		H	H												Vertical Delineation - RSCOs (if needed)
		F02R-2.5-3	2.5-3		H	H												
		F02R-3-3.5	3-3.5		H	H												
		F02R-3.5-4	3.5-4		H	H												
Western Parcel	F03R	F03R-6-8	6-8					X										Vertical Delineation - UUSCOs
		F03R-8-10	8-10					H										
Western Parcel	F07R	F07R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		F07R-1-1.5	1-1.5								H							
		F07R-1.5-2	1.5-2								H							
Western Parcel	F08R	F08R-0.5-1	0.5-1					X			X	X						Vertical Refinement - RSCOs Exceedance
		F08R-1-1.5	1-1.5					H			H	H						
		F08R-1.5-2	1.5-2					H			H	H						
Western Parcel	F10R	F10R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		F10R-1-1.5	1-1.5					H			H							
		F10R-1.5-2	1.5-2					H			H							
Western Parcel	F11R	F11R-0.5-1	0.5-1					X			X	X			X			Vertical Refinement - RSCOs Exceedance
		F11R-1-1.5	1-1.5					H			H	H			H			
		F11R-1.5-2	1.5-2					H			H	H			H			
Eastern Parcel	F13R	F13R-0.5-1	0.5-1					X										Vertical Refinement/Delineation - UUSCOs Exceedance - Resample for Pesticides
		F13R-1-1.5	1-1.5					H										
		F13R-1.5-2	1.5-2					H										
		F13R-2-2.5	2-2.5					H										
		F13R-2.5-3	2.5-3					H										
		F13R-3-3.5	3-3.5					H										
		F13R-3.5-4	3.5-4					H										
		F13R-2-4	2-4					X										
		F13R-4-4.5	4-4.5					H										
		F13R-4.5-5	4.5-5					H										
		F13R-5-5.5	5-5.5					H										
		F13R-5.5-6	5.5-6					H										
		F13R-4-6	4-6					X										
		F13R-6-8	6-8					H										
		F13R-8-10	8-10					H										

Table A-1
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses														
											Individual Metal Analyses[1]							
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**TCL Pesticides**	**TCL Herbicides**	**TAL Metals + Hex Chrome**	**Arsenic**	**Total + Hex Chrome**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**Sampling Rationale**
Eastern Parcel	F15R	F15R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		F15R-1-1.5	1-1.5					H										
		F15R-1.5-2	1.5-2					H										
Western Parcel	G02R	G02R-6-8	6-8													X		Vertical Delineation - UUSCOs
		G02R-8-10	8-10													H		
Western Parcel	G03R	G03R-6-8	6-8					X										Vertical Delineation - UUSCOs
		G03R-8-10	8-10					H										
Western Parcel	G04R	G04R-2-2.5	2-2.5												X			Vertical Refinement - RSCOs Exceedance
		G04R-2.5-3	2.5-3												H			
		G04R-3-3.5	3-3.5												H			
		G04R-3.5-4	3.5-4												H			
		G04R-6-8	6-8					X							X			Vertical Delineation - UUSCOs
		G04R-8-10	8-10					H							H			
Western Parcel	G06R	G06R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		G06R-1-1.5	1-1.5												H			
		G06R-1.5-2	1.5-2												H			
Western Parcel	G07R	G07R-2-4	2-4					X										Vertical Delineation - UUSCOs
		G07R-4-6	4-6					H										
Western Parcel	G08R	G08R-2-4	2-4					X				X						Vertical Delineation - UUSCOs
		G08R-4-6	4-6					H				H						
Western Parcel	G09R	G09R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		G09R-1-1.5	1-1.5					H			H							
		G09R-1.5-2	1.5-2					H			H							
		G09R-2-2.5	2-2.5					H			H							Vertical Delineation - RSCOs (if needed)
		G09R-2.5-3	2.5-3					H			H							
		G09R-3-3.5	3-3.5					H			H							
		G09R-3.5-4	3.5-4					H			H							
		G09R-2-4	2-4					H			H				X			Vertical Delineation - UUSCOs
		G09R-4-6	4-6					H			H				H			
Western Parcel	G10R	G10R-2-4	2-4					X										Vertical Delineation - UUSCOs
		G10R-4-6	4-6					H										
Western Parcel	G11R	G11R-2-4	2-4					X										Vertical Delineation - UUSCOs
		G11R-4-6	4-6					H										
Eastern Parcel	G15R	G15R-0.5-1	0.5-1												X			Vertical Refinement - UUSCOs Exceedance
		G15R-1-1.5	1-1.5												H			
		G15R-1.5-2	1.5-2												H			
Western Parcel	H01R	H01R-2-4	2-4					X										Vertical Delineation - UUSCOs
		H01R-4-6	4-6					H										
Western Parcel	H02R	H02R-4-6	4-6														X	Vertical Delineation - UUSCOs
		H02R-6-8	6-8														H	
Western Parcel	H03R	H03R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		H03R-1-1.5	1-1.5								H							
		H03R-1.5-2	1.5-2								H							
Western Parcel	H04R	H04R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		H04R-1-1.5	1-1.5												H			
		H04R-1.5-2	1.5-2												H			
		H04R-4-6	4-6													X	X	Vertical Delineation - UUSCOs
		H04R-6-8	6-8													H	H	
Western Parcel	H05R	H05R-0.5-1	0.5-1								X							Vertical Refinement - RSCOs Exceedance
		H05R-1-1.5	1-1.5								H							
		H05R-1.5-2	1.5-2								H							

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Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Western Parcel	H06R	H06R-0.5-1	0.5-1					X										Vertical Refinement - RSCOs Exceedance
		H06R-1-1.5	1-1.5					H										
		H06R-1.5-2	1.5-2					H										
		H06R-4-6	4-6					X										Vertical Delineation - UUSCOs
		H06R-6-8	6-8					H										
Western Parcel	H08R	H08R-4-6	4-6					X										Vertical Delineation - UUSCOs
		H08R-6-8	6-8					H										
Western Parcel	H09R	H09R-0.5-1	0.5-1												X			Vertical Refinement - RSCOs Exceedance
		H09R-1-1.5	1-1.5												H			
		H09R-1.5-2	1.5-2												H			
		H09R-6-8	6-8					X										Vertical Delineation - UUSCOs
		H09R-8-10	8-10					H										
Eastern Parcel	H12R	H12R-0.5-1	0.5-1												X			Vertical Refinement - UUSCOs Exceedance
		H12R-1-1.5	1-1.5												H			
		H12R-1.5-2	1.5-2												H			
Eastern Parcel	H13R	H13R-0.5-1	0.5-1					X			X	X		X	X			Vertical Refinement - UUSCOs Exceedance
		H13R-1-1.5	1-1.5					H			H	H		H	H			
		H13R-1.5-2	1.5-2					H			H	H		H	H			
Eastern Parcel	H14R	H14R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		H14R-1-1.5	1-1.5					H										
		H14R-1.5-2	1.5-2					H										
Western Parcel	I01R	I01R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I01R-6-8	6-8					H										
Western Parcel	I04R	I04R-0.5-1	0.5-1					X			X							Vertical Refinement - RSCOs Exceedance
		I04R-1-1.5	1-1.5					H			H							
		I04R-1.5-2	1.5-2					H			H							
		I04R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I04R-6-8	6-8					H										
Western Parcel	I06R	I06R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I06R-6-8	6-8					H										
Western Parcel	I09R	I09R-0.5-1	0.5-1					X			X				X			Vertical Refinement - RSCOs Exceedance
		I09R-1-1.5	1-1.5					H			H				H			
		I09R-1.5-2	1.5-2					H			H				H			
		I09R-2-2.5	2-2.5					H										
		I09R-2.5-3	2.5-3					H										
		I09R-3-3.5	3-3.5					H										
		I09R-3.5-4	3.5-4					H										
		I09R-2-4	2-4					X										Vertical Delineation - UUSCOs Exceedance
		I09R-4-6	4-6					H							X			
		I09R-6-8	6-8					H							H			
Western Parcel	I10R	I10R-0.5-1	0.5-1					X			X	X						Vertical Refinement - RSCOs Exceedance
		I10R-1-1.5	1-1.5					H			H	H						
		I10R-1.5-2	1.5-2					H			H	H						
		I10R-4-6	4-6					X										Vertical Delineation - UUSCOs
		I10R-6-8	6-8					H										

Table A-1

Proposed Supplemental Soil Sampling Plan

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

				Soil Analyses														
											Individual Metal Analyses[1]							
Area	**Location ID**	**Sample ID**	**Sample Depth** (ft bgs)	**VOCs**	**SVOCs**	**PCBs**	**PFAS**	**TCL Pesticides**	**TCL Herbicides**	**TAL Metals + Hex Chrome**	**Arsenic**	**Total + Hex Chrome**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**Sampling Rationale**
Eastern Parcel	I12R	I12R-0.5-1	0.5-1					X			X	X		X	X			Vertical Refinement - UUSCOs Exceedance
		I12R-1-1.5	1-1.5					H			H	H		H	H			
		I12R-1.5-2	1.5-2					H			H	H		H	H			
		I12R-2-2.5	2-2.5					H										
		I12R-2.5-3	2.5-3					H										
		I12R-3-3.5	3-3.5					H										
		I12R-3.5-4	3.5-4					H										
		I12R-2-4	2-4					H										Vertical Delineation - UUSCOs
		I12R-4-6	4-6					H										
		I12R-6-8	6-8					H										
Eastern Parcel	I13R	I13R-0.5-1	0.5-1					X			X	X		X	X			Vertical Refinement - UUSCOs Exceedance
		I13R-1-1.5	1-1.5					H			H	H		H	H			
		I13R-1.5-2	1.5-2					H			H	H		H	H			
		I13R-2-2.5	2-2.5									H				X		
		I13R-2.5-3	2.5-3									H				H		
		I13R-3-3.5	3-3.5									H				H		
		I13R-3.5-4	3.5-4									H				H		
		I13R-4-6	4-6									H				H		Vertical Delineation - UUSCOs
		I13R-6-8	6-8									H				H		
Eastern Parcel	I14R	I14R-0.5-1	0.5-1					X										Vertical Refinement - UUSCOs Exceedance
		I14R-1-1.5	1-1.5					H										
		I14R-1.5-2	1.5-2					H										
Western Parcel	TS-01R	TS-01R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-01R-1-1.5	1-1.5		X			X		X								
		TS-01R-1.5-2	1.5-2		H			H		H								
		TS-01R-2-2.5	2-2.5		H			H		H								
		TS-01R-2.5-3	2.5-3		H			H		H								
		TS-01R-3-3.5	3-3.5		H			H		H								
		TS-01R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-02R	TS-02R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-02R-1-1.5	1-1.5		X			X		X								
		TS-02R-1.5-2	1.5-2		H			H		H								
		TS-02R-2-2.5	2-2.5		H			H		H								
		TS-02R-2.5-3	2.5-3		H			H		H								
		TS-02R-3-3.5	3-3.5		H			H		H								
		TS-02R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-03R	TS-03R-0-1	0-1	X	X		X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-03R-1-1.5	1-1.5		X		X	X		X								
		TS-03R-1.5-2	1.5-2		H		H	H		H								
		TS-03R-2-2.5	2-2.5		H		H	H		H								
		TS-03R-2.5-3	2.5-3		H		H	H		H								
		TS-03R-3-3.5	3-3.5		H		H	H		H								
		TS-03R-3.5-4	3.5-4		H		H	H		H								
Western Parcel	TS-04R	TS-04R-0-1	0-1	X	X	X		X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-04R-1-1.5	1-1.5		X	H		X		X								
		TS-04R-1.5-2	1.5-2		H	H		H		H								
		TS-04R-2-2.5	2-2.5		H	H		H		H								
		TS-04R-2.5-3	2.5-3		H	H		H		H								
		TS-04R-3-3.5	3-3.5		H	H		H		H								
		TS-04R-3.5-4	3.5-4		H	H		H		H								

Table A-1
Proposed Supplemental Soil Sampling Plan
Elmwood Preserve Site - NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Western Parcel	TS-05R	TS-05R-0-1	0-1	X	X		X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-05R-1-1.5	1-1.5		X		X	X		X								
		TS-05R-1.5-2	1.5-2		H		H	H		H								
		TS-05R-2-2.5	2-2.5		H		H	H		H								
		TS-05R-2.5-3	2.5-3		H		H	H		H								
		TS-05R-3-3.5	3-3.5		H		H	H		H								
		TS-05R-3.5-4	3.5-4		H		H	H		H								
Western Parcel	TS-06R	TS-06R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-06R-1-1.5	1-1.5		X			X		X								
		TS-06R-1.5-2	1.5-2		H			H		H								
		TS-06R-2-2.5	2-2.5		H			H		H								
		TS-06R-2.5-3	2.5-3		H			H		H								
		TS-06R-3-3.5	3-3.5		H			H		H								
		TS-06R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-07R	TS-07R-0-1	0-1	X	X			X		X								Vertical Delineation - UUSCOs Exceedance[2]
		TS-07R-1-1.5	1-1.5		X			X		X								
		TS-07R-1.5-2	1.5-2		H			H		H								
		TS-07R-2-2.5	2-2.5		H			H		H								
		TS-07R-2.5-3	2.5-3		H			H		H								
		TS-07R-3-3.5	3-3.5		H			H		H								
		TS-07R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-08R	TS-08R-0-1	0-1	X	X	X		X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-08R-1-1.5	1-1.5		X	X		X		X								
		TS-08R-1.5-2	1.5-2		H	H		H		H								
		TS-08R-2-2.5	2-2.5		H	H		H		H								
		TS-08R-2.5-3	2.5-3		H	H		H		H								
		TS-08R-3-3.5	3-3.5		H	H		H		H								
		TS-08R-3.5-4	3.5-4		H	H		H		H								
Western Parcel	TS-09R	TS-09R-0-1	0-1	X	X			X		X								Vertical Delineation - UUSCOs Exceedance[2]
		TS-09R-1-1.5	1-1.5		X	H		X		X								
		TS-09R-1.5-2	1.5-2		H	H		H		H								
		TS-09R-2-2.5	2-2.5		H	H		H		H								
		TS-09R-2.5-3	2.5-3		H	H		H		H								
		TS-09R-3-3.5	3-3.5		H	H		H		H								
		TS-09R-3.5-4	3.5-4		H	H		H		H								
Western Parcel	TS-10R	TS-10R-0-1	0-1	X	X	X	X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-10R-1-1.5	1-1.5		X	H	X	X		X								
		TS-10R-1.5-2	1.5-2		H	H	H	H		H								
		TS-10R-2-2.5	2-2.5		H	H	H	H		H								
		TS-10R-2.5-3	2.5-3		H	H	H	H		H								
		TS-10R-3-3.5	3-3.5		H	H	H	H		H								
		TS-10R-3.5-4	3.5-4		H	H	H	H		H								
Western Parcel	TS-11R	TS-11R-0-1	0-1	X	X	X		X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-11R-1-1.5	1-1.5		X	X		X		X								
		TS-11R-1.5-2	1.5-2		H	H		H		H								
		TS-11R-2-2.5	2-2.5		H	H		H		H								
		TS-11R-2.5-3	2.5-3		H	H		H		H								
		TS-11R-3-3.5	3-3.5		H	H		H		H								
		TS-11R-3.5-4	3.5-4		H	H		H		H								

Table A-1

Proposed Supplemental Soil Sampling Plan

Elmwood Preserve Site - NYSDEC Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

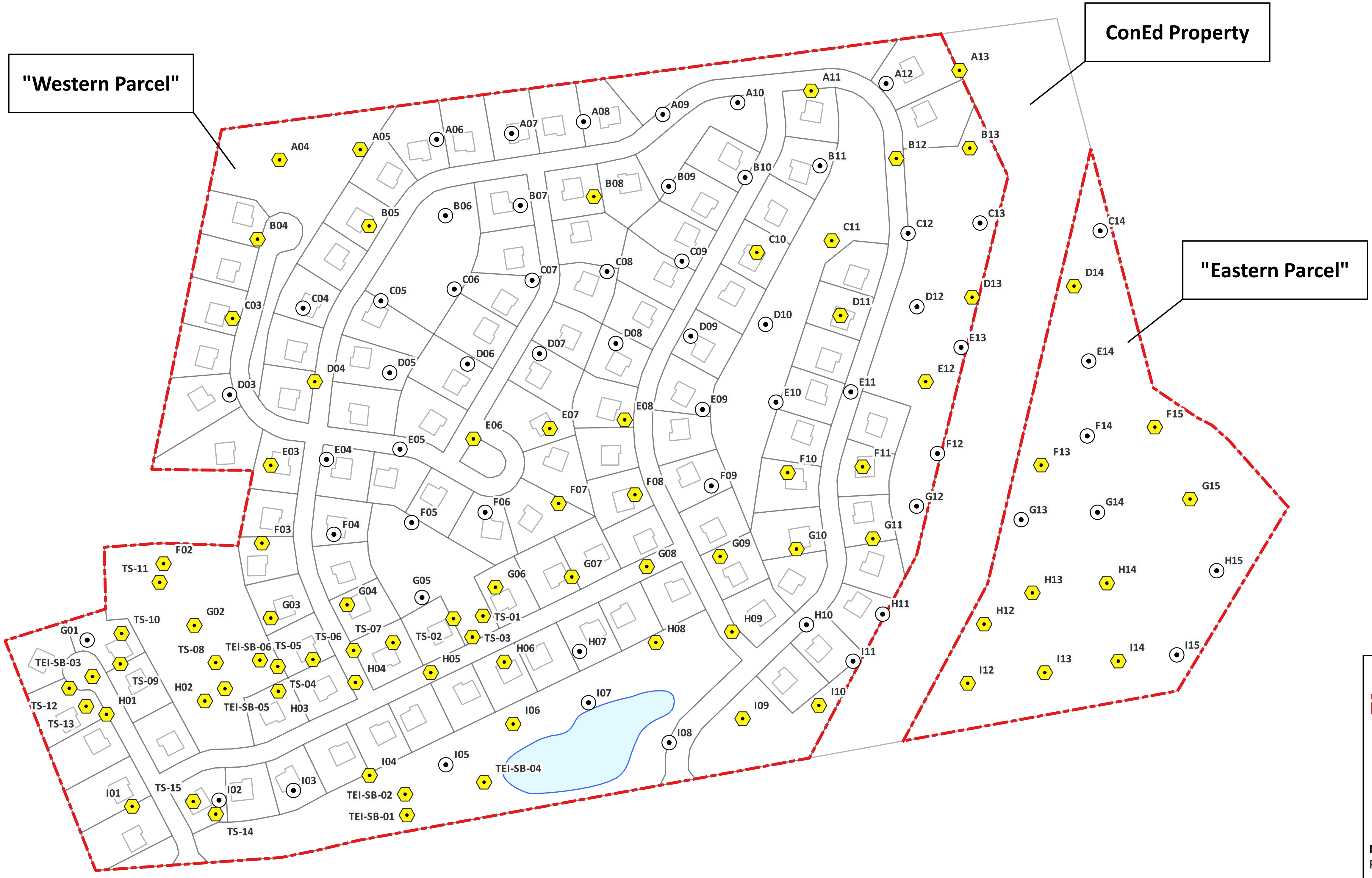
Area	Location ID	Sample ID	Sample Depth (ft bgs)	Soil Analyses														Sampling Rationale
											Individual Metal Analyses[1]							
				VOCs	SVOCs	PCBs	PFAS	TCL Pesticides	TCL Herbicides	TAL Metals + Hex Chrome	Arsenic	Total + Hex Chrome	Copper	Lead	Mercury	Nickel	Zinc	
Western Parcel	TS-12R	TS-12R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-12R-1-1.5	1-1.5		X			X		X								
		TS-12R-1.5-2	1.5-2		H			H		H								
		TS-12R-2-2.5	2-2.5		H			H		H								
		TS-12R-2.5-3	2.5-3		H			H		H								
		TS-12R-3-3.5	3-3.5		H			H		H								
		TS-12R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-13R	TS-13R-0-1	0-1	X	X			X		X								Vertical Delineation - UUSCOs Exceedance[2]
		TS-13R-1-1.5	1-1.5		X			X		X								
		TS-13R-1.5-2	1.5-2		H			H		H								
		TS-13R-2-2.5	2-2.5		H			H		H								
		TS-13R-2.5-3	2.5-3		H			H		H								
		TS-13R-3-3.5	3-3.5		H			H		H								
		TS-13R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-14R	TS-14R-0-1	0-1	X	X			X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-14R-1-1.5	1-1.5		X			X		X								
		TS-14R-1.5-2	1.5-2		H			H		H								
		TS-14R-2-2.5	2-2.5		H			H		H								
		TS-14R-2.5-3	2.5-3		H			H		H								
		TS-14R-3-3.5	3-3.5		H			H		H								
		TS-14R-3.5-4	3.5-4		H			H		H								
Western Parcel	TS-15R	TS-15R-0-1	0-1	X	X		X	X		X								Vertical Delineation - RSCOs Exceedance[2]
		TS-15R-1-1.5	1-1.5		X		X	X		X								
		TS-15R-1.5-2	1.5-2		H		H	H		H								
		TS-15R-2-2.5	2-2.5		H		H	H		H								
		TS-15R-2.5-3	2.5-3		H		H	H		H								
		TS-15R-3-3.5	3-3.5		H		H	H		H								
		TS-15R-3.5-4	3.5-4		H		H	H		H								
Western Parcel	TEI-SB-01	TEI-SB-01-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-01-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]
Western Parcel	TEI-SB-02	TEI-SB-02-X.X-X.X	X.X-X.X	X	X	X	X	X	X	X								NYSDEC Request - Vicinity of Septic Tank[2]
		TEI-SB-02-X.X-X.X	X.X-X.X	H	H	H	H	H	H	H								NYSDEC Request - Vicinity of Septic Tank[2]
Western Parcel	TEI-SB-03	TEI-SB-03-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-03-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]
Western Parcel	TEI-SB-04	TEI-SB-04-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of AST[2]
		TEI-SB-04-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of AST[2]
Western Parcel	TEI-SB-05	TEI-SB-05-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-05-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]
Western Parcel	TEI-SB-06	TEI-SB-06-X.X-X.X	X.X-X.X	X	X													NYSDEC Request - Vicinity of UST[2]
		TEI-SB-06-X.X-X.X	X.X-X.X	H	H													NYSDEC Request - Vicinity of UST[2]

Abbreviations:

X - run analysis
H - hold analysis
AST - aboveground storage tank
ft bgs - feet below ground surface
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances
RSCO - residential use soil cleanup objectives
SVOC - semi-volatile organic compounds
TAL - target analyte list
TCL - target compound list
UST - underground storage tank
UUSCO - unrestricted use soil cleanup objectives
VOC - volatile organic compounds

Note:

1 - As applicable, samples will be analyzed for only the specific metal analytes which exceeded SCOs in the RI Data.
2 - See Section 3.2.3 of the Supplemental Remedial Investigation Work Plan for sampling depth interval rationale.



Legend

▭	Site Boundary
🟦	Pond
▭	Proposed Development Plan
⊙	RI Soil Sampling Location
⬢	Proposed Supplemental Soil Sampling Location

Note:
Proposed soil sampling locations are located at the RI sampling locations. See Table 2 for the proposed sampling depths and analyses for each location.

Abbreviation:
RI -- Remedial Investigation

DRAFT

0 300 600 900 1,200 ft
1 Inch = 300 Feet

N

SAFETY FIRST

carsonvoci
engineering and geology dpc
an affiliate of Terraphase Engineering Inc

CLIENT: Ridgewood Elmwood Owner, LLC

PROJECT: Elmwood Preserve Site
NYSDEC Site No. C360239
850 Dobbs Ferry Road, White Plains, New York

PROJECT NUMBER: CV04.001

Proposed Supplemental Soil Sample Locations

Figure 4

N:\GIS\Prj\105.004_Elmwood Country Club\QGIS\20240927-Terraphase-Elmwood-SO.qgz 20241204_ProposedSamplingLocations 2024-09-26T18:29:52.000 Created by: M.Ingling Checked by: NK

APPENDIX B

RESUMES

Nicholas Krasnecky, PE

Associate Engineer

Nicholas Krasnecky, PE, has over 12 years of progressive experience in environmental consulting working on a variety of environmental characterization and remediation projects for municipal, commercial, industrial, and private clients. Mr. Krasnecky specializes in site characterization leading to the evaluation of remedial alternatives, followed by the design and implementation of the selected remedial alternative, particularly in New York and New Jersey via application of state specific environmental guidance. He utilizes his extensive environmental consulting and remediation background to support regulatory site closure, property development, risk management, evaluation for New York State Brownfield Cleanup Program (BCP) applicability, and additional client specific project goals.

Mr. Krasnecky has extensive experience with remedial treatment system design, implementation, optimization, and operations and maintenance, including groundwater pump and treat, air sparge, soil-vapor extraction (SVE), sub-slab depressurization, and dual-phase extraction systems. He has also designed and implemented in-situ remediation technologies at numerous sites, including in-situ chemical oxidation, aerobic bioremediation, in-situ chemical reduction, permeable reactive barriers, and enhanced anaerobic bioremediation.

Mr. Krasnecky has served as an engineer for various large-scale, complex remedial actions involving large work forces with multiple phases of work occurring simultaneously. His responsibilities include preparing proposals and cost estimates, producing engineering plans and specifications, collecting and analyzing field data, construction management and engineering oversight, health and safety, budget tracking, environmental and stormwater permitting, and technical report writing. Mr. Krasnecky's work has involved direct interaction with regulators, clients, and various stakeholders throughout the duration of projects including progress updates, scope alterations, and pathway to achieve project goals and regulatory closure.

Mr. Krasnecky has expertise in the assessment of vapor intrusion and mitigation practices, in particular the design, construction, and commissioning of active and passive vapor intrusion mitigation systems in both new construction and existing buildings. His experience includes direct coordination with multiples trades during planning and active construction to ensure vapor intrusion mitigation systems are installed in synergy with already prepared building and architectural plans.

Education

BS in Environmental Engineering, Rensselaer Polytechnic Institute, 2011

Years of Experience

12

Joined Terraphase

2023

Professional History

Terraphase Engineering Inc., Associate Engineer, 2023

ECC Horizon, Senior Environmental Engineer, 2018 – 2023

Kennedy/Jenks Consultants, Senior Staff Environmental Engineer, 2015 – 2017

ARCADIS, Environmental Engineer II, 2012 – 2015

Licenses/Registrations

Professional Engineer,

New York #100006

New Jersey #24GE05369900

Indiana #11900093

Certification/Training

40-Hour OSHA HAZWOPER

OSHA 10-hour Construction Safety and Health

Silica Awareness

Project Experience

401 Hunts Point - NYSDEC Brownfield Cleanup Program Site, Bronx, New York (2022 – Present)

Associate/Senior Environmental Engineer. Serves as the licensed professional engineer for the 401 Hunts Point Site enrolled in the New York State Department of Environmental Conservation (NYSDEC) BCP. Prepared the BCP application and provided regulatory coordination and consulting support through the NYSDEC review process. Prepared a Remedial Investigation Work Plan and oversees the ongoing implementation of the Remedial Investigation to fully delineate and characterize potential impacts at the site in accordance with the BCP requirements. Currently designing the Remedial Action that will incorporate soil removal via excavation, in-situ injections to treat groundwater, and the installation of an active sub-slab depressurization system, as a Remedial Action Work Plan submittal to NYSDEC. Provides ongoing project management, regulatory coordination, cost to closure estimates, and strategy support for the project.

Former Gasoline Service Station Remediation/Redevelopment, Oakland, CA (2023 – present)

Associate Engineer. Provided technical and engineering support for the remediation and redevelopment of a former gasoline service station to multi-family residential housing. Prepared engineering cost estimates and subsequent bid package for the removal of 10,000 tons of lead- and petroleum-impacted soils, prior to redevelopment. Coordinated and oversaw the implementation of a Community Air Monitoring Plan for protection of neighboring properties and communities during the ongoing excavation activities. Currently preparing a passive vapor intrusion mitigation system design and plans to be installed as part of redevelopment to mitigate potential remaining vapor intrusion impacts.

Marion County Community Justice Campus – Vapor Mitigation System, Indianapolis, Indiana, City of Indianapolis (2019 – 2021)

Senior Environmental Engineer. Engineer of Record for the design, installation oversight, and commissioning of active sub-slab vapor mitigation systems at four buildings at the City of Indianapolis's new Community Justice Campus, to mitigate potential vapor impacts from subsurface impacts associated with a Former Manufactured Gas Plant. The vapor mitigation systems were designed and installed in accordance with local, state, and federal guidance including: the IDEM Draft Interim Guidance Document (February 2014): Vapor Remedy Selection and Implementation, U.S. EPA Brownfield Technology Primer Vapor Intrusion Considerations for Redevelopment, EPA 542-R-08-001, March 2008, and applicable guidance within ANSI/AARST CC-1000-2018 – Soil Gas Control Systems in New Construction of Buildings. Buildings ranged in size from 22,000 to 120,000 square feet and required active sub-slab systems consisting of a vapor barrier, sub-slab infrastructure, and electrically powered inline fans equipped with continuous monitoring via integrated alarms and controls into the overall building management systems.

Bridge Cleaners Site Remediation and Redevelopment, Long Island City, New York, 39-26th Street LLC (2020 – Present)

Associate/Senior Environmental Engineer. Serves as the licensed professional engineer for ongoing remediation and subsequent redevelopment of the Bridge Cleaners Site, which is a former commercial dry-cleaner property enrolled as a NYSDEC State Superfund Site. Designed, constructed, and implemented an expansion to the existing Air Sparge/Soil Vapor Extraction (AS/SVE) system to expand the treatment radius of onsite groundwater. Worked in conjunction with the NYSDEC to develop and implement a Proposed Remedial Action Plan (PRAP) and Record of Decision (ROD) for the Site. Prepared NYSDEC approved work plans for the AS/SVE disconnection and relocation and redevelopment excavation and associated Community Air Monitoring Plan (CAMP) for the proposed and ongoing redevelopment of the property to an 11-story residential unit building. Provided regulatory coordination with the NYSDEC, New York State Department of Health (NYSDOH), and New York City Office of Environmental Regulation (NYC OER). Continues to provide environmental consulting and licensed profession engineering services in accordance with the redevelopment work plans and Site Management Plan (SMP).

Former Johnson and Hoffman Manufacturing Redevelopment, Carle Place, New York, Simone Development Companies (2020 – Present)

Associate/Senior Environmental Engineer. Serves as the licensed professional engineer for ongoing monitoring and reporting associated with the Site Management Plan (SMP) and for the proposed redevelopment of the Former Johnson and Hoffman Manufacturing Site, which is enrolled in the NYSDEC Voluntary Remediation Program (VRP). The redevelopment of the site involves the installation of below grade stormwater retention chambers and re-grading and paving of the property. Prepared an NYSDEC approved Redevelopment Excavation Work Plan for the management of soil potentially impacted with chlorinated solvents and polyaromatic hydrocarbons (PAHs) and the Stormwater Pollution Prevention Plan (SWPPP) for the site redevelopment. Provides regulatory coordination with the NYSDEC and NYSDOH.

Phase I and Phase II Environmental Site Assessments, New York Metro Area, Simone Development Companies

Senior Environmental Engineer. Served as the technical lead for multiple Phase I and Phase II Environmental Site Assessments (ESAs) for properties within the New York Metro Area. The Phase I and II ESAs were conducted for potential property transactions, particularly with respect to eligibility for entrance into the NYSDEC BCP.

Former Sav-O-Mat Station Petroleum Remediation, Sterling, Colorado, QBE Insurance Group Ltd. (2020 – 2023)

Senior Environmental Engineer. Served as the lead remedial engineer for the remediation of a benzene, toluene, ethylbenzene, and xylenes (BTEX) groundwater plume stemming from gas station leaking underground storage tanks (USTs) and a historical gasoline tanker spill. Evaluated the effectiveness of the ongoing AS/SVE remedial system via groundwater concentrations trends and conducted additional investigation activities, including a Membrane Interface Hydraulic Profiling (MIHPT) investigation to develop an updated conceptual site model to evaluate remedial treatment alternatives. Designed a remedial treatment approach utilizing a Vertebrae Well System® (designed and manufactured by ENRx) to deliver an in-situ chemical oxidation solution to the subsurface to treat the BTEX groundwater plume extending under a State Highway and parking lot.

Former S&S Hancock Cleaners – Site Remediation, Bedford, Indiana, Confidential Insurance Carrier (2020 – 2023)

Senior Environmental Engineer. Served as the lead remedial engineer for the remediation of a chlorinated volatile organic compound (cVOC) groundwater plume located in Karst bedrock, stemming from a former dry-cleaner. Evaluated historical groundwater data trends, groundwater flow, and geochemistry to prepare an updated conceptual site model. Prepared a remedial design and work plan for the Indiana Department of Environmental Management (IDEM) for the treatment of the cVOC groundwater plume via co-metabolic aerobic bioremediation via direct push technology injections. Implemented the proposed remedial work plan in conjunction with regular groundwater monitoring to continuously evaluate the remedial progress and adjust the remedial design accordingly.

Spivey Properties LLC – Site Remediation, Indianapolis, Indiana, Confidential Insurance Carrier (2021 – 2023)

Senior Environmental Engineer. Served as the lead remedial engineer for the remedial design for a cVOC-impacted site, stemming from a former dry-cleaner. The cVOC impacts were located in the soil, shallow groundwater, and soil vapor below a strip mall currently occupied by a daycare and commercial shops. Designed and installed a sub-slab depressurization system within the daycare tenant space, upon receipt of data indicating sub-slab soil vapor and indoor air levels above applicable standards. Evaluated on-site groundwater, soil, and soil vapor data in conjunction with the site use and current building to evaluate remedial alternatives. Prepared a remedial design and work plan for the Indiana Department of Environmental Management (IDEM) for the treatment of the cVOC impacts via limited excavation and off-site disposal of vadose zone soils and application of micro scale zero valent iron and enhanced anaerobic bioremediation solutions via direct push technology injections within the saturated zone.

Former Launderers Facility – Site Remediation, Carmel, Indiana, Confidential Insurance Carrier (2019 – 2022)

Senior Environmental Engineer. Served as the remedial engineer for the remediation of a cVOC-impacted site, stemming from a former dry-cleaner. Evaluated historical data and prepared a remedial design and work plan for the Indiana Department of Environmental Management (IDEM) for the treatment of the cVOC-impacted sub-surface soils and shallow groundwater plume. The remedial design consisted of excavation and off-site disposal of vadose zone soils and soil mixing of an enhanced anaerobic bioremediation amendment within the saturated soils. Implemented the proposed remedial work plan in conjunction post-remediation groundwater monitoring to continuously evaluate the remedial progress and design and implement a future micro scale zero valent iron and enhanced anaerobic bioremediation injection to further remediate the shallow groundwater.

Fuel Oil Underground Storage Tank – Site Remediations, New Jersey, Insurance Carriers (2018 – 2023)

Senior Environmental Engineer. Served as the lead remedial engineer for multiple fuel oil–impacted soil and groundwater remediation projects stemming from USTs, involving in-situ and ex-situ treatment strategies. Remedial technologies designed and implemented include in-situ chemical oxidation injections, bioremediation and bio-stimulation, oil recovery groundwater treatment systems, surfactant assisted free product recovery, and excavation and off-site disposal. Responsibilities included; cost evaluation and feasibility analysis of remedial technologies for final remedial design determination, engineering design and planning of remedial injections and ground water treatment systems, provide project management and technical and operations support for implementation of remedial actions, review and evaluation of collected data for remedial progress monitoring and design modifications.

Former Gasoline Station – Site Remediations, New Jersey, Insurance Carriers (2018 – 2023)

Senior Environmental Engineer. Served as the lead remedial engineer for multiple gasoline-impacted soil and groundwater remediation projects stemming from historical former gasoline station operations involving in-situ and ex-situ treatment strategies. Worked in conjunction with a New Jersey Licensed Site Remediation Professional (LSRP) to develop conceptual site models and remedial strategies to meet the developed response action objectives (RAOs). Evaluated remedial alternatives, developed remedial designs, and prepared Remedial Action Work Plans (RAWPs) and Discharge to Groundwater Permit by Rule (DGW-PBR) applications for the implementation of the remedial actions. Remedial technologies designed and implemented include limited excavation and off-site disposal with soil mixing/backfill amendments, in-situ chemical oxidation injections, bioremediation and bio-stimulation, permeable reactive barriers, and in-situ liquid carbon injections. Responsibilities included; cost evaluation and feasibility analysis of remedial technologies for final remedial design determination, engineering design and planning of remedial injections, provide project management and technical and operations support for implementation of remedial actions, review and evaluation of collected data for remedial progress monitoring and design modifications.

Former Safer Textiles - Site Remediation, New Jersey, Confidential Client (2014 – 2017)

Senior Staff Environmental Engineer. Provided engineering design and remedial oversight for a chlorinated solvent soil and groundwater remediation project involving in-situ and ex-situ treatment and containment strategies in New Jersey. Remedial technologies implemented include dual-phase vacuum extraction of dissolved and free phase tetrachloroethylene and daughter products, vapor mitigation system installation oversight in an existing building and continued air monitoring, enhanced anaerobic bioremediation, in-situ pH buffering, sediment dredging and capping, and sheet pile containment followed by site restoration including wetlands mitigation. Responsibilities included engineering oversight of remediation contractor; design, operations, maintenance, and optimization of dual-phase vacuum extraction system; design and implementation of enhanced anaerobic bioremediation injections and associated groundwater monitoring; and preparation and continued compliance of required New Jersey Department of Environmental Protection (NJDEP), County, and Town permits.

Feasibility Studies, Montana, Confidential Client (2014 – 2015)

Senior Staff Environmental Engineer. Preparation of two Feasibility Study (FS) reports and Rough Order of Magnitude (ROM) costs to identify and evaluate remedial alternatives for two sites impacted by historical railway operations. The FS addresses alternatives for multiple contaminants impacting soil and groundwater at the sites and included an excavation cut/fill and capping evaluation with respect to environmental exposure pathways risk evaluation and management.

Ramapo Paint Sludge Site, Ramapo, New York, Confidential Client (2013 – 2015)

Engineer II. Project Engineer for a remediation project in New York involving excavation and off-site disposal of paint–sludge impacted soil at 15.5-acre site. Approximately 35,000 tons of impacted soil was excavated, waste streams segregated, shipped off site for disposal, and the site subsequently backfilled, graded, and restored. Remedial action was conducted in accordance with permitting constraints involving endangered and protected wildlife habitat and location within the flood plain of a national waterway. Responsibilities included, development of the Remedial Design, based on the issued Record of Decision, in accordance with the NYSDEC Technical Regulations (DER-10); preparation of County, State, and Federal permits including the SWPPP, Soil Management Plan, and required U.S. Army Corps of Engineers (USACE) Nationwide Permits; development of technical specifications and contract drawings as part of the Request for Proposal for subcontractor selection; and performed construction engineering oversight of the implementation of the Remedial Action.

Former Manufactured Gas Plant – Site Remediation, New Jersey, Confidential MGP Client (2012 – 2014)

Engineer II. Staff Engineer for a remediation project involving excavation and off-site disposal of contaminated material underlying a bridge at a former manufactured gas plant site in New Jersey. Approximately 6,000 tons of impacted soil was excavated and sent off site for disposal. The bridge and associated storm water drainage was demolished and rebuilt according to New Jersey Department of Transportation Specifications and Regulations. Impacted material was within a tidal creek therefore creek diversion and a two-part excavation was implemented. Responsibilities included design and development of a Remedial Action Work Plan (RAWP), technical specifications, contract drawings, and bid package; review and recommendation of remedial contractor proposals; reviewed and approval of remedial contractor submittals, change orders, and progress reports throughout the duration of construction.

Manufacturing Facility HSCA Site Remediation, Delaware, Confidential Client (2012 – 2014)

Engineer II. Staff Engineer for remedial design and implementation of a HSCA Site Remediation in Delaware for PCB- and pesticide-impacted soils and sediments; and a dissolved benzene and BCEE plume. PCB and pesticide impacts were located in a 50,000 square foot drainage channel and were remediated via capping and excavation and off-site disposal to mitigate human and ecological risks. A pump and treat system was designed and implemented to treat the 10 to 15 acre dissolved benzene and BCEE plume to protect an active water supply well. Soil and sediment remediation responsibilities included design of grading plans for soil and sediment remediation, pre-excavation delineation and confirmatory sampling plan, and the PCB Clean-Up plan based on the EPA voluntary clean-up regulation; analysis of risk assessment via ProUCL to design the excavation and grading limits to meet the required ecological and human health based risk concentrations. Dissolved plume remediation responsibilities included design, sizing, and equipment selection of the groundwater conveyance and treatment system including submersible pumps, pipe sizes and material, trenching details, bag filters, GAC units; and the P&ID; design and development of associated figures and site plans for contract documents; and development of cost estimates.

Christopher Voci, PG

Senior Principal Geologist | Vice President of East Coast Operations

Christopher Voci, PG, is Vice President of East Coast Operations for Terraphase Engineering Inc. and a Senior Principal Geologist in the Philadelphia, Pennsylvania, office. Mr. Voci's career encompasses three decades in the design, management, and implementation of environmental restoration programs under federal, state, and voluntary regulatory compliance initiatives across the nation with a focus on site closure strategies. Mr. Voci develops creative solutions to hydrogeologic characterization and remediation challenges, specializing in the application of innovative remediation technologies. Mr. Voci is a pioneer in the field of bioremediation for chlorinated solvents and has decades of remediation experience with conventional and novel technologies for a wide range of compounds in soil and groundwater. Mr. Voci has managed soil and groundwater sites with emerging contaminants including per- and polyfluoroalkyl substances (PFAS), 1,4-dioxane, and chlorinated propane compounds.

Mr. Voci leads hydrogeological investigations, performs contaminant forensics using compound-specific isotope analysis (CSIA) and resolves complexities associated with multi-source and commingled groundwater plumes in porous media and fractured bedrock aquifer systems. Mr. Voci has been engaged as a third-party expert to review cost allocation models, conceptual site models and remediation system performance.

In his role as a strategic adviser and advocate to potentially responsible parties (PRPs), Mr. Voci brings decades of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) experience from Superfund sites across the country and has been involved with each stage of the CERCLA process from National Priority List (NPL) inception to delisting. Mr. Voci manages polychlorinated biphenyl (PCB) clean-up sites under Toxic Substances Control Act (TSCA) and has a depth of experience with inorganic compounds in soil and sediment and groundwater.

Mr. Voci is a leader in Terraphase's Due Diligence practice in an advisory role to large-scale private equity acquisition and transaction programs for a wide range of commercial, industrial, and agricultural properties.

Mr. Voci is involved with environmental litigation cases and mediation projects, upon which he has developed successful strategies to support cost allocation and liability defense matters. His client advocacy for legal, industrial manufacturing, and investment clients is nationally recognized. Mr. Voci has also served as the technical lead for environmental cost allocation mediation involving private and public parties. He is a strong client advocate and effective regulatory negotiator.

As an active member of the Interstate Technology and Regulatory Council, Mr. Voci is engaged in the developing science of PFAS characterization and remediation and collaborates with regulators and stakeholders in the management of PFAS sites. Mr. Voci has contributed to advances in remediation technologies through his decades of applied research on contaminated properties.

Education

MA in Physical Science/Geology, West Chester University, 1996

BA in Geo/Environmental Studies, Shippensburg University of Pennsylvania, 1991

Years of Experience

30+

Joined Terraphase

2015

Professional History

Terraphase Engineering Inc., Senior Principal Geologist, 2022 – present
Principal Geologist, 2015 – 2022

Geosyntec Consultants, Associate Hydrogeologist, 2009 – 2015

O'Brien & Gere, Technical Associate, 2002 – 2008

Levine Fricke Recon, Hydrogeologist, 1997 – 2002

Advanced Geoservices, Geologist, 1992 – 1997

Licenses/Registrations

Professional Geologist, Pennsylvania – #PG-0003892

Registered Professional Geologist, South Carolina – #2368

Professional Geologist, Illinois – # 196.001434

Professional Geologist, Kansas – #PG920

Professional Geologist, Kentucky – #KY-2475

Professional Geologist, Virginia – #2801001818

Professional Geologist, New York – #001239-01

Project Experience

North Penn Area 5 Superfund Site, Colmar, Pennsylvania, PRP Group (2012 – present)

Project Director 2012 – 2017, Project Coordinator 2018 to present. Project Coordinator for a volatile organic compound (VOC) Superfund Site in U.S. Environmental Protection Agency (USEPA) Region 3. The project includes work under three Unilateral Administrative Orders: an interim remediation of the overburden groundwater aquifer; investigation of vapor intrusion for the facility above the groundwater contamination; and the Remedial Investigation (RI) on the groundwater contamination in the bedrock aquifer beneath the site. Mr. Voci has led work under all three orders including design and implementation of the overburden bioremediation, the bedrock groundwater characterization, a CSIA groundwater forensics study, and regulatory advocacy and support for the PRPs.

Metro-Container Superfund Site, Stauffer Management Company (2015 – present)

Technical Committee Representative. Technical Committee Representative for Stauffer Management Company, a PRP to a CERCLA site in Delaware County, Pennsylvania. The project involves the investigation and remediation of PCBs, light non-aqueous phase liquids (LNAPL), and VOCs, including 1,4-dioxane from a former drum recycling facility with a history of chemical manufacturing and petroleum refining dating back over 100 years. The focused remedial investigation (FRI) includes a PFAS investigation.

Spectron Superfund Site, Elkton, Maryland, Confidential Client (2009 – 2013, 2023 - Present)

Technical Advisor 2009 – 2013. Technical advisor for in-situ reductive dechlorination (IRD) remedy for Operable Unit 1 of the Spectron Superfund Site in Elkton, Maryland. Authored and implemented the USEPA Region 3 approved Treatability Study Workplan. The IRD was applied to a mixed suite of over 20 dense non-aqueous phase liquid (DNAPLs) and high-concentration VOCs in soil and bedrock groundwater.

Project Hydrogeologist, Project Director 2023 – Present. Technical and regulatory lead for ongoing long-term monitoring program currently in the third 5-year review period. Current work included a bedrock groundwater characterization for PFAS.

Confidential Client, Port of Los Angeles (2018 – 2022)

Remediation Design Lead. Remediation design lead for a large-scale enhanced in-situ biodegradation application for a VOC source area in a saline groundwater system beneath an active shipping terminal. The project involves client advocacy for a multi-party dispute and regulatory negation with the Los Angeles Regional Water Quality Control Board (RWQCB).

Philadelphia Energy Solutions Refinery, Hilco Redevelopment Partners (HRP) (2021 – present)

Project Director. Project Director for the redevelopment of the largest refinery on the East Coast, which was purchased out of bankruptcy in 2021. The 150-year-old former petroleum refinery is also enrolled in the Pennsylvania Regulated Tank Corrective Actions Program. Terraphase is engaged to provide consulting support under Pennsylvania's Land Recycling Program (Act 2) for the site, which is being redeveloped as a state-of-the-art e-commerce, logistics and life science hub. Mr. Voci is Pennsylvania Professional Geologist of record for Pennsylvania Department of Environmental Protection (PADEP) regulatory submittals.

Campus Bay, Richmond, California, Zeneca (2019 – present)

Remediation Design Lead. Remediation Design Lead for a large-scale enhanced in-situ bioremediation program at an 86-acre site to address VOCs in groundwater from a former chemical, pesticide, and fertilizer plant operations. Responsibilities include contributions to the Feasibility Study/Remedial Action Plan (FS/RAP), implementation of a bench-scale treatability study, 100% Design development and regulatory response, and implementation of the full-scale chemical reduction with zero-valent iron (ZVI) and in-situ bioremediation (ISB) remedy in 2023 and 2024.

Lower Passaic Superfund Site, Confidential Client (2018 – present)

Principal Consultant. Evaluation of potential contaminant contributions on a $2 billion Superfund Sediment site in New Jersey to quantify a paint manufacturing client's allocation percentage. The cost allocation exercise was reviewed by third-party allocator for approximately 100 participating parties and presented to USEPA. Work also included a CERCLA cost recovery claim filed by a large contributing PRP against our client.

Wellington, Kansas, RICOH, Aircraft Manufacturing Facility (2017 – present)

Project Director/Manager. Project Manager and Director for a former manufacturing facility groundwater site investigation project under Kansas Department of Health & Environment (KDHE) oversight. RICOH engaged Terraphase to review the results of over two decades of environmental investigation and remediation activities and to develop a closure strategy for the legacy site. Through this process, Mr. Voci revealed that additional bedrock groundwater investigation was unnecessary due to errors in the historical dataset and analyzed the data to resolve the conceptual site model for the site. As the hydrogeologist for the site, Mr. Voci completed the site characterization, designed and implemented a novel combination of chemical reduction with ZVI and ISB to pursue site closure in 2024.

Irvine, CA, Confidential Client

Principal/Project Manager. Remediation support for a former agricultural pesticide packaging facility with groundwater impacted with 1,2-dichloropropane (1,2-DCP), 1,3-dichloropropene (1,3-DCP), ethylene dibromide (EDB or 1,2-DBA), methyl bromide, and methylene chloride. Responsible for developing an alternative in-situ remediation strategy, and for an on- and off-site groundwater monitoring program.

Store Space, Philadelphia, Pennsylvania (2022 – 2023)

Technical Director. Design lead for implementation of a mercury and PCB building material remediation project at storage facility that was constructed in a former 19th century pyrometer and thermometer manufacturing facility. The work involved implementation of the mercury and PCB abatement of over 30,000 square feet and wall surfaces concurrent with site construction activities under an accelerated schedule.

Former H.B Ives Plant, New Haven, Connecticut, Schlage Lock (2015 – 2020)

Project Director & Geologist. Project Director and Lead Geologist for a multi-media full site characterization and final remediation of the former H.B. Ives hardware manufacturing facility in New Haven, Connecticut, under the Transfer Act. The investigation work involved > 200 soil borings, 50 soil-vapor points, and 30 monitoring wells to consolidate 42 Areas of Concern (AOCs) into 12 release areas that were remediated using soil-vapor extraction and cap/cover design. With the investigation and remediation complete, Schlage sold the property in 2020 with support from Terraphase in completing the Transfer Act closure.

Lawrence Berkeley National Laboratory, Berkeley, California (2020)

PCB Task Manager. Developed a clean-up plan for PCBs in extant tunnels beneath the University of California, Lawrence Berkeley National Laboratory. The work involved investigation design, PCB sampling and data interpretation, and regulatory support for a PCB Performance Based Disposal under the 40 CFR section 761.61(b) TSCA.

1065 Park Avenue, New York, New York

Project Director. Managed the response and clean-up of a heating oil release from a 10,000-gallon underground storage tank (UST) beneath a 30-story-high rise cooperative apartment building on the Upper East Side of Manhattan. The work involved regulatory interactions with the New York State Department of Environmental Conservation (NYSDEC) and the New York City Department of Environmental Protection (NYCDEP).

Due Diligence Support, Pennsylvania and New Jersey Properties, Hilco Real Estate (HRE; 2021 – present)

Project Director. Project director for due diligence and site investigation of numerous properties in Pennsylvania and New Jersey to perform American Society for Testing and Materials (ASTM) Phase I Environmental Site Assessments (ESAs), New

Jersey Preliminary Assessments, and direct site characterization and cleanup under Act 2 in Pennsylvania and the Site Remediation Program in New Jersey.

Private Developer, Redwood City, California

Remediation Task Manager. Design and implementation support for an in-situ thermal conductive heating program that resulted in a 99% destruction of the chlorinated solvent source associated with a former dry-cleaner that operated at the property.

Pennsylvania Act 2 Investigation, Scranton, Pennsylvania (2018 – present)

Project Director. Investigation and closure of a spill of No. 4 Fuel Oil, which occurred from a former 15,000-gallon UST in 1996, that was never officially closed by PADEP. Prepared Remedial Action Completion and Final Reports to support the closure without the need for additional active remedial actions. The case was officially closed by PADEP pursuant to Pennsylvania Act 2 regulations.

Gowanus Canal Superfund Site, Confidential Client (2017)

Project Director. Project Director for a cost allocation model review to support Gowanus Canal Superfund Site PRP contribution negotiations. The work involved mapping, deconstruction, and testing of a model that was developed to assign cost allocation percentages to parties involved in the Gowanus Canal Superfund Site. The second phase of work focused on developing a sensitivity analysis by running multiple scenarios to reveal biases and limitations of the cost allocation model.

Newtown Superfund Site, Confidential Client (2017 – present)

Project Director. Project Director for consulting support to a public utility involved in the Newtown Creek Superfund Site.

Agricultural Due Diligence Portfolio Manager, Private Equity Client (2016 – present)

Partnership Support. Project strategist and Director for numerous of due diligence projects performed to support large-scale agricultural investments throughout the West Coast from a private equity investor in California.

National Due Diligence Portfolio Manager, Confidential Clients (2012 – present)

Attorney-Investor Partnership Support. Project strategist and manager for scores of due diligence projects ranging from ASTM E1527-13 and E2247–08 Phase I ESAs to complicated environmental liability valuation support on capital asset projects. Most projects are performed to support large-scale prospective deals by private equity and institutional investors that rely on the project outcomes to inform their decision process and purchase negotiations.

Multiple Sites and Locations, Allegion (2013 – present)

Project Manager. Project Director and National Client Manager for a $2 billion international lock manufacturer. The projects include (soil, soil-vapor, and groundwater) investigation and remediation sites associated with former manufacturing facilities in throughout the country. Due diligence services include domestic and international Phase I and Phase II ESAs in the U.S., China, Mexico, and Australia. Project successes include finalizing site closure under Michigan Department of Environmental Quality (MDEQ) regulations of a former facility in Saranac, Michigan, and a PCB clean-up and Region I USEPA TSCA closure of a large former hardware manufacturing in USEPA Region I. Current projects under Mr. Voci's direction and management include soil and groundwater remediation and closure strategy development under the Connecticut property transfer law ("Transfer Act") and project strategy support for a former industrial property in Orange County, California.

Swope Oil Superfund Site, Camden County, New Jersey, Swope Superfund Group (2009 – 2014)

Project Manager/Lead Hydrogeologist. Project Manager/Lead Hydrogeologist for a chlorinated solvent site within a regional VOC plume located in Camden County, New Jersey. Site compounds included chlorinated ethenes and chlorinated ethanes and 1,4 dioxane. Mr. Voci authored the site RI, and completed a vapor intrusion study and the feasibility study. Region II USEPA accepted and issued a Record of Decision for a Monitored Natural Attenuation remedy for groundwater.

Malvern TCE Superfund Site, Chester County, Pennsylvania, Malvern-TCE PRP Group (2002 – 2009)

Hydrogeologist – Remediation Design. Optimized an enhanced in-situ biodegradation (EISB) groundwater study resulting in the negotiated change of the Superfund Site Record of Decision (ROD) from groundwater extraction and treatment to EISB.

Carolawn Superfund Site, Fort Lawn, South Carolina, Carolawn Superfund Group (2002 – 2008)

Remediation Manager. Technical Design and Implementation – Remediation manager for EISB remedy to replace the current pump-and-treat remedy of a former solvent storage facility in the Piedmont region of north central South Carolina.

Dresser Rand Active Heavy Equipment Manufacturing Facilities in Olean, Painted Post and Wellsville, New York, Ingersoll Rand (2012 – 2017)

Project Manager. Project Manager for an active spill case in Olean, New York, under NYSDEC management. Mr. Voci was brought in by the responsible party of the site to negotiate with NYSDEC on the status and path forward for an active facility with 27 AOCs. Through the analysis, evaluation and presentation of the previous site consultant's investigation data, Mr. Voci successfully reduced the number of AOCs from 27 to 3, and obtained a No Further Action designation for the site, which was closed in 2014. Ingersoll Rand has retained Terraphase to pursue regulatory closure of two other NYDEC Spills Program sites in Painted Post and Wellsville, New York, in 2015. Both sites have undergone remediation and are currently pursuing regulatory closure.

NPL Delisting, Marathon Battery Superfund Site, Eastlake Ohio, New York, Confidential Client (1993 – 1996)

Field Manager. Provided field coordination for remedial closure of a former nickel-cadmium battery plant sediment site adjacent to mature marshland, a tidal estuary, and the shoals of the Hudson River. The project was conducted with USEPA and U.S. Army Corps of Engineers (USACE) oversight in conjunction with the National Audubon Society. The site remedy for lead and cadmium involved on-site ex-situ phosphate-chemistry-based soil stabilization and off-site disposal via rail. Surface water was treated through an on-site wastewater treatment plant and discharged to the Hudson River.

Former Chemical Manufacturing Facility, Cleveland, Ohio, BASF Chemical Company (2013 – 2015)

Project Director. Project director for a multi-million-dollar Resource Conservation and Recovery Act (RCRA) Corrective Action Program at the former Harshaw Chemical Company facility. The facility dates back to the late 1800s with chemical manufacturing, plating operations, uranium fluoride production, uranium oxide production, hydrofluoric acid production, catalysts production, and metal finishing products that lead to present-day RCRA Corrective Action. Additional site activities include operation and optimization of an existing operating groundwater treatment system and overseeing the decontamination and demolition of several site structures. Constituents of concern include chlorinated solvents, fuel-related hydrocarbons, 1,4-dioxane, heavy metals, PCBs, and radiological constituents (uranium, thorium, radium). Demolition and corrective action have been initiated and will continue through 2015.

Multiple Railyard Properties, Pennsylvania and New Jersey, Confidential Client (2009 – present)

Technical Advisor/Third-Party Reviewer. Mr. Voci served as a technical advisor and continues in a litigation support role for a national rail company on several properties in Pennsylvania and New Jersey. The projects range from environmental management; site investigation; and remediation of LNAPL, PCBs, metals, semivolatile compounds, and petroleum-related contamination. Mr. Voci is currently an expert in a litigation support capacity for ongoing matter involving historical railroad property transfers. His current railroad projects also include a complex coast allocation project to support a rail client in the pursuit of PRPs resulting from the discovery of buried wastes during a pipeline utility construction in northern New Jersey.

Active Manufacturing Facility, Henderson, Kentucky, Confidential Client (2010 – 2012)

Kentucky Professional Geologist. Technical Consultant, Site Kentucky Professional Geologist for remediation of chromium in groundwater using a novel application of in-situ redox management using emulsified soybean oil to effect a change in groundwater oxidation reduction potential to favor chemical precipitation of chromium. Initial injections were completed in September 2009, site closure reports were submitted in 2011, and the site was closed in 2012.

Marjol Battery Superfund Site, Throop, Pennsylvania, Confidential Client (1993 – 1996)

Field Manager. Provided field coordination for several investigation sequences of a former lead-acid battery recycling facility adjacent to the Lackawanna River in the Borough of Throop, Lackawanna County in the coal region of Pennsylvania. Project highlights included the development of a novel soil pore water sampling approach and invention of silica flour injection equipment to emplace lysimeter filter packs in deep battery casing material landfill areas.

Somerville Landfill Redevelopment Project, Somerset County, New Jersey, Somerville Borough (2009 – 2015)

Hydrogeologist. Hydrogeologist and remediation team leader for the groundwater investigations associated with the redevelopment of a former municipal landfill owned by the Borough of Somerville. Investigations developed and managed include surface geophysical surveys, borehole geophysical logging and packer testing, and a trial application of a proprietary magnetic groundwater tracer technology to map leachate and overburden groundwater flow. Lead author for the remedial action portion of a combined Remedial Investigation Report/Remedial Action Workplan (RIR/RAW) that was approved by New Jersey Department of Environmental Protection (NJDEP) in September 2011. Managed the final design for a stream replacement and engineered wetland remedy at the site.

Act 2 Spill Response, Johnsonburg, Pennsylvania, Confidential Client (2011 – 2012)

Project Manager and Geologist. Mr. Voci was engaged to respond to a diesel spill in rural northwestern Pennsylvania in February 2011. The spill occurred approximately one-half mile upstream from a local community’s water supply intake. The project goal to complete the soil and surface water investigation, remediate the site, conduct the site restoration, and obtain a release of liability under Act 2 through demonstration of attainment of the Statewide Health Standard within a compressed 90-day period was met under Mr. Voci’s management and regulatory negotiation.

Act 2 Former Fuel Dispenser Site, Jones Township, Pennsylvania (2011 – 2012)

Geologist. Mr. Voci performed an investigation and remediation of a historical fuel dispenser operation and completed a Statewide Health Standard attainment demonstration for the site under Act 2. The work involved access to a remote forested area and the investigation of a historical logging fuel system that was discovered during road construction. Mr. Voci self-performed all aspects of the project and obtained regulatory closure for the site owner.

In Situ Bioremediation, Former Brewery Canning Facility, Volney, New York, Miller Brewing (2005 – 2008)

Lead Scientist. Lead scientist for implementation of an EISB program for large mixed chlorinated solvent plume (tetrachloroethene [PCE] and 1,1,1-trichloroethane [1,1,1-TCA]) in groundwater. The EISB program included groundwater geochemistry evaluation, laboratory treatability study design and data interpretation, injection of electron donor/substrate, and performance monitoring.

Remediation Design and Implementation, Chemical Manufacturing Facility, Birmingham, New Jersey, Laxness Chemical Company (2002 – 2009)

Remediation Lead. Designed and implemented in-situ chemical oxidation (ISCO) for a mixed chlorinated solvent/hydrocarbon plume using ozone injection technology for an Industrial Site Recovery Act (ISRA) site. Prepared and submitted a groundwater remedial action workplan (RAW) detailing a large-scale EISB remedy for the treatment of chlorinated propane compounds in groundwater.

Insurance Cost Recovery, Confidential Client, Automobile Industry (2002 – 2009)

Technical Support Hydrogeologist. Technical support hydrogeologist for environmental cost estimation and technical review; report preparation included analysis of potential private party environmental (property value diminution/bodily injury) claim and natural resource damage claim liabilities; report was used to support settlement negotiations related to historical insurance policies. Supported successful technical negotiations with multiple insurance carriers resulting in more than $20 million in recoveries.

Insurance Cost Recovery, Confidential Client, Transformer Manufacturing Industry (2009)

Lead Hydrogeologist. Lead Hydrogeologist for environmental cost estimation and technical review and settlement report preparation involving quantification of past and potential future environmental cost liabilities for numerous former and active domestic and international transformer manufacturing facilities associated with PCB and VOC contamination.

Active Manufacturing Facility, Stonewall, Virginia, Confidential Client (2009 – 2011)

Technical Consultant. Technical Consultant, Site Professional Geologist for the monitoring natural attenuation remediation of chlorinated solvents in groundwater downgradient of three different Solid Waste Management Units.

MTBE Plume Investigation and Remediation, Valley Stream, New York, Confidential Client (2000 – 2001)

Project Manager. Managed groundwater investigation and remediation activities associated with a half-mile-long methyl tert-butyl ether (MTBE) plume on Long Island. The site was the first in New York to employ continuous multi-chamber tubing wells for vertical groundwater characterization and ozone injection for MTBE remediation.

Newport News Shipyard, Newport News, Virginia, Northrop Grumman (2002 – 2007)

Lead Hydrogeologist. Technical Design and Implementation - Lead hydrogeologist for Remedy Identification, Evaluation and Selection (RIDES) process. Mr. Voci refined the site conceptual model using membrane interface probe (MIP) characterization techniques and designed the ozone injection remediation system for the site and directed the overall design program for the solid waste management unit (SWMU).

RCRA Facility EISB Application, Lancaster County, Pennsylvania, Confidential Client

Project Manager/Hydrogeologist. Project manager/Hydrogeologist for a RCRA site involving EISB, and a groundwater extraction and treatment remedy. Successfully implemented one of the first biostimulations/bioaugmentations in fractured rock.

Cosmetic Implements Manufacturing Facility ISRA Program, EISB Application, Essex County, New Jersey, Revlon (2002 – 2008)

Remediation Designer. Remediation designer for an ISRA site with NJDEP approval and oversight. Site involved batch delivery of sodium lactate and KB-1 bioaugmentation.

Support Investigation and Remediation, Central California, Confidential Client, Project Manager (1997 – 2000)

Project Manager. Managed groundwater and vadose zone investigations and remediation associated with a PCE release beneath a shopping center in Central California. All work was conducted with third-party review under a California RWQCB order.

Selected Abstracts and Presentations

- Voci, C.J., Campeau, D., Jones C., Elmendorf, C.N. Large-scale Design and Implementation of Zero-Valent Iron Coupled with In-Situ Bioremediation for VOC Treatment. Thirteenth International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Denver, Colorado. June 2024. (pending)
- Voci, C.J., Chlorinated Solvent Remediation via Hydraulic Emplacement of Zero-Valent Iron and In-Situ Bioremediation, 38th Annual Conference on Soils, Sediments, Water, and Energy. Amherst, Massachusetts. October 17-20, 2022.
- Voci, C.J. and Roberts, J.D. The Salt Life - Reductive Dechlorination of Chlorinated Ethenes and Ethanes in Saline Groundwater. Twelfth International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palms Springs, California. May 2022.
- Voci, C.J. and Gulli. A.K., Post-Bioremediation Bulk Vinyl Chloride Attenuation Rate Estimation in an Overburden Groundwater Aquifer in Kansas. Eleventh International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palms Springs, California. May 2018.

- Voci, C.J. and Croteau, D. Challenges of Managing a Low Concentration 1,2,3-Trichloropropane Site in California. Eleventh International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palms Springs, California. May 2018.
- Voci, C.J., Croteau, D and Geckler, G., Targeted Small Source Zone In Situ Thermal Treatment: Lessons Learned at Two Chlorinated VOC Applications. Eleventh International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palms Springs, California. May 2018.
- Voci, C., N. Durant, and J. Roberts. 2010. Bioaugmentation for Treatment of a High-Concentration Chlorinated Solvent Complex Mixture. Platform Presentation. Seventh International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterey, California. May 2010.
- Voci, C., J. Roberts, S. Dworatzek, and P. Dennis. 2009. Biodegradation of High 1,2-Dichloropropane Concentrations in Microcosms Containing Dehalococcoides and Dehalobacter Organisms. Platform Presentation. 10th International In Situ and On-Site Bioremediation Symposium. Baltimore, Maryland. May 2009.
- Voci, C., S. Fogel, M. Findlay. 2008. Bioaugmentation Overcomes Inhibitory Conditions Resulting In Complete TCA and TCE Dechlorination in Fractured Rock. Platform Presentation. Sixth International Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterey, California. May 2008.
- Voci, C., S. Fogel, M. Findlay. 2007. Bioaugmentation Culture Acclimation Troubleshooting in Initially Inhibitory Groundwater Conditions. Poster Presentation. Battelle.
- Voci, C. 2004. Ethanol Biostimulation and Bioaugmentation of a VOC-Impacted Carbonate Aquifer. Battelle Press, Paper/Platform Presentation Proceedings from the Battelle Conference for the Remediation of Recalcitrant Compounds, May 2004.
- Voci, C. 2004. Ethanol Biostimulation and Bioaugmentation of a VOC-Impacted Carbonate Aquifer Update. Platform Presentation. National Groundwater Association Fractured Bedrock Conference, September 2004.
- Nichols, E.M., and Voci, C.J., 2001. Evaluation of an Ozone-Air Sparging Pilot Test to Remediate MTBE in Groundwater on Long Island, NY. Presented at the 17th Annual International Conference on Contaminated Soils, Sediments and Water, October 22-25, 2001.
- Voci, C. 1996. Comparison of X-Ray Refinements and Electron Microprobe Analyses for Pyromorphite and Chlorapatite. West Chester University of Pennsylvania, MS Thesis.

Alexander Strohl, PG

Project Geologist

Mr. Strohl is a Licensed Professional Geologist with more than 9 years of experience in the environmental consulting industry. As a Project Geologist, he is responsible for directing multi-media site characterization programs involving groundwater, soil, surface water, soil vapor, and sediment sample collection for a variety of target contaminants including, chlorinated hydrocarbons, petroleum hydrocarbons, per- and polyfluoroalkyl substances (PFAS), metals, Polychlorinated Biphenyls (PCBs) and others. He has supervised environmental investigation and remediation including soil excavation, in-situ groundwater remediation, petroleum and chemical storage tank decommissioning, and monitoring well installation and abandonment. Mr. Strohl is also responsible for preparing Work Plans, Phase I Environmental Site Assessments (ESAs), and investigation-related technical reports for clients and regulatory agencies. Mr. Strohl is experienced in utilizing groundwater contaminant plume models in addition to his experience in developing environmental conceptual site models.

Mr. Strohl's project experience includes complex remedial investigation projects, the Pennsylvania Voluntary Cleanup (Act 2) Program, PFAS sampling and reporting, Phase I and II ESAs, tank investigations/removal, desktop auditing of oil and gas waste disposal facilities, Spill Prevention, Control, and Countermeasure (SPCC) inspections of oil and gas facilities, regulatory reporting for landfills, and National Pollutant Discharge Elimination System (NPDES) sampling and reporting.

Project Experience

Former Philadelphia Refinery, Philadelphia, Pennsylvania, Philadelphia Energy Solutions Refining and Marketing (2021 – present)

Professional Geologist of Record. Developed investigation work plans and site characterization reports to assist with closure of a 1,400-acre, 150-year-old former petroleum refinery. The site is currently enrolled in the Pennsylvania Regulated Tank Corrective Actions Program and the Pennsylvania Voluntary Cleanup Program for multiple sources of contamination. Certified the closure reports as the Professional Geologist of record.

Jennersville Hospital, West Grove, Pennsylvania, Tower Health (2022 – present)

Project Manager. Planned and managed a complex site investigation for PFAS at a hospital property impacted by the discharge of laundry greywater. The investigation included a rigorous quality assurance program, which was executed to the satisfaction of the client and third-party consultant reviewers. The implemented protocols for prevention of cross contamination have proven to be effective; quality assurance blanks have not detected PFAS substances above laboratory detection limits. The site will be enrolled in Act 2.

Multiple Act 2 Project Sites, Pennsylvania (2021 – present)

Professional Geologist of Record. Developed and certified Final Reports as the Professional Geologist of record to receive release of liability through the Act 2 program. Sites have included a recently developed car dealership where improper reporting for former underground storage tanks (USTs) had previously failed to demonstrate attainment of the selected

Education

BS in Geosciences, with a minor in Spanish, The Pennsylvania State University, 2015

Years of Experience

9

Joined Terraphase

2021

Professional History

Terraphase Engineering Inc.,

Project Geologist, 2024 – present

Senior Staff Geologist, 2021 – 2023

Environmental Standards, Inc., Staff Geoscientist, 2015 – 2021

Licenses/Registrations

Pennsylvania Licensed Professional Geologist (PG) No. 5519, 2021

Delaware Licensed Professional Geologist (PG) No. S4-0011440, 2024

New Hampshire Licensed Professional Geologist (PG) No. 927, 2024

Certification/Training

Synergis Technologies' 32-Hour AutoCAD Essentials, 2015

OSHA HAZWOPER 29 CFR 1910.120 and 8-Hour Refresher, Valid through 2023

First Aid/CPR/AED Trained, Valid through 4/2025

SafeLand USA Trained

standard, and a former rail yard where multiple potential sources of contamination were investigated as part of the redevelopment of a property to a large residential apartment complex.

Pollock Park and Pottstown Plating Works, Pottstown, Pennsylvania, Montgomery County Redevelopment Authority (2017 – 2021)

Task Manager and Field Team Leader. Managed soil and groundwater sampling activities at chlorinated hydrocarbon-impacted sites. Neighboring properties were also heavily impacted with chlorinated hydrocarbons, making cooperation between multiple consulting firms, regulatory agencies, and clients a necessity. Developed work plans, proposals, conceptual site models, and groundwater contaminant plume models for environmental investigation and closure reports. The investigations and cleanups assisted in the efforts to rejuvenate a former industrial area to re-develop a community park in Pottstown.

Store Space, Philadelphia, Pennsylvania (2022 – 2023)

Project Manager. Developed work plans and managed the implementation of a remediation of concrete floors impacted with mercury and PCBs at a facility that was the former location of a thermometer manufacturer. A request for proposal was distributed to multiple remediation contractors. Contractors were evaluated and the bid was awarded based on their qualifications, price, and remediation methodology. The success of the remediation allowed for the sale of the property.

Lanchester Landfill, Narvon, Pennsylvania, Chester County Solid Waste Authority (2019 – 2021)

Project Manager and Field Team Leader. Performed regulatory reporting for a landfill facility in Pennsylvania. Developed sampling and analysis plans, executed a PFAS leachate sampling investigation, and assisted in streamlining the routine sampling process for the facility.

Triumph Accessory Services, Wellington, Kansas, RICOH (2021 – 2022)

Senior Staff Geologist. Assisted with the development and planning, and oversaw the field implementation of an in-situ remediation methodology designed to significantly reduce concentrations of chlorinated solvents in groundwater. The success of the remediation will allow the client to receive regulatory closure for the property within the framework of the Kansas Voluntary Cleanup Program.

The Poplar, Philadelphia, Pennsylvania, Post Brothers Apartments (2018 – 2021)

Task Manager and Field Team Leader. Managed complex site assessment and investigation reporting activities at a large-scale residential redevelopment site. The site is currently enrolled in a voluntary cleanup program for six separate historical sources of contamination, including a former dry-cleaner, on-site and off-site petroleum USTs, and historical fill.

Superfund Sites, Maryland and Pennsylvania (2015 – present)

Task Manager and Field Team Leader. Planned and executed numerous successful investigations and routine field sampling events at Superfund Sites located in Maryland and Pennsylvania impacted by chlorinated hydrocarbons and PFAS. The sites included former disposal facilities with long term pump-and-treat remediation systems. Complex bedrock geology and difficult field conditions frequently necessitated problem solving and flexibility.

Municipal Water and Sewer Authorities, Schuhmann Consulting (2020 – 2021)

Task Manager and Field Team Leader. Conducted water and biosolids sampling for PFAS chemicals at sites located in Utah and Maryland. Sample results were summarized and provided to the client to aid in proposed litigation.

Brandt Drive Apartments, Cranberry Township, Pennsylvania, Radnor Property Group (2021)

Project Manager. Conducted Phase I and II ESA activities at a vacant property and assisted in guiding a client through environmental decision-making process to find the best solution for their development plan. Developed a large-scale soil sampling, delineation, excavation, and disposal plan for the property, resulting in nearly 2,000 cubic yards of impacted soil being removed from the site.

Madison Ingling

Senior Staff I Scientist

Madison Ingling comes to Terraphase with an academic background in Earth and Environmental Engineering, which included research on snowmelt trends in the Western United States that involved historical data compilation and use of GIS-based tools for data visualization and analysis.

As a Senior Staff I Scientist, Ms. Ingling provides support in the application of risk management strategies for public and private sector projects under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and various state cleanup programs. This includes assistance in developing multi-receptor human health and ecological risk assessments for contaminated environmental media such as soil, air, surface water, and sediment and modeling fate and transport of chemicals (e.g., vapor intrusion). Ms. Ingling performs comprehensive data queries for the evaluation of site-specific exposure scenarios not routinely addressed by standard guidance and uses geographic information system (GIS)-based tools for data analysis and the presentation of risk assessment results.

Education

BS in Earth and Environmental Engineering, Columbia University, 2022

BS in Physical Science, Analytics Minor, Muhlenberg College, 2020

Years of Experience

2

Joined Terraphase

2022

Professional History

Terraphase Engineering Inc., Senior Staff I Scientist, 2022 - present

Columbia University, Laboratory Research Assistant, 2021

Muhlenberg College Academic Resource Center, Workshop and Peer Tutor, 2017 – 2020 and Information Desk Specialist, Trexler Library, 2017 - 2020

Project Experience

Former Philadelphia Energy Solutions Refinery, Pennsylvania, Philadelphia Energy Solutions Refining and Marketing LLC (July 2022 – Present)

Risk Assessment Support. Provides risk assessment consulting support to a client and its team in redeveloping a large refinery for mixed commercial/industrial use. Responsibilities have included producing supplementary materials to aid decisions regarding the need for and scope of investigation and risk assessment to allow for site grading and soil management and the regulatory closure of aboveground storage tanks (ASTs) necessary to facilitate redevelopment.

IR Site 4, Former Naval Fuel Depot Point Molate, California, City of Richmond (July 2022 – Present)

Risk Assessment Support. Provides risk assessment consulting support to a client in redeveloping a former naval fuel depot for potential residential use. Responsibilities have included assisting with report writing and producing supplementary materials to evaluate relevant and applicable exposure scenarios and identify areas of the site that would warrant risk management action to facilitate site redevelopment.

Block 43, Lot 1, 15, 16, and 27; Block 166, Lot 1 and 4, New Jersey, EP Henry Corporation (February 2023-April 2023)

Remedial Investigation Support. Provided support of a remedial investigation of a site with mixed residential/commercial use. Responsibilities have included performing compliance averaging for remedial action verification to determine whether compliance with the applicable soil remediation standard had been achieved at the site and support decisions regarding the need for and scope of potential remedial action.

Civil Action, California, Judicial Arbitration and Mediation Services (JAMS) (September 2022-January 2023)

Litigation Support. Provided risk assessment consulting support in a civil litigation matter regarding the significance of potential human exposures to chemicals in soil due to releases form a facility in California which manufactured aluminum panels for aircrafts. Responsibilities have included evaluating existing data to assess risks associated with potential human exposure under current and future land use and support the opinion on whether risk management action is necessary.

Former Manufacturing Facility, Eighty-Four, Pennsylvania (August 2022-April 2023)

Risk Assessment Support. Provided risk assessment consulting support to a client in redeveloping a former phenothiazine manufacturing facility for potential recreational use. Responsibilities have included compiling a complete historical database to assess risks associated with aquatic life and potential human exposure under current and future land uses and support decisions regarding the need for risk management action.

Block 170, Lots 1, 42, & 44, New Jersey, Berkeley Development Co. (August 2022-October 2022)

Remedial Investigation Support. Provided support of a remedial investigation of a site with mixed residential/commercial use. Responsibilities have included assisting with compliance averaging for remedial action verification to determine whether compliance with the applicable soil remediation standard had been achieved at the site and producing supplementary materials to visualize the adjustments made to the Thiessen polygons to better represent the bounded nature of the contamination at the site.

Block 2607, Lot 46, New Jersey, Matrix Hamilton Land, LLC (July 2022 – February 2023)

Remedial Investigation Support. Provided support with a remedial investigation of a predominantly wooded vacant site in an area with surrounding mixed commercial and residential properties. Responsibilities have included assisting with the production of supplementary materials for a soil remediation investigation and ecological evaluation to evaluate relevant and applicable exposure scenarios and identify areas of the site that would warrant risk management action to facilitate site redevelopment.

Preliminary Endangerment Assessment (PEA) Support, California, Multiple Facilities (2022 – present)

Risk Assessment Support. Provides human health screening risk assessment support for PEAs at multiple facilities in California. Responsibilities have included evaluating the potential significance of human exposures and supporting decisions regarding the need for and scope of further site investigation.

CHRIS W. TAYLOR
845 412 5656 (office)
845 239 0132 (cell)
eqainc.1@gmail.com

SUMMARY

Significant progressively responsible experience in the chemical, pharmaceutical, semiconductor and environmental industries. Over 35 years environmental operations, compliance, laboratory and QA management experience, including 30 years as independent third-party data assessment and quality assurance operations practitioner. NELAC/ISO17025 trained laboratory assessor. Current focus and expertise in environmental laboratory data validation and assessment of practices, including organic, inorganic and classical chemistry methods and emerging-contaminant method assessment, including PFAS chemicals.

Experience

Environmental Quality Associates, Inc. (EQA), Middletown, NY 1994 - current
Principal and Quality Assurance Director

- Conduct and manage data assessment and regulatory compliance projects
- Coordinate project staffing requirements to ensure project completion within specifications, schedule and budget
- Review and approve all final project reports prior to release to clients
- Direct and perform evaluative and investigative laboratory assessments

Malcolm Pirnie, Inc., White Plains, NY 1992 – 1993

Quality Assurance Manager, Corporate Environmental Laboratory
GLP Quality Assurance Unit, Aquatics Toxicity Laboratory

EnviroTest Laboratories, Newburgh, NY 1988 - 1992

Quality Assurance Director

IBM Corporation, East Fishkill, NY / San Jose, CA / Burlington, VT 1968 - 1988

Semiconductor Process Development / Site Air Quality Compliance / Trace Organics Lab Group Leader

SELECT PROJECT EXPERIENCE

TerraPhase Engineering, Inc., Princeton, NJ and Conshohocken, PA 2022 - 2024

Performed Data Quality Assessment / Data Usability Evaluation reviews of laboratory reports for site investigation / remediation studies for numerous hazardous waste sites in New Jersey.

Performed Stage 2 and Stage 4 validation of groundwater data (PFAS and VOCs) from Spectron Superfund Site, Elkton, MD.

CdFriday Environmental, Inc., Katy, TX 2017 - 2023

Performed independent QA review of radionuclide data validation Site Investigation reports to assist private client with regulatory compliance project.

Performed laboratory assessments at southern utilities laboratory to assist laboratory management with planned improvements in overall quality management, efficiency and productivity (organics, inorganics and classical chemistry).

Gradient Corporation, Cambridge and Boston, MA 2011 - 2022

Performed data validation of PFAS chemicals in groundwater, soils and serum samples for private client to support quality assurance oversight activities associated with litigation support activities.

Performed data validation and methods assessment for QA oversight for private client in support of analytical activities associated with Deepwater Horizon oil spill

Dresdner - Robin Environmental Services, Jersey City, NJ 2010 - 2024

Performed data validation of drinking water, groundwater soil and ambient air samples under NJDEP DKQP protocols

Performed Data Quality Assessment / Data Usability Evaluation review of laboratory reports for site investigation / remediation studies for Hudson Generating Plant site in New Jersey.

Performed numerous hexavalent chromium data validation reviews for groundwater and soil samples at New Jersey orphan-chrome sites.

Environ International and Ramboll - Environ, Princeton, NJ 2008 - 2017

Performed data validation of groundwater samples in support of remediation activities at Pohatcong Valley Superfund Site

Performed data validation of groundwater and soil samples for organic, metals and classical chemistry methods under EPA Region III protocols at Palmerton, PA Superfund Site

Malcolm Pirnie, Inc. and Louis Berger, Inc. 2005 - 2012

Performed data validation of PCB congeners and Dioxins/Furans in support of assessment and remediation activities for the Lower Passaic River Restoration Project.

Performed data validation of PCB congeners in support of assessment and remediation activities for the Hudson River Superfund Project.

EQM, Inc. and Dade Moeller, Inc. 2003 - 2015

Performed data validation of organic, inorganic and classical chemistry deliverables in support of contract with Louisiana DEQ.

Performed data validation in support of remediation activities at DOE Hanford, WA site.

Performed data validation in support of RCRA closure assessments at Johnston Atoll and Umatilla Chemical Agent Disposal Facilities.

NJDEP, Division of Publicly-Funded Site Remediation, Trenton, NJ 1998 - 2005

Performed primary independent data validation services for successive three-year contracts for providing data validation of publicly-funded hazardous waste remediation sites in New Jersey. Performed Level-4 validation of CLP deliverables for organics, inorganics and hexavalent chromium. Several thousand samples in a variety of media were validated, including VOCs, SVOCs, pesticides, PCBs, TAL metals, cyanide and hexavalent chromium.

EDUCATION

A.A.S., Chemistry, Orange County Community College (SUNY Orange)

26 Chemistry Credit-hrs.

TRAINING

- Ambient Air Quality Monitoring and Impact Modeling (EPA, RTP-NC)
- Assessments for ISO/IEC 17025 and NELAC (Advanced Systems, Inc.)
- Chemical Safety and Emergency Response (IBM Corp.)
- Environmental Regulatory Compliance (Government Institutes)
- Gas Chromatography (Radian Corp.)
- Lead and Copper Desktop Corrosion Control Studies (AWWA)
- Mass Spectral Interpretation (Finnigan - MAT)
- GLP Auditing Under EPA/FDA/OECD (ICHEE)
- CGMP Auditing for Pharmaceuticals (Novartis)
- Groundwater Remediation Technology (NGWA)
- Industrial Toxicology and Chemical Hygiene (IBM Corp.)
- ISO 9000 Internal Auditing and Registration (IBIG)
- ISO 14000 Management Overview (SGS)
- OSHA Laboratory Safety / Right-to-Know (IBM Corp. / Fisher Chemical)
- Organic Data Validation (NYSDEC / WCC)
- Techniques for Using Routine and In-Depth Data Review (AZDHS)

APPENDIX C

NYSDEC SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS), APRIL 2023

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Under NYSDEC's Part 375 Remedial Programs

April 2023

www.dec.ny.gov

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April 2023

ERRATA SHEET for

SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) Under NYSDEC's Part 375 Remedial Programs Issued January 17, 2020

Citation and Page Number	Current Text	Corrected Text	Date
Title of Appendix I, page 32	Appendix H	Appendix I	2/25/2020
Document Cover, page 1	Guidelines for Sampling and Analysis of PFAS	Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs	9/15/2020
Data Assessment and Application to Site Cleanup Page 3	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published	Until such time as Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published	3/28/2023
Water Sample Results Page 3	PFOA and PFOS should be further assessed and considered as potential contaminants of concern in groundwater or surface water if PFOA or PFOS is detected in any water sample at or above 10 ng/L (ppt) and is determined to be attributable to the site, either by a comparison of upgradient and downgradient levels, or the presence of soil source areas, as defined below.	NYSDEC has adopted ambient water quality guidance values for PFOA and PFOS. Groundwater samples should be compared to the human health criteria of 6.7 ng/l (ppt) for PFOA and 2.7 ng/l (ppt) for PFOS. These guidance values also include criteria for surface water for PFOS applicable for aquatic life, which may be applicable at some sites. Drinking water sample results should be compared to the NYS maximum contaminant level (MCL) of 10 ng/l (ppt).Analysis to determine if PFOA and PFOS concentrations are attributable to the site should include a comparison between upgradient and downgradient levels, and the presence of soil source areas, as defined below.	3/28/2023
Soil Sample Results Page 3	Soil cleanup objectives for PFOA and PFOS have been proposed in an upcoming revision to 6 NYCRR Part 375-6. Until SCOs are in effect, the following are to be used as guidance values:	NYSDEC will delay adding soil cleanup objectives for PFOA and PFOS to 6 NYCRR Part 375-6 until the PFAS rural soil background study has been completed. Until SCOs are in effect, the following are to be used as guidance values:	3/28/2023
Protection of Groundwater Page 3	PFOA (ppb) 1.1 PFOS (ppb) 3.7	PFOA (ppb) 0.8 PFOS (ppb) 1.0	3/28/2023

Citation and Page Number	Current Text	Corrected Text	Date
Footnote 2 Page 3	The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	The Protection of Groundwater values are based on the above referenced ambient groundwater guidance values. Details on that calculation are available in the following document, prepared for the February 2022 proposed changes to Part 375 (https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375techsupport.pdf). The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	3/28/2023
Testing for Imported Soil Page 4	If the concentrations of PFOA and PFOS in leachate are at or above 10 ppt (the Maximum Contaminant Levels established for drinking water by the New York State Department of Health), then the soil is not acceptable.	If the concentrations of PFOA and PFOS in leachate are at or above the ambient water quality guidance values for groundwater, then the soil is not acceptable.	3/28/2023
Routine Analysis, page 9	“However, laboratories analyzing environmental samples…PFOA and PFOS in drinking water by EPA Method 537, 537.1 or ISO 25101.”	“However, laboratories analyzing environmental samples…PFOA and PFOS in drinking water by EPA Method 537, 537.1, ISO 25101, or Method 533.”	9/15/2020
Additional Analysis, page 9, new paragraph regarding soil parameters	None	“In cases where site-specific cleanup objectives for PFOA and PFOS are to be assessed, soil parameters, such as Total Organic Carbon (EPA Method 9060), soil pH (EPA Method 9045), clay content (percent), and cation exchange capacity (EPA Method 9081), should be included in the analysis to help evaluate factors affecting the leachability of PFAS in site soils.”	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Data Assessment and Application to Site Cleanup Page 10	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFAS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Target levels for cleanup of PFAS in other media, including biota and sediment, have not yet been established by the DEC.	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Preliminary target levels for cleanup of PFOA and PFOS in other media, including biota and sediment, have not yet been established by the DEC.	9/15/2020
Water Sample Results Page 10	PFAS should be further assessed and considered as a potential contaminant of concern in groundwater or surface water (…) If PFAS are identified as a contaminant of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.	PFOA and PFOS should be further assessed and considered as potential contaminants of concern in groundwater or surface water (…) If PFOA and/or PFOS are identified as contaminants of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Soil Sample Results, page 10	“The extent of soil contamination for purposes of delineation and remedy selection should be determined by having certain soil samples tested by Synthetic Precipitation Leaching Procedure (SPLP) and the leachate analyzed for PFAS. Soil exhibiting SPLP results above 70 ppt for either PFOA or PFOS (individually or combined) are to be evaluated during the cleanup phase.”	“Soil cleanup objectives for PFOA and PFOS will be proposed in an upcoming revision to 6 NYCRR Part 375-6. Until SCOs are in effect, the following are to be used as guidance values. “ [Interim SCO Table] “PFOA and PFOS results for soil are to be compared against the guidance values listed above. These guidance values are to be used in determining whether PFOA and PFOS are contaminants of concern for the site and for determining remedial action objectives and cleanup requirements. Site-specific remedial objectives for protection of groundwater can also be presented for evaluation by DEC. Development of site-specific remedial objectives for protection of groundwater will require analysis of additional soil parameters relating to leachability. These additional analyses can include any or all the parameters listed above (soil pH, cation exchange capacity, etc.) and/or use of SPLP. As the understanding of PFAS transport improves, DEC welcomes proposals for site-specific remedial objectives for protection of groundwater. DEC will expect that those may be dependent on additional factors including soil pH, aqueous pH, % organic carbon, % Sand/Silt/Clay, soil cations: K, Ca, Mg, Na, Fe, Al, cation exchange capacity, and anion exchange capacity. Site-specific remedial objectives should also consider the dilution attenuation factor (DAF). The NJDEP publication on DAF can be used as a reference: https://www.nj.gov/dep/srp/guidance/rs/daf.pdf. ”	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Testing for Imported Soil Page 11	Soil imported to a site for use in a soil cap, soil cover, or as backfill is to be tested for PFAS in general conformance with DER-10, Section 5.4(e) for the PFAS Analyte List (Appendix F) using the analytical procedures discussed below and the criteria in DER-10 associated with SVOCs. If PFOA or PFOS is detected in any sample at or above 1 µg/kg, then soil should be tested by SPLP and the leachate analyzed for PFAS. If the SPLP results exceed 10 ppt for either PFOA or PFOS (individually) then the source of backfill should be rejected, unless a site-specific exemption is provided by DER. SPLP leachate criteria is based on the Maximum Contaminant Levels proposed for drinking water by New York State's Department of Health, this value may be updated based on future Federal or State promulgated regulatory standards. Remedial parties have the option of analyzing samples concurrently for both PFAS in soil and in the SPLP leachate to minimize project delays. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.	Testing for PFAS should be included any time a full TAL/TCL analyte list is required. Results for PFOA and PFOS should be compared to the applicable guidance values. If PFOA or PFOS is detected in any sample at or above the guidance values then the source of backfill should be rejected, unless a site-specific exemption is provided by DER based on SPLP testing, for example. If the concentrations of PFOA and PFOS in leachate are at or above 10 ppt (the Maximum Contaminant Levels established for drinking water by the New York State Department of Health), then the soil is not acceptable. PFOA, PFOS and 1,4-dioxane are all considered semi-volatile compounds, so composite samples are appropriate for these compounds when sampling in accordance with DER-10, Table 5.4(e)10. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Footnotes	None	[1] TOP Assay analysis of highly contaminated samples, such as those from an AFFF (aqueous film-forming foam) site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances. [2] The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the soil cleanup objective for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	9/15/2020
Additional Analysis, page 9	In cases… soil parameters, such as Total Organic Carbon (EPA Method 9060), soil…	In cases… soil parameters, such as Total Organic Carbon (Lloyd Kahn), soil…	1/8/2021
Appendix A, General Guidelines, fourth bullet	List the ELAP-approved lab(s) to be used for analysis of samples	List the ELAP- certified lab(s) to be used for analysis of samples	1/8/2021
Appendix E, Laboratory Analysis and Containers	Drinking water samples collected using this protocol are intended to be analyzed for PFAS by ISO Method 25101.	Drinking water samples collected using this protocol are intended to be analyzed for PFAS by EPA Method 537, 537.1, 533, or ISO Method 25101	1/8/2021
Water Sample Results Page 9	“In addition, further assessment of water may be warranted if either of the following screening levels are met: a. any other individual PFAS (not PFOA or PFOS) is detected in water at or above 100 ng/L; or b. total concentration of PFAS (including PFOA and PFOS) is detected in water at or above 500 ng/L”	Deleted	6/15/2021

Citation and Page Number	Current Text	Corrected Text	Date
Routine Analysis, Page XX	Currently, New York State Department of Health's Environmental Laboratory Approval Program (ELAP)… criteria set forth in the DER's laboratory guidelines for PFAS in non-potable water and solids (Appendix H - Laboratory Guidelines for Analysis of PFAS in Non-Potable Water and Solids).	Deleted	5/31/2022
Analysis and Reporting, Page XX	As of October 2020, the United States Environmental Protection Agency (EPA) does not have a validated method for analysis of PFAS for media commonly analyzed under DER remedial programs (non-potable waters, solids). DER has developed the following guidelines to ensure consistency in analysis and reporting of PFAS.	Deleted	5/31/2022
Routine Analysis, Page XX	LC-MS/MS analysis for PFAS using methodologies based on EPA Method 537.1 is the procedure to use for environmental samples. Isotope dilution techniques should be utilized for the analysis of PFAS in all media.	EPA Method 1633 is the procedure to use for environmental samples.	
Soil Sample Results, Page XX	Soil cleanup objectives for PFOA and PFOS will be proposed in an upcoming revision to 6 NYCRR Part 375-6	Soil cleanup objectives for PFOA and PFOS have been proposed in an upcoming revision to 6 NYCRR Part 375-6	
Appendix A	"Include in the text… LC-MS/MS for PFAS using methodologies based on EPA Method 537.1"	"Include in the text ….EPA Method 1633"	
Appendix A	"Laboratory should have ELAP certification for PFOA and PFOS in drinking water by EPA Method 537, 537.1, EPA Method 533, or ISO 25101"	Deleted	
Appendix B	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	

Citation and Page Number	Current Text	Corrected Text	Date
Appendix C	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	
Appendix D	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	
Appendix G		Updated to include all forty PFAS analytes in EPA Method 533	
Appendix H		Deleted	
Appendix I	Appendix I	Appendix H	
Appendix H	"These guidelines are intended to be used for the validation of PFAS analytical results for projects within the Division of Environmental Remediation (DER) as well as aid in the preparation of a data usability summary report."	"These guidelines are intended to be used for the validation of PFAS using EPA Method 1633 for projects within the Division of Environmental Remediation (DER)."	
Appendix H	"The holding time is 14 days…"	"The holding time is 28 days…"	
Appendix H, Initial Calibration	"The initial calibration should contain a minimum of five standards for linear fit…"	"The initial calibration should contain a minimum of six standards for linear fit…"	
Appendix H, Initial Calibration	Linear fit calibration curves should have an R^2 value greater than 0.990.	Deleted	
Appendix H, Initial Calibration Verification	Initial Calibration Verification Section	Deleted	
Appendix H	secondary Ion Monitoring Section	Deleted	
Appendix H	Branched and Linear Isomers Section	Deleted	

April 2023

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs

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Objective

New York State Department of Environmental Conservation's Division of Environmental Remediation (DER) performs or oversees sampling of environmental media and subsequent analysis of PFAS as part of remedial programs implemented under 6 NYCRR Part 375. To ensure consistency in sampling, analysis, reporting, and assessment of PFAS, DER has developed this document which summarizes currently accepted procedures and updates previous DER technical guidance pertaining to PFAS.

Applicability

All work plans submitted to DEC pursuant to one of the remedial programs under Part 375 shall include PFAS sampling and analysis procedures that conform to the guidelines provided herein.

As part of a site investigation or remedial action compliance program, whenever samples of potentially affected media are collected and analyzed for the standard Target Analyte List/Target Compound List (TAL/TCL), PFAS analysis should also be performed. Potentially affected media can include soil, groundwater, surface water, and sediment. Based upon the potential for biota to be affected, biota sampling and analysis for PFAS may also be warranted as determined pursuant to a Fish and Wildlife Impact Analysis. Soil vapor sampling for PFAS is not required.

Field Sampling Procedures

DER-10 specifies technical guidance applicable to DER's remedial programs. Given the prevalence and use of PFAS, DER has developed "best management practices" specific to sampling for PFAS. As specified in DER-10 Chapter 2, quality assurance procedures are to be submitted with investigation work plans. Typically, these procedures are incorporated into a work plan, or submitted as a stand-alone document (e.g., a Quality Assurance Project Plan). Quality assurance guidelines for PFAS are listed in Appendix A - Quality Assurance Project Plan (QAPP) Guidelines for PFAS.

Field sampling for PFAS performed under DER remedial programs should follow the appropriate procedures outlined for soils, sediments, or other solids (Appendix B), non-potable groundwater (Appendix C), surface water (Appendix D), public or private water supply wells (Appendix E), and fish tissue (Appendix F).

QA/QC samples (e.g. duplicates, MS/MSD) should be collected as specified in DER-10, Section 2.3(c). For sampling equipment coming in contact with aqueous samples only, rinsate or equipment blanks should be collected. Equipment blanks should be collected at a minimum frequency of one per day per site or one per twenty samples, whichever is more frequent.

Analysis and Reporting

The investigation work plan should describe analysis and reporting procedures, including laboratory analytical procedures for the methods discussed below. As specified in DER-10 Section 2.2, laboratories should provide a full Category B deliverable. In addition, a Data Usability Summary Report (DUSR) should be prepared by an independent, third-party data validator. Electronic data submissions should meet the requirements provided at: https://www.dec.ny.gov/chemical/62440.html.

DER has developed a *PFAS Analyte List* (Appendix G) for remedial programs to understand the nature of contamination at sites. It is expected that reported results for PFAS will include, at a minimum, all the compounds listed. If lab and/or matrix specific issues are encountered for any analytes, the DER project manager, in consultation with the DER chemist, will make case-by-case decisions as to whether certain analytes may be temporarily or permanently discontinued from analysis at each site. As with other contaminants that are analyzed for at a site, the *PFAS Analyte List* may be refined for future sampling events based on investigative findings.

Routine Analysis

EPA Method 1633 is the procedure to use for environmental samples. Reporting limits for PFOA and PFOS in aqueous samples should not exceed 2 ng/L. Reporting limits for PFOA and PFOS in solid samples should not exceed 0.5 µg/kg. Reporting limits for all other PFAS in aqueous and solid media should be as close to these limits as possible. If laboratories indicate that they are not able to achieve these reporting limits for the entire *PFAS Analyte List*, site-specific decisions regarding acceptance of elevated reporting limits for specific PFAS can be made by the DER project manager in consultation with the DER chemist. Data review guidelines were developed by DER to ensure data comparability and usability (Appendix H - Data Review Guidelines for Analysis of PFAS in Non-Potable Water and Solids).

Additional Analysis

Additional laboratory methods for analysis of PFAS may be warranted at a site, such as the Synthetic Precipitation Leaching Procedure (SPLP) and Total Oxidizable Precursor Assay (TOP Assay).

In cases where site-specific cleanup objectives for PFOA and PFOS are to be assessed, soil parameters, such as Total Organic Carbon (Lloyd Kahn), soil pH (EPA Method 9045), clay content (percent), and cation exchange capacity (EPA Method 9081), should be included in the analysis to help evaluate factors affecting the leachability of PFAS in site soils.

SPLP is a technique used to determine the mobility of chemicals in liquids, soils and wastes, and may be useful in determining the need for addressing PFAS-containing material as part of the remedy. SPLP by EPA Method 1312 should be used unless otherwise specified by the DER project manager in consultation with the DER chemist.

Impacted materials can be made up of PFAS that are not analyzable by routine analytical methodology. A TOP Assay can be utilized to conceptualize the amount and type of oxidizable PFAS which could be liberated in the environment, which approximates the maximum concentration of perfluoroalkyl substances that could be generated if all polyfluoroalkyl substances were oxidized. For example, some polyfluoroalkyl substances may degrade or transform to form perfluoroalkyl substances (such as PFOA or PFOS), resulting in an increase in perfluoroalkyl substance concentrations as contaminated groundwater moves away from a source. The TOP Assay converts, through oxidation, polyfluoroalkyl substances (precursors) into perfluoroalkyl substances that can be detected by routine analytical methodology.[1]

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[1] TOP Assay analysis of highly contaminated samples, such as those from an AFFF (aqueous film-forming foam) site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances.

Commercial laboratories have adopted methods which allow for the quantification of targeted PFAS in air and biota. The EPA's Office of Research and Development (ORD) is currently developing methods which allow for air emissions characterization of PFAS, including both targeted and non-targeted analysis of PFAS. Consult with the DER project manager and the DER chemist for assistance on analyzing biota/tissue and air samples.

Data Assessment and Application to Site Cleanup

Until such time as Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Preliminary target levels for cleanup of PFOA and PFOS in other media, including biota and sediment, have not yet been established by the DEC.

Water Sample Results

NYSDEC has adopted ambient water quality guidance values for PFOA and PFOS. Groundwater samples should be compared to the human health criteria of 6.7 ng/l (ppt) for PFOA and 2.7 ng/l (ppt) for PFOS. These human health criteria should also be applied to surface water that is used as a water supply. This guidance also includes criteria for surface water for PFOS applicable for aquatic life, which may be applicable at some sites. Drinking water sample results should be compared to the NYS maximum contaminant level (MCL) of 10 ng/l (ppt). Analysis to determine if PFOA and PFOS concentrations are attributable to the site should include a comparison between upgradient and downgradient levels, and the presence of soil source areas, as defined below.

If PFOA and/or PFOS are identified as contaminants of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.

Soil Sample Results

NYSDEC will delay adding soil cleanup objectives for PFOA and PFOS to 6 NYCRR Part 375-6 until the PFAS rural soil background study has been completed. Until SCOs are in effect, the following are to be used as guidance values:

Guidance Values for Anticipated Site Use	PFOA (ppb)	PFOS (ppb)
Unrestricted	0.66	0.88
Residential	6.6	8.8
Restricted Residential	33	44
Commercial	500	440
Industrial	600	440
Protection of Groundwater[2]	0.8	1.0

PFOA and PFOS results for soil are to be compared against the guidance values listed above. These guidance values are to be used in determining whether PFOA and PFOS are contaminants of concern for the site and for determining remedial action objectives and cleanup requirements. Site-specific remedial objectives for protection of groundwater can also be presented for evaluation by DEC. Development of site-specific remedial objectives for protection of groundwater will require analysis of additional soil parameters relating to leachability. These

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[2] The Protection of Groundwater values are based on the above referenced ambient groundwater guidance values. Details on that calculation are available in the following document, prepared for the February 2022 proposed changes to Part 375 (https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375techsupport.pdf). The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).

additional analyses can include any or all the parameters listed above (soil pH, cation exchange capacity, etc.) and/or use of SPLP.

As the understanding of PFAS transport improves, DEC welcomes proposals for site-specific remedial objectives for protection of groundwater. DEC will expect that those may be dependent on additional factors including soil pH, aqueous pH, % organic carbon, % Sand/Silt/Clay, soil cations: K, Ca, Mg, Na, Fe, Al, cation exchange capacity, and anion exchange capacity. Site-specific remedial objectives should also consider the dilution attenuation factor (DAF). The NJDEP publication on DAF can be used as a reference: https://www.nj.gov/dep/srp/guidance/rs/daf.pdf.

Testing for Imported Soil

Testing for PFAS should be included any time a full TAL/TCL analyte list is required. Results for PFOA and PFOS should be compared to the applicable guidance values. If PFOA or PFOS is detected in any sample at or above the guidance values then the source of backfill should be rejected, unless a site-specific exemption is provided by DER based on SPLP testing, for example. If the concentrations of PFOA and PFOS in leachate are at or above the ambient water quality guidance values for groundwater, then the soil is not acceptable.

PFOA, PFOS and 1,4-dioxane are all considered semi-volatile compounds, so composite samples are appropriate for these compounds when sampling in accordance with DER-10, Table 5.4(e)10. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.

Appendix A - Quality Assurance Project Plan (QAPP) Guidelines for PFAS

The following guidelines (general and PFAS-specific) can be used to assist with the development of a QAPP for projects within DER involving sampling and analysis of PFAS.

General Guidelines in Accordance with DER-10

- Document/work plan section title – Quality Assurance Project Plan
- Summarize project scope, goals, and objectives
- Provide project organization including names and resumes of the project manager, Quality Assurance Officer (QAO), field staff, and Data Validator
    - The QAO should not have another position on the project, such as project or task manager, that involves project productivity or profitability as a job performance criterion
- List the ELAP certified lab(s) to be used for analysis of samples
- Include a site map showing sample locations
- Provide detailed sampling procedures for each matrix
- Include Data Quality Usability Objectives
- List equipment decontamination procedures
- Include an “Analytical Methods/Quality Assurance Summary Table” specifying:
    - Matrix type
    - Number or frequency of samples to be collected per matrix
    - Number of field and trip blanks per matrix
    - Analytical parameters to be measured per matrix
    - Analytical methods to be used per matrix with minimum reporting limits
    - Number and type of matrix spike and matrix spike duplicate samples to be collected
    - Number and type of duplicate samples to be collected
    - Sample preservation to be used per analytical method and sample matrix
    - Sample container volume and type to be used per analytical method and sample matrix
    - Sample holding time to be used per analytical method and sample matrix
- Specify Category B laboratory data deliverables and preparation of a DUSR

Specific Guidelines for PFAS

- Include in the text that sampling for PFAS will take place
- Include in the text that PFAS will be analyzed by EPA Method 1633
- Include the list of PFAS compounds to be analyzed (*PFAS Analyte List*)
- Include the laboratory SOP for PFAS analysis
- List the minimum method-achievable Reporting Limits for PFAS
    - Reporting Limits should be less than or equal to:
        - Aqueous – 2 ng/L (ppt)
        - Solids – 0.5 µg/kg (ppb)
- Include the laboratory Method Detection Limits for the PFAS compounds to be analyzed
-
- Include detailed sampling procedures
    - Precautions to be taken
    - Pump and equipment types
    - Decontamination procedures
    - Approved materials only to be used
- Specify that regular ice only will be used for sample shipment
- Specify that equipment blanks should be collected at a minimum frequency of 1 per day per site for each matrix

Appendix B - Sampling Protocols for PFAS in Soils, Sediments and Solids

General

The objective of this protocol is to give general guidelines for the collection of soil, sediment and other solid samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Containers

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in to contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel spoon
- stainless steel bowl
- steel hand auger or shovel without any coatings

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Sampling is often conducted in areas where a vegetative turf has been established. In these cases, a pre-cleaned trowel or shovel should be used to carefully remove the turf so that it may be replaced at the conclusion of sampling. Surface soil samples (e.g. 0 to 6 inches below surface) should then be collected using a pre-cleaned, stainless steel spoon. Shallow subsurface soil samples (e.g. 6 to ~36 inches below surface) may be collected by digging a hole using a pre-cleaned hand auger or shovel. When the desired subsurface depth is reached, a pre-cleaned hand auger or spoon shall be used to obtain the sample.

When the sample is obtained, it should be deposited into a stainless steel bowl for mixing prior to filling the sample containers. The soil should be placed directly into the bowl and mixed thoroughly by rolling the material into the middle until the material is homogenized. At this point the material within the bowl can be placed into the laboratory provided container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A soil log or sample log shall document the location of the sample/borehole, depth of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix C - Sampling Protocols for PFAS in Monitoring Wells

General

The objective of this protocol is to give general guidelines for the collection of groundwater samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including plumbers tape and sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel inertia pump with HDPE tubing
- peristaltic pump equipped with HDPE tubing and silicone tubing
- stainless steel bailer with stainless steel ball
- bladder pump (identified as PFAS-free) with HDPE tubing

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Monitoring wells should be purged in accordance with the sampling procedure (standard/volume purge or low flow purge) identified in the site work plan, which will determine the appropriate time to collect the sample. If sampling using standard purge techniques, additional purging may be needed to reduce turbidity levels, so samples contain a limited amount of sediment within the sample containers. Sample containers that contain sediment may cause issues at the laboratory, which may result in elevated reporting limits and other issues during the sample preparation that can compromise data usability. Sampling personnel should don new nitrile gloves prior to sample collection due to the potential to contact PFAS containing items (not related to the sampling equipment) during the purging activities.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Collect one equipment blank per day per site and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers
- Additional equipment blank samples may be collected to assess other equipment that is utilized at the monitoring well
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A purge log shall document the location of the sample, sampling equipment, groundwater parameters, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix D - Sampling Protocols for PFAS in Surface Water

General

The objective of this protocol is to give general guidelines for the collection of surface water samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel cup

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Where conditions permit, (e.g. creek or pond) sampling devices (e.g. stainless steel cup) should be rinsed with site medium to be sampled prior to collection of the sample. At this point the sample can be collected and poured into the sample container.

If site conditions permit, samples can be collected directly into the laboratory container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Collect one equipment blank per day per site and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A sample log shall document the location of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix E - Sampling Protocols for PFAS in Private Water Supply Wells

General

The objective of this protocol is to give general guidelines for the collection of water samples from private water supply wells (with a functioning pump) for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Drinking water samples collected using this protocol are intended to be analyzed for PFAS by EPA Method 537, 537.1, 533, or ISO Method 25101. The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials (e.g. plumbers tape), including sample bottle cap liners with a PTFE layer.

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Locate and assess the pressure tank and determine if any filter units are present within the building. Establish the sample location as close to the well pump as possible, which is typically the spigot at the pressure tank. Ensure sampling equipment is kept clean during sampling as access to the pressure tank spigot, which is likely located close to the ground, may be obstructed and may hinder sample collection.

Prior to sampling, a faucet downstream of the pressure tank (e.g., washroom sink) should be run until the well pump comes on and a decrease in water temperature is noted which indicates that the water is coming from the well. If the homeowner is amenable, staff should run the water longer to purge the well (15+ minutes) to provide a sample representative of the water in the formation rather than standing water in the well and piping system including the pressure tank. At this point a new pair of nitrile gloves should be donned and the sample can be collected from the sample point at the pressure tank.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- If equipment was used, collect one equipment blank per day per site and a minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers.
- A field reagent blank (FRB) should be collected at a rate of one per 20 samples. The lab will provide a FRB bottle containing PFAS free water and one empty FRB bottle. In the field, pour the water from the one bottle into the empty FRB bottle and label appropriately.
- Request appropriate data deliverable (Category B) and an electronic data deliverable
- For sampling events where multiple private wells (homes or sites) are to be sampled per day, it is acceptable to collect QC samples at a rate of one per 20 across multiple sites or days.

Documentation

A sample log shall document the location of the private well, sample point location, owner contact information, sampling equipment, purge duration, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate and available (e.g. well construction, pump type and location, yield, installation date). Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appendix F - Sampling Protocols for PFAS in Fish

This appendix contains a copy of the current SOP developed by the Division of Fish and Wildlife (DFW) entitled "General Fish Handling Procedures for Contaminant Analysis" (Ver. 8). This SOP should be followed when collecting fish for contaminant analysis. Note, however, that the Bureau of Ecosystem Health will not be supplying bags or tags. All supplies are the responsibility of the collector

Procedure Name: General Fish Handling Procedures for Contaminant Analysis

Number: FW-005

Purpose: This procedure describes data collection, fish processing and delivery of fish collected for contaminant monitoring. It contains the chain of custody and collection record forms that should be used for the collections.

Organization: Environmental Monitoring Section
Bureau of Ecosystem Health
Division of Fish and Wildlife (DFW)
New York State Department of Environmental Conservation (NYSDEC)
625 Broadway
Albany, New York 12233-4756

Version: 8

Previous Version Date: 21 March 2018

Summary of Changes to this Version: Updated bureau name to Bureau of Ecosystem Health. Added direction to list the names of all field crew on the collection record. Minor formatting changes on chain of custody and collection records.

Originator or Revised by: Wayne Richter, Jesse Becker

Date: 26 April 2019

Quality Assurance Officer and Approval Date: Jesse Becker, 26 April 2019

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

GENERAL FISH HANDLING PROCEDURES FOR CONTAMINANT ANALYSES

A. Original copies of all continuity of evidence (i.e., Chain of Custody) and collection record forms must accompany delivery of fish to the lab. A copy shall be directed to the Project Leader or as appropriate, Wayne Richter. All necessary forms will be supplied by the Bureau of Ecosystem Health. Because some samples may be used in legal cases, it is critical that each section is filled out completely. Each Chain of Custody form has three main sections:

1. The top box is to be filled out **and signed** by the person responsible for the fish collection (e.g., crew leader, field biologist, researcher). This person is responsible for delivery of the samples to DEC facilities or personnel (e.g., regional office or biologist).

2. The second section is to be filled out **and signed** by the person responsible for the collections while being stored at DEC, before delivery to the analytical lab. This may be the same person as in (1), but it is still required that they complete the section. Also important is the **range of identification numbers** (i.e., tag numbers) included in the sample batch.

3. Finally, the bottom box is to record any transfers between DEC personnel and facilities. Each subsequent transfer should be **identified, signed, and dated**, until laboratory personnel take possession of the fish.

B. The following data are required on each **Fish Collection Record** form:

1. Project and Site Name.

2. DEC Region.

3. All personnel (and affiliation) involved in the collection.

4. Method of collection (gill net, hook and line, etc.)

5. Preservation Method.

C. The following data are to be taken on each fish collected and recorded on the **Fish Collection Record** form:

1. Tag number - Each specimen is to be individually jaw tagged at time of collection with a unique number. Make sure the tag is turned out so that the number can be read without opening the bag. Use tags in sequential order. For small fish or composite samples place the tag inside the bag with the samples. The Bureau of Ecosystem Health can supply the tags.

2. Species identification (please be explicit enough to enable assigning genus and species). Group fish by species when processing.

3. Date collected.

4. Sample location (waterway and nearest prominent identifiable landmark).

5. Total length (nearest mm or smallest sub-unit on measuring instrument) and weight (nearest g or

smallest sub-unit of weight on weighing instrument). Take all measures as soon as possible with calibrated, protected instruments (e.g. from wind and upsets) and prior to freezing.

6. Sex - fish may be cut enough to allow sexing or other internal investigation, but do not eviscerate. Make any incision on the right side of the belly flap or exactly down the midline so that a left-side fillet can be removed.

D. General data collection recommendations:

1. It is helpful to use an ID or tag number that will be unique. It is best to use metal striped bass or other uniquely numbered metal tags. If uniquely numbered tags are unavailable, values based on the region, water body and year are likely to be unique: for example, R7CAY11001 for Region 7, Cayuga Lake, 2011, fish 1. If the fish are just numbered 1 through 20, we have to give them new numbers for our database, making it more difficult to trace your fish to their analytical results and creating an additional possibility for errors.

2. Process and record fish of the same species sequentially. Recording mistakes are less likely when all fish from a species are processed together. Starting with the bigger fish species helps avoid missing an individual.

3. If using Bureau of Ecosystem Health supplied tags or other numbered tags, use tags in sequence so that fish are recorded with sequential Tag Numbers. This makes data entry and login at the lab and use of the data in the future easier and reduces keypunch errors.

4. Record length and weight as soon as possible after collection and before freezing. Other data are recorded in the field upon collection. An age determination of each fish is optional, but if done, it is recorded in the appropriate “Age” column.

5. For composite samples of small fish, record the number of fish in the composite in the Remarks column. Record the length and weight of each individual in a composite. All fish in a composite sample should be of the same species and members of a composite should be visually matched for size.

6. Please submit photocopies of topographic maps or good quality navigation charts indicating sampling locations. GPS coordinates can be entered in the Location column of the collection record form in addition to or instead for providing a map. These records are of immense help to us (and hopefully you) in providing documented location records which are not dependent on memory and/or the same collection crew. In addition, they may be helpful for contaminant source trackdown and remediation/control efforts of the Department.

7. When recording data on fish measurements, it will help to ensure correct data recording for the data recorder to call back the numbers to the person making the measurements.

E. Each fish is to be placed in its own individual plastic bag. For small fish to be analyzed as a composite, put all of the fish for one composite in the same bag but use a separate bag for each composite. It is important to individually bag the fish to avoid difficulties or cross contamination when processing the fish for chemical analysis. Be sure to include the fish’s tag number inside the bag, preferably attached to the fish with the tag number turned out so it can be read. Tie or otherwise secure the bag closed. **<u>The Bureau of Ecosystem Health will supply the bags.</u>** If necessary, food grade bags may be procured from a suitable vendor (e.g., grocery store). It is preferable to redundantly label each bag with a manila tag tied between the knot and the body of the bag. This tag should be labeled with the project name, collection location, tag number, collection date, and fish species. If scales are collected, the scale envelope should be labeled with the same information.

F. Groups of fish, by species, are to be placed in one large plastic bag per sampling location. **The Bureau of Ecosystem Health will supply the larger bags.** Tie or otherwise secure the bag closed. Label the site bag with a manila tag tied between the knot and the body of the bag. The tag should contain: project, collection location, collection date, species and **tag number ranges**. Having this information on the manila tag enables lab staff to know what is in the bag without opening it.

G. Do not eviscerate, fillet or otherwise dissect the fish unless specifically asked to. If evisceration or dissection is specified, the fish must be cut along the exact midline or on the right side so that the left side fillet can be removed intact at the laboratory. If filleting is specified, the procedure for taking a standard fillet (SOP PREPLAB 4) must be followed, including removing scales.

H. Special procedures for PFAS: Unlike legacy contaminants such as PCBs, which are rarely found in day to day life, PFAS are widely used and frequently encountered. Practices that avoid sample contamination are therefore necessary. While no standard practices have been established for fish, procedures for water quality sampling can provide guidance. The following practices should be used for collections when fish are to be analyzed for PFAS:

No materials containing Teflon.
No Post-it notes.
No ice packs; only water ice or dry ice.
Any gloves worn must be powder free nitrile.
No Gore-Tex or similar materials (Gore-Tex is a PFC with PFOA used in its manufacture).
No stain repellent or waterproof treated clothing; these are likely to contain PFCs.
Avoid plastic materials, other than HDPE, including clipboards and waterproof notebooks.
Wash hands after handling any food containers or packages as these may contain PFCs. Keep pre-wrapped food containers and wrappers isolated from fish handling.
Wear clothing washed at least six times since purchase.
Wear clothing washed without fabric softener.
Staff should avoid cosmetics, moisturizers, hand creams and similar products on the day of sampling as many of these products contain PFCs (Fujii et al. 2013). Sunscreen or insect repellent should not contain ingredients with “fluor” in their name. Apply any sunscreen or insect repellent well downwind from all materials. Hands must be washed after touching any of these products.

I. All fish must be kept at a temperature <45° F (<8° C) immediately following data processing. As soon as possible, freeze at -20° C ± 5° C. Due to occasional freezer failures, daily freezer temperature logs are required. The freezer should be locked or otherwise secured to maintain chain of custody.

J. In most cases, samples should be delivered to the Analytical Services Unit at the Hale Creek field station. Coordinate delivery with field station staff and send copies of the collection records, continuity of evidence forms and freezer temperature logs to the field station. For samples to be analyzed elsewhere, non-routine collections or other questions, contact Wayne Richter, Bureau of Ecosystem Health, NYSDEC, 625 Broadway, Albany, New York 12233-4756, 518-402-8974, or the project leader about sample transfer. Samples will then be directed to the analytical facility and personnel noted on specific project descriptions.

K. A recommended equipment list is at the end of this document.

richter (revised): sop_fish_handling.docx (MS Word: H:\documents\procedures_and_policies); 1 April 2011, revised 10/5/11, 12/27/13, 10/05/16, 3/20/17, 3/23/17, 9/5/17, 3/22/18, 4/26/19 page ______ of ______

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF FISH AND WILDLIFE
FISH COLLECTION RECORD

Project and Site Name ____ DEC Region ____________

Collections made by (include all crew) ____

Sampling Method: ☐Electrofishing ☐Gill netting ☐Trap netting ☐Trawling ☐Seining ☐Angling ☐Other ______________________________

Preservation Method: ☐Freezing ☐Other ______________________ Notes (SWFDB survey number): ______________________________

FOR LAB USE ONLY- LAB ENTRY NO.	COLLECTION OR TAG NO.	SPECIES	DATE TAKEN	LOCATION	AGE	SEX &/OR REPROD. CONDIT	LENGTH ( )	WEIGHT ( )	REMARKS

richter: revised 2011, 5/7/15, 10/4/16, 3/20/17; becker: 3/23/17, 4/26/19

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CHAIN OF CUSTODY

I, ______________________________, of ____ collected the
(Print Name) (Print Business Address)

following on ____________________, 20____ from ____
(Date) (Water Body)

in the vicinity of ____
(Landmark, Village, Road, etc.)

Town of _______________________________________, in _________________________________ County.

Item(s) ____

____

Said sample(s) were in my possession and handled according to standard procedures provided to me prior to collection. The sample(s) were placed in the custody of a representative of the New York State Department of Environmental Conservation on ____________________________________, 20______.

____ ____________________________
Signature Date

I, ___________________________________, received the above mentioned sample(s) on the date specified and assigned identification number(s) ____ to the sample(s). I have recorded pertinent data for the sample(s) on the attached collection records. The sample(s) remained in my custody until subsequently transferred, prepared or shipped at times and on dates as attested to below.

_______________________________________ ___________________
Signature Date

SECOND RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
THIRD RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
FOURTH RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
RECEIVED IN LABORATORY BY (Print Name)	TIME & DATE	REMARKS
SIGNATURE	UNIT	
LOGGED IN BY (Print Name)	TIME & DATE	ACCESSION NUMBERS
SIGNATURE	UNIT	

richter: revised 21 April 2014; becker: 23 March 2017, 26 April, 2019

NOTICE OF WARRANTY

By signature to the chain of custody (reverse), the signatory warrants that the information provided is truthful and accurate to the best of his/her ability. The signatory affirms that he/she is willing to testify to those facts provided and the circumstances surrounding the same. Nothing in this warranty or chain of custody negates responsibility nor liability of the signatories for the truthfulness and accuracy of the statements provided.

HANDLING INSTRUCTIONS

On day of collection, collector(s) name(s), address(es), date, geographic location of capture (attach a copy of topographic map or navigation chart), species, number kept of each species, and description of capture vicinity (proper noun, if possible) along with name of Town and County must be indicated on reverse.

Retain organisms in manila tagged plastic bags to avoid mixing capture locations. Note appropriate information on each bag tag.

Keep samples as cool as possible. Put on ice if fish cannot be frozen within 12 hours. If fish are held more than 24 hours without freezing, they will not be retained or analyzed.

Initial recipient (either DEC or designated agent) of samples from collector(s) is responsible for obtaining and recording information on the collection record forms which will accompany the chain of custody. This person will seal the container using packing tape and writing his signature, the time and the date across the tape onto the container with indelible marker. Any time a seal is broken, for whatever purpose, the incident must be recorded on the Chain of Custody (reason, time, and date) in the purpose of transfer block. Container then is resealed using new tape and rewriting signature, with time and date.

EQUIPMENT LIST

Scale or balance of appropriate capacity for the fish to be collected.

Fish measuring board.

Plastic bags of an appropriate size for the fish to be collected and for site bags.

Individually numbered metal tags for fish.

Manila tags to label bags.

Small envelops, approximately 2” x 3.5”, if fish scales are to be collected.

Knife for removing scales.

Chain of custody and fish collection forms.

Clipboard.

Pens or markers.

Paper towels.

Dish soap and brush.

Bucket.

Cooler.

Ice.

Duct tape.

Appendix G – PFAS Analyte List

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonic acids	Perfluorobutanesulfonic acid	PFBS	375-73-5
	Perfluoropentanesulfonic acid	PFPeS	2706-91-4
	Perfluorohexanesulfonic acid	PFHxS	355-46-4
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanesulfonic acid	PFOS	1763-23-1
	Perfluorononanesulfonic acid	PFNS	68259-12-1
	Perfluorodecanesulfonic acid	PFDS	335-77-3
	Perfluorododecanesulfonic acid	PFDoS	79780-39-5
Perfluoroalkyl carboxylic acids	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	PFHpA	375-85-9
	Perfluorooctanoic acid	PFOA	335-67-1
	Perfluorononanoic acid	PFNA	375-95-1
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUnA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTeDA	376-06-7
Per- and Polyfluoroether carboxylic acids	Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
	4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
	Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
	Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5
	Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6
Fluorotelomer sulfonic acids	4:2 Fluorotelomer sulfonic acid	4:2-FTS	757124-72-4
	6:2 Fluorotelomer sulfonic acid	6:2-FTS	27619-97-2
	8:2 Fluorotelomer sulfonic acid	8:2-FTS	39108-34-4
Fluorotelomer carboxylic acids	3:3 Fluorotelomer carboxylic acid	3:3 FTCA	356-02-5
	5:3 Fluorotelomer carboxylic acid	5:3 FTCA	914637-49-3
	7:3 Fluorotelomer carboxylic acid	7:3 FTCA	812-70-4
Perfluorooctane sulfonamides	Perfluorooctane sulfonamide	PFOSA	754-91-6
	N-methylperfluorooctane sulfonamide	NMeFOSA	31506-32-8
	N-ethylperfluorooctane sulfonamide	NEtFOSA	4151-50-2
Perfluorooctane sulfonamidoacetic acids	N-methylperfluorooctane sulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethylperfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6
Perfluorooctane sulfonamide ethanols	N-methylperfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7
	N-ethylperfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2

Group	Chemical Name	Abbreviation	CAS Number
Ether sulfonic acids	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F-53B Major)	9Cl-PF3ONS	756426-58-1
	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	11Cl-PF3OUdS	763051-92-9
	Perfluoro(2-ethoxyethane) sulfonic acid	PFEESA	113507-82-7

Appendix H - Data Review Guidelines for Analysis of PFAS in Non-Potable Water and Solids

General

These guidelines are intended to be used for the validation of PFAS using EPA Method 1633 for projects within the Division of Environmental Remediation (DER). Data reviewers should understand the methodology and techniques utilized in the analysis. Consultation with the end user of the data may be necessary to assist in determining data usability based on the data quality objectives in the Quality Assurance Project Plan. A familiarity with the laboratory's Standard Operating Procedure may also be needed to fully evaluate the data. If you have any questions, please contact DER's Quality Assurance Officer, Dana Barbarossa, at dana.barbarossa@dec.ny.gov.

Preservation and Holding Time

Samples should be preserved with ice to a temperature of less than 6°C upon arrival at the lab. The holding time is 28 days to extraction for aqueous and solid samples. The time from extraction to analysis for aqueous samples is 28 days and 40 days for solids.

Temperature greatly exceeds 6ºC upon arrival at the lab*	Use professional judgement to qualify detects and non-detects as estimated or rejected
Holding time exceeding 28 days to extraction	Use professional judgement to qualify detects and non-detects as estimated or rejected if holding time is grossly exceeded

*Samples that are delivered to the lab immediately after sampling may not meet the thermal preservation guidelines. Samples are considered acceptable if they arrive on ice or an attempt to chill the samples is observed.

Initial Calibration

The initial calibration should contain a minimum of six standards for linear fit and six standards for a quadratic fit. The relative standard deviation (RSD) for a quadratic fit calibration should be less than 20%.

The low-level calibration standard should be within 50% - 150% of the true value, and the mid-level calibration standard within 70% - 130% of the true value.

%RSD >20%	J flag detects and UJ non detects

Continuing Calibration Verification

Continuing calibration verification (CCV) checks should be analyzed at a frequency of one per ten field samples. If CCV recovery is very low, where detection of the analyte could be in question, ensure a low level CCV was analyzed and use to determine data quality.

CCV recovery <70 or >130%	J flag results

Blanks

There should be no detections in the method blanks above the reporting limits. Equipment blanks, field blanks, rinse blanks etc. should be evaluated in the same manner as method blanks. Use the most contaminated blank to evaluate the sample results.

Blank Result	Sample Result	Qualification
Any detection	<Reporting limit	Qualify as ND at reporting limit
Any detection	>Reporting Limit and >10x the blank result	No qualification
>Reporting limit	>Reporting limit and <10x blank result	J+ biased high

Field Duplicates

A blind field duplicate should be collected at rate of one per twenty samples. The relative percent difference (RPD) should be less than 30% for analyte concentrations greater than two times the reporting limit. Use the higher result for final reporting.

RPD >30%	Apply J qualifier to parent sample

Lab Control Spike

Lab control spikes should be analyzed with each extraction batch or one for every twenty samples. In the absence of lab derived criteria, use 70% - 130% recovery criteria to evaluate the data.

Recovery <70% or >130% (lab derived criteria can also be used)	Apply J qualifier to detects and UJ qualifier to non detects

Matrix Spike/Matrix Spike Duplicate

One matrix spike and matrix spike duplicate should be collected at a rate of one per twenty samples. Use professional judgement to reject results based on out of control MS/MSD recoveries.

Recovery <70% or >130% (lab derived criteria can also be used)	Apply J qualifier to detects and UJ qualifier to non detects of parent sample only
RPD >30%	Apply J qualifier to detects and UJ qualifier to non detects of parent sample only

Extracted Internal Standards (Isotope Dilution Analytes)

Problematic analytes (e.g. PFBA, PFPeA, fluorotelomer sulfonates) can have wider recoveries without qualification. Qualify corresponding native compounds with a J flag if outside of the range.

Recovery <50% or >150%	Apply J qualifier
Recovery <25% or >150% for poor responding analytes	Apply J qualifier
Isotope Dilution Analyte (IDA) Recovery <10%	Reject results

Signal to Noise Ratio

The signal to noise ratio for the quantifier ion should be at least 3:1. If the ratio is less than 3:1, the peak is discernable from the baseline noise and symmetrical, the result can be reported. If the peak appears to be baseline noise and/or the shape is irregular, qualify the result as tentatively identified.

Reporting Limits

If project-specific reporting limits were not met, please indicate that in the report along with the reason (e.g. over dilution, dilution for non-target analytes, high sediment in aqueous samples).

Peak Integrations

Target analyte peaks should be integrated properly and consistently when compared to standards. Ensure branched isomer peaks are included for PFAS where standards are available. Inconsistencies should be brought to the attention of the laboratory or identified in the data review summary report.

APPENDIX D

ANALYTICAL LABORATORY PFAS STANDARD OPERATION PROCEDURES AND REPORTING LIMITS

ENV-SOP-MANS-0111 v01 Preparation and Analysis of PFAS in Aqueous, Solid, and Tissue by EPA Method 1633

Effective Date: 08/07/2024

Management Approval:
John Trimble Approved on 8/7/2024 11:55:41 AM
Laura Vanasse Approved on 8/7/2024 11:32:33 AM
Pete Henriksen Approved on 8/7/2024 10:20:05 AM
Jason Hebert Approved on 8/7/2024 12:02:07 PM

1.0 SCOPE & APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure used by Alpha, a Pace Analytical Laboratory for the determination of the per- and polyfluoroalkyl substances (PFAS) by liquid chromatography/mass spectrometry (LC-MS/MS) following EPA 1633, published January 2024. This SOP is applicable to aqueous (all non-potable water and leachate), solid (soil, biosolids, sediment), and tissue matrices.

The instrumental portion of this method is for use only by analysts experienced with LC-MS/MS or under the close supervision of such qualified persons. The laboratory must demonstrate the ability to generate acceptable results using the procedures in Sections 11.3.1 and 11.3.2.

By their very nature, many components of PFAS present analytical challenges unique to this class of analytes. For example, PFAS analytes readily adhere to the walls of the sample containers and may also stratify in the container.

1.1 Target Analyte List, Limits of Detection & Quantitation (LOD & LOQ)

The target analytes that can be determined by this SOP and the associated LODs and LOQs are provided in Appendix A, Tables 1, 2, and 3.

LOQs are established in accordance with PAS policies and procedures for method validation, determination of detection limits (LOD), and quantitation limits (LOQ). Refer to laboratory SOP ID 1732 (Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)) for additional information. DL and LOQ are routinely verified and updated when needed. DL and LOQ are always adjusted to account for actual sample amounts used and for dilution.

The reporting limit (RL) is the value to which analytes are reported as detected or non-detect in the final report. When the RL is less than the lower limit of quantitation (LLOQ), all detections and non-detects at the RL are qualitative. The LLOQ is the lowest point of the calibration curve used for each target analyte.

1.2 Reference Methods & Documents

This SOP is based on reference method EPA 1633 (2024). If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modifications is provided in Section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

1.3 Quantitation Range

The quantitation range for each target analyte in this procedure is defined in Appendix A, Table 5: Calibration Standard Concentrations.

1.4 Program Specific Requirements

Not Applicable.

2.0 SUMMARY OF METHOD

Environmental samples are prepared and extracted using method-specific procedures. Sample extracts are subjected to cleanup procedures designed to remove interferences. Analyses of the sample extracts are conducted by LC-MS/MS in the multiple reaction monitoring (MRM) mode. Sample concentrations are determined by isotope dilution or extracted internal standard quantification (see Section 9.2.1) using isotopically labeled compounds added to the samples before extraction.

Individual PFAS analytes are identified through peak analysis of the quantification and confirmation ions, where applicable. Where linear and branched isomers are present in the sample and either qualitative or quantitative standards containing branched and linear isomers are commercially available, the PFAS analyte is reported as a single analyte consisting of the sum of the linear and branched isomer concentrations.

Quantitative determination of target analyte concentrations is made with respect to an isotopically labeled PFAS standard; the concentrations are then used to convert raw peak areas in sample chromatograms to final concentrations.

Results for target analytes are recovery corrected by the method of quantification (i.e., either isotope dilution or extracted internal standard quantification, see Section 9.2.1). Recoveries of isotopically labeled extracted internal standards (EIS) are determined by comparison to the responses of one of seven non-extracted internal standards (NIS) and are used as general indicators of overall analytical quality.

The quality of the analysis is assured through reproducible calibration and testing of the extraction, cleanup, and LC-MS/MS systems.

- Aqueous samples are spiked with isotopically labeled standards (EIS), extracted using solid-phase extraction (SPE) cartridges and undergo cleanup using carbon before analysis.

- Solid samples are spiked with EIS, extracted into basic methanol, and cleaned up by carbon and SPE cartridges before analysis.

- Tissue samples are spiked with EIS, extracted in methanol with potassium hydroxide followed by acetonitrile, and cleaned up by carbon and SPE cartridges before analysis.

3.0 INTERFERENCES

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and elevated baselines causing misinterpretation of chromatograms. Specific selection of reagents and solvents is required.

Clean all equipment prior to, and after, each use to avoid PFAS cross-contamination. Typical cleaning solvents include water, methanol, and methanolic ammonium hydroxide. The residual PFAS content of disposable plasticware and filters must be verified by batch/lot number and may be used without cleaning if PFAS levels are less than the Method Detection Limit (MDL).

Prior to use, glassware must be solvent rinsed and then air dried. A solvent rinse procedure using methanolic ammonium hydroxide (1%) and methanol is recommended.

Sample manifold ports and transfer tubing should be inspected regularly for signs of wear and/or discoloration. When such observations are made, the associated components should be replaced.

All parts of the SPE manifold must be cleaned between samples by rinsing with methanolic ammonium hydroxide (1%) and air drying prior to use. Smaller parts, like the needles, adapters, reservoirs, transfer lines, and stopcocks associated with the manifold should be rinsed with tap water prior to rinsing with methanolic ammonium hydroxide (1%) and air drying. After loading the samples but prior to elution procedures, the chamber should be rinsed with methanolic ammonium hydroxide (1%).

All materials used in the analysis must be demonstrated to be free from interferences by running method blanks (Section 11.1.1) at the beginning and with each extraction batch (samples started through the extraction process on a given batch to a maximum of 20 field samples).

Reagent water (Section 8.1) can be used to simulate water samples and Ottawa sand and/or reagent-grade sand (Section 7.3) can be used to simulate soils. Fish fillets (tilapia/ cod), chicken breast or other similar animal tissue (see Section 7.3) may be used as the reference matrix for tissue. The laboratory must verify that the source product used does not contain PFAS in detectable amounts.

Interferences co-extracted from samples will vary considerably from source to source, depending on the diversity of the site being sampled. Interfering compounds may be present at concentrations several orders of magnitude higher than the native PFAS. Because low levels of PFAS are measured by this method, elimination of interferences is essential. The cleanup steps given in Section 9.3 can be used to reduce or eliminate these interferences and thereby permit reliable determination of the PFAS at the levels shown in Tables 1, 2 and 3. The most frequently encountered interferences are fluoropolymers; however, bile salts (e.g., Taurodeoxycholic Acid [TDCA]) may be present in various matrices, including fish and wastewaters, and can interfere in the chromatography. For this reason, analysis of a standard containing TDCA is required as part of establishing the initial chromatographic conditions (see Sections 8.3.2 and 8.3.3) and each analytical sequence (see Section 9.4).

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **Extracted Internal Standard (EIS) quantification:** The response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities.
- **Isotope dilution (ID) quantitation:** A means of determining a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. The labeled PFAS are spiked into each sample and allow identification and correction of the concentration of the native compounds in the analytical process.
- **Isotopically labeled compound:** An analog of a target analyte in the method which has been synthesized with one or more atoms in the structure replaced by a stable (non-radioactive) isotope of that atom. Common stable isotopes used are 13C (Carbon-13) or Deuterium (D or 2H). These labeled compounds do not occur in nature, so they can be used for isotope dilution quantitation or other method-specific purposes.

- **Minimum Level of quantitation (ML):** The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. The ML represents the lowest concentration at which an analyte can be measured with a known level of confidence. It may be equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
- **PAS:** Acronym for Pace® Analytical Services, LLC

5.0 HEALTH & SAFETY

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

PAS does not offer sample collection services for this test method. PAS advises customers to collect samples in accordance with a sampling plan and collection procedures appropriate to meet regulatory requirements and data quality objectives for the project. The minimum sample amounts required for the test are provided in this section.

PAS provides containers for the collection of samples upon client request. The routine container type and size is provided in the following table along with requirements for sample size, preservation and holding time. Refer to Bottle Order Preparation (ENV-SOP-WEST-0005), or however named, for procedures related to preparation of bottle kits.

Container Type, Minimum Sample Amount, Preservation, and Holding Time

Matrix	Container Size & Type[1]	Minimum Sample Amount[2]	Preservation	Holding Time
Aqueous (non-potable water)	2 x 500 mL linerless HDPE 1 x 125 mL linerless HDPE[3]	500 mL	Thermal: 0-6°C (or ≤ -20°C)	Collection to Preparation: 28 Days (or 90 Days) Preparation to Analysis: 28 Days
Aqueous (leachate)	2 x 125 mL linerless HDPE	100 mL	Thermal: 0-6°C (or ≤ -20°C)	Collection to Preparation: 28 Days (or 90 Days) Preparation to Analysis: 28 Days
Solid (sediment and soil)	3 oz/ 90 mL linerless polypropylene wide mouth	5 g	Thermal: 0-6°C or ≤ -20°C	Collection to Preparation: 90 Days Preparation to Analysis: 28 Days
Solid (biosolid)	3 oz/ 90 mL linerless polypropylene wide mouth	0.5 g	Thermal: 0-6°C or ≤ -20°C	Collection to Preparation: 90 Days Preparation to Analysis: 28 Days
Tissue[4]	3 oz/ 90 mL linerless polypropylene wide mouth	2 g	Thermal: ≤ -20°C	Collection to Preparation: 90 Days Preparation to Analysis: 28 Days

[1] *Default container type provided in sample kit. To allow room for expansion during freezing (if necessary), aqueous sample containers should not be overfilled. Aqueous sample containers should be filled only to the appropriate gradation marked on the container, or to the shoulder of the container if no gradations are provided.*

[2] *Nominal amount of sample required for each discrete test. Solid and biosolid sample amounts reflect dry weight.*

[3] *Used for pre-screening analyses.*

[4] *Container listed here will be used for tissue homogenate; samples may be received at the laboratory as whole fish or filets wrapped in aluminum foil or food grade polyethylene wrap. Ideally fish should be frozen upon collection and shipped to the laboratory as soon as possible.*

Note: Project-specific requirements dictate which storage condition applies. The storage condition to be used for each project must be formally documented in written form (QAPP or otherwise) before samples are received. Without any prior indication from the client, the lab will store all aqueous and solid/biosolid samples at 0-6°C until extraction, with a 28-day holding time (collection to prep) for aqueous matrices and a 90-day holding time (collection to prep) for solid/biosolid matrices.

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP (ENV-SOP-WEST-0003, Sample Receipt and Login), or however named.

After receipt, samples are stored as listed above until sample preparation. Prepared sample extracts of all matrices are stored at 0-6°C until sample analysis.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method.

Due to the possibility of adsorption of analytes onto glass, plastic containers are used for all standard, sample, and extraction preparations. Any time a new lot of SPE cartridges, solvents, cryovials, or autosampler vials are used, it must be demonstrated that a MB is reasonably free of contamination and that the criteria in Section 11.1.1 are met.

7.1 Instrumentation

- High-performance liquid chromatograph (HPLC) equipped with tandem quadrupole mass spectrometer – Sciex 5500+ or equivalent
- Agilent Zorbax RRHD Eclipse Plus C18, 2.1 x 50 mm (1.8 µm) analytical column (Agilent Part # 959757-902), or equivalent
- Guard cartridge/column – Agilent Zorbax Eclipse Plus C18, 2.1 x 5 mm, 1.8 um (Agilent Part# 821725-901), or equivalent
- Trap/delay column – InfinityLab PFC Delay Column, 4.6 x 30 mm (Agilent Part# 5062-8100), or equivalent

7.2 Support Equipment

- Oven – Capable of maintaining a temperature of 105 ± 5 ºC
- Analytical balance – Capable of weighing 0.0001 g
- Top loading balance – Capable of weighing 0.01 g
- Calibrated mechanical variable volume pipettes with disposable HDPE or polypropylene tips (10 µL to 5 mL) – used for preparation of calibration standards and spiked samples
- Point of Use water preparation system – Thermo Scientific Barnstead E-Pure; model 7119 – Used for QC samples to verify the systems are PFAS free
- Ultrasonic mixer – Fisherbrand; Model CPX3800 – 5.7L, 40 kHZ, 120V, 2.9 Amp with timer
- Analog or digital vortex mixer, single or multi-tube (Fisher Scientific 02-215-452, or equivalent)
- Variable speed mixing table (VWR Model 3500 Orbital Shaker, or equivalent)

- Centrifuge (Beckman Allegra 6, Hettich Rotanta 460, or equivalent), capable of reaching at least 3000 rpm (~2000 RCF)
- Vacuum Pump – Sufficient capacity to maintain a vacuum of approximately 10 to 15 inches of mercury for extraction cartridges. GAST model # DOA-P704-AA, Waters Cat# 725000417, 115V, 60Hz, 4.2A
- Vacuum manifold for SPE Cartridges – Waters Cat# WAT200609: SPE Vacuum manifold, or equivalentCat
- Vacuum tubing – 1/4” ID, 5/8” OD, 3/16” wall; Fisher Scientific part# 14-176-6B or equivalent
- PE Transfer tubing – 1/8” X .062 x 500ft, Freelin Wade part# 1C-109-10 or equivalent.

7.3 Supplies

- Solid Phase Extraction (SPE) cartridges – Phenomenex part# CS0-9216, 250 mg WAX/20mL, or equivalent
- Carbon Cleanup cartridges – Phenomenex part# 8B-S528-CAJ, 50 mg GCB, or equivalent
- SPE reservoirs – 60 mL, Phenomenex part# AH0-7189, or equivalent
- SPE adapter caps – Supelco part# 57267 (Adapter cap for 12, 20 & 60 mL SPE tubes)
- Disposable liners for Vacuum Manifold – Waters part# 20685 or equivalent
- Silanized glass wool (Pyrex 3950 or equivalent)
- Reference matrix: Aqueous – reagent water
- Reference matrix: Solid – Ottawa sand
- Reference matrix: Tissue – fish fillets, chicken breast or similar animal tissue. First preference will be frozen cod fillets.
- Bottles – HDPE or PP, with linerless HDPE or polypropylene caps. Various sizes. QEC item # 6212-Q016/BC-150-PACE (500 mL), 6212-Q008BC-P (250 mL), 6213-U004BC-P (125 mL), 6214-003PPGBC-P (90 mL)
- Screw top vials, Polypropylene 0.7-mL with polypropylene caps – used in sample analysis and pre-screening (Waters Cat # 186005219 and 186004169 or equivalent)
- 15- and 50-mL conical polypropylene tubes with polypropylene screw caps for preparing and storing extract solutions and for collection of eluents (Fisher Scientific 05-527-90 and 14-432-22, or equivalent)
- 500-mL conical polypropylene centrifuge bottles for sample centrifugation (Fisher Scientific 07-200-621 or equivalent)
- Extract/Standard storage containers – 15-mL, 8-mL, or 4-mL narrow-mouth HDPE container - Thermo Scientific item# 2002-9050, 2002-9025, 2002-9125; 2.0-mL screw-top polypropylene cryogenic vials – Grainger item# 6EMV1/ Wheaton item# W985872;1.5-mL snap-cap polypropylene microcentrifuge tubes - Fisher item# 05-408-129; or equivalent
- pH Paper, range 0-14 - (VWR Cat# BD3539.606 or equivalent), 0.5-unit readability

- Disposable glass and plastic pipets

8.0 REAGENTS & STANDARDS

Refer to laboratory SOP (ENV-SOP-MANS-0112, Reagent, Solvent, and Standard Control), or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared, when available. Expiration and storage requirements are defined per manufacturer.

8.1 Reagents

Use of equivalent reagents from alternative vendors is acceptable so long as the substitution meets the performance specifications required by the reference method.

- Acetic acid – ACS grade or equivalent, store at room temperature; VWR cat# BDH3098-3.8LP or equivalent
- Acetonitrile – UV grade or equivalent, verified before use, store at room temperature; Honeywell Cat# 018-4 or equivalent (for extraction)
- Ammonium acetate – ACS or equivalent, store at 2-8° C, replace 2 years after opening date; VWR BDH9204-500G or equivalent.
- 1M aqueous ammonium acetate (Waters Cat# 186006693-1) used for mobile phase additive; store as indicated by manufacturer.
- Ammonium hydroxide – certified ACS+ grade or equivalent, 30% in water, store at room temperature; Fisher A470-500 or equivalent
- Formic acid – greater than 96% purity or equivalent, store at room temperature; Acros 147930010 or equivalent
- Methanol – HPLC grade or better, 99.9% purity, store at room temperature; Honeywell CAT# 230-4 or equivalent
- Mobile Phase A – 2 mM ammonium acetate in 95:5 water/acetonitrile. Aliquot 0.4 mL of aqueous 5M ammonium acetate in 949.6 mL of water and 50 mL of acetonitrile. Alternatively, dissolve 0.154 g of neat ammonium acetate into 950 mL of water and 50 mL of acetonitrile. Store at room temperature; shelf life is 2 months.
- Mobile Phase B – Acetonitrile, Ultra HPLC grade or equivalent; OmniSolv AX0142-1 or equivalent
- Potassium hydroxide – certified ACS or equivalent, store at room temperature, replace after 2 years; Fisher P250-500 or equivalent.
- Reagent water – Laboratory reagent water, test by lot/batch number for residual PFAS content.

8.2 Standards

Use of equivalent standards from alternative vendors is acceptable so long as they are traceable to a national standard, when commercially available. Follow manufacturer’s recommended storage conditions and expiration dates.

8.2.1 Primary PFAS Standard

- EPA Method 1633 Native PFAS Standard mix from Wellington Laboratories (item# EPA-1633STK) – used to prepare the calibration standards and to spike the reference QC samples prepared/analyzed with every batch of samples. Also used to prepare an intermediate standard for calibration standard preparation and low-level QC sample spiking, as described below.

8.2.2 Secondary PFAS Standard

- Method 1633-PFCs-Calibration Standard mix from Absolute Standards (item# 65735) – used to prepare the ICV standard as described below.

8.2.3 Extracted Internal Standard (EIS)

- Mass-labelled PFAS Extraction Standard mix from Wellington Laboratories (item# MPFAC-HIF-ES) – used to prepare analytical standards and spike each sample prior to extraction.

8.2.4 Non-extracted Internal Standard (NIS)

- Mass-labelled PFAS Injection Standard mix from Wellington Laboratories (item# MPFAC-HIF-IS) – used to prepare analytical standards and spike sample extracts prior to instrumental analysis.

8.2.5 Bile Salt (TDCA) Standard

- Neat Taurodeoxycholic acid from Cayman Chemical (item# 15935), or equivalent – used to prepare analytical standards for bile salt interference check.

8.3 Formulations

Prepare standard solutions from materials of known purity and composition or purchase as solutions or mixtures with certification to their purity, concentration, and authenticity. Observe the safety precautions in Section 5.

Purchase of commercial standard solutions or mixtures is highly recommended for this method; however, when these are not available, preparation of stock solutions from neat materials may be necessary. If the chemical purity is 98% or greater, the weight may be used without correction to calculate the concentration of the standard.

When not being used, store standard solutions in the dark at 4 °C, unless the vendor recommends otherwise, in tightly sealed screw-capped vials. Place a mark on the vial at the level of the solution so that solvent loss by evaporation can be detected. Replace the solution if solvent loss has occurred.

Note: 18O-mass labeled perfluoroalkyl sulfonates may undergo isotopic exchange with water under certain conditions, which lowers the isotopic purity of the standards over time.

The laboratory must maintain records of the certificates for all standards for traceability purposes. Copies of the certificates should be provided as part of the data packages in order to check that proper calculations were performed.

8.3.1 Analytical and Preparation Reagents

Analytical and Preparation reagents are stored in plastic or glass containers under ambient conditions. Expiries are listed with each reagent.

- Instrument Blank Mix (IBLK Mix) – Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid – add ammonium hydroxide (3.3 mL, 30%), reagent water (1.67 mL) and acetic acid (0.625 mL) to methanol (94.4 mL); store at room temperature, replace after 1 month. This solution is used to prepare the instrument blank (Sections 8.3.3.3 and 9.2.5) and sample extract dilutions.
- Mobile Phase A – 2 mM ammonium acetate in 95:5 water: acetonitrile. Aliquot 2.0 mL of aqueous 1M ammonium acetate in 948 mL of water and 50 mL of acetonitrile. Store at room temperature; replace after 2 months or less.
- Mobile Phase B – Acetonitrile, HPLC grade or equivalent; Omnisolv AX0142-1 or equivalent
- Acetic acid (0.1%) - dissolve acetic acid (1 mL) in reagent water (1 L); store at room temperature, replace after 3 months.
- Aqueous ammonium hydroxide (3%) – add ammonium hydroxide (10 mL, 30%) to reagent water (90 mL), store at room temperature, replace after 3 months.
- Methanolic ammonium hydroxide (0.3%) – add ammonium hydroxide (1 mL, 30%) to methanol (99 mL), store at room temperature, replace after 1 month.
- Methanolic ammonium hydroxide (1%) – add ammonium hydroxide (3.3 mL, 30%) to methanol (97 mL), store at room temperature, replace after 1 month.
- Methanolic ammonium hydroxide (2%) – add ammonium hydroxide (6.6 mL, 30%) to methanol (93.4 mL), store at room temperature, replace after 1 month.
- Formic acid (aqueous, 0.1 M) – dissolve formic acid (4.6 g / 3.77 mL) in reagent water (1 L), store at room temperature, replace after 2 years.
- Formic acid (aqueous, 0.3 M) – dissolve formic acid (13.8 g / 11.31 mL) in reagent water (1 L), store at room temperature, replace after 2 years.
- Formic acid (aqueous, 5% v/v) – mix 5 mL formic acid with 95 mL reagent water, store at room temperature, replace after 2 years.
- Formic acid (aqueous, 50% v/v) – mix 50 mL formic acid with 50 mL reagent water, store at room temperature, replace after 2 years.
- Formic acid (methanolic 1:1, 0.1 M formic acid/methanol) – mix equal volumes of methanol and 0.1 M formic acid, store at room temperature, replace after 2 years.
- Methanolic potassium hydroxide (0.05 M KOH) – add 3.3 g of potassium hydroxide to 1 L of methanol, store at room temperature, replace after 3 months.

8.3.2 Intermediate Standards

Intermediate standards are stored in plastic containers as listed below. Expiries are listed with each formulation.

- TDCA Stock Solution: Dissolve 10 mg of neat TDCA into 5 mL of MeOH; final concentration equals 2000 µg/mL. Store frozen (<0°C) when not in use; replace after 1 year, or sooner if degradation is observed.
- STK-10X Solution: Dilute 200 µL of EPA-1633STK with 1.8 mL of MeOH for a final volume of 2 mL; final concentrations vary by analyte – 25, 50, 100, 125, 250, or 625 ng/mL. Store at 0-6°C when not in use; replace every time a new lot of 1633STK is used, or after 1 month.

8.3.3 Working Solutions

Working solutions are stored in plastic containers under refrigerated conditions at 0-6°C and expire 1 month from the date of preparation.

8.3.3.1 Calibration Standards

A series of calibration solutions containing the target analytes and the EIS and NIS is used to establish the initial calibration of the analytical instrument. The concentration of the method analytes in the solutions varies to encompass the working range of the instrument, while the concentrations of the EIS and NIS (and TDCA) remain constant. The calibration solutions are prepared using the standards and intermediate standards described above. The final solvent composition will match the solvent mix of sample extracts, which contain methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid. Calibration standard solutions do not undergo solid phase extraction/cleanup. Prepare the calibration standard solutions according to the table below. Following all formulations listed in this SOP will require 3 ampoules of the 1633STK mix to prepare a full calibration set; other final volumes may be prepared. If the lab follows all formulations in this SOP as written, the remaining volumes of 1633STK and STK-10X solutions after preparing the calibration should be enough to spike approximately 40 sets of aqueous batch QC. The remainder of MPFAC-HIF-ES and MPFAC-HIF-IS mixes should provide enough volume to spike approximately 40-45 samples.

Component[1]	L1	L2 (LOQ)	L3	L4	L5 (CCV)	L6	L7	L8	L9
STK-10X	20	16	40						
EPA-1633STK				20	100	100	200	400	500
MPFAC-HIF-ES	25	10	10	10	25	10	10	10	10
MPFAC-HIF-IS	25	10	10	10	25	10	10	10	10
TDCA Stock	25				25				10
IBLK Mix	4905	1964	1940	1960	4825	1880	1780	1580	1470
Final Volume	5000	2000	2000	2000	5000	2000	2000	2000	2000

[1] *All values listed are µL*

8.3.3.2 Initial Calibration Verification Standard (ICV)

Prepare the ICV standard using the Absolute Standards 1633 PFC Mix, following the table below; expected concentration for all compounds in the ICV will be 10 ng/mL. The ICV is prepared from a separate, second source (or separate manufacturer lot) than that used for the calibration solutions. If a second source or lot is unavailable, a separate preparation using the same stocks is acceptable.

Component	Volume used (µL)
1633 PFC Mix	20
MPFAC-HIF-ES	20
MPFAC-HIF-IS	20
IBLK Mix	3940
ICV Final Volume	4000

8.3.3.3 Instrument Blank

A solvent blank is analyzed at the beginning of each analytical sequence, to demonstrate clean instrumental background, and after samples containing high levels of target compounds (e.g., calibration, CCV) to monitor carryover from the previous injection. The instrument blank consists of clean reagent fortified with the EIS and NIS for quantitation purposes. Prepare the IBLK using the IBLK mix (Section 8.3.1) and an appropriate volume of EIS and NIS; alternatively, prep the IBLK from 1887 µL of 1% Methanolic ammonium hydroxide, 80 µL of reagent water, 12.5 µL of acetic acid, and 10 µL each of EIS and NIS.

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Instrument Setup

9.1.1.1 Routine Instrument Operating Conditions

Example LC Gradient

Step	Total Time (min)	Flow Rate (µL/min)	A: 5% Acetonitrile w/ 10mM Ammonium Acetate (%)	B: Acetonitrile (%)
1	0.00	400	80	20
2	6.00	400	0	100
3	6.50	400	0	100
4	6.51	400	80	20
5	8.50	400	80	20

Example MS Parameters

MS Parameter	Setting or Value
Sample Loop	100 µL
Injection Volume	2 µL
Column Oven Temperature	40° C
MRM Scan Window	60 sec
Curtain Gas (CUR)	30.0
Collision Gas (CAD)	9
Ion Spray Voltage (IS)	-4500 V
Source Temperature (TEM)	450° C
Ion Source Gas 1 (GS1)	30.0
Ion Source Gas 2 (GS2)	50.0

9.1.1.2 Mass Calibration

The mass spectrometer must undergo mass calibration to ensure accurate assignments by the instrument. This mass calibration must be performed at least annually to maintain instrument sensitivity and stability. Mass calibration must be repeated on an as-needed basis (e.g., QC failures, ion masses fall outside of the instrument required mass window, major instrument maintenance, or if the instrument is moved). Mass calibration must be performed using the calibration compounds and procedures prescribed by the manufacturer. The procedures used for mass calibration and mass calibration verification must evaluate an ion range that encompasses the ion range (Q1 and Q2 m/z) of the analytes of interest of this method.

9.1.1.3 Mass Calibration Verification

A mass calibration verification must be performed following mass calibration, prior to standard and sample analyses. Mass verification checks must also be performed after any subsequent mass calibrations. The laboratory must follow the instructions for the individual instrument software to confirm the mass calibration, mass resolution and peak relative response. If the manufacturer's instructions include options for evaluation of mass resolution, the tightest resolution requirements (typically called unit resolution) must be met.

9.1.1.4 Retention Time (RT) calibration

Once RT windows have been confirmed for each target analyte, EIS, and NIS compound, then once per ICAL and at the beginning of the analytical sequence, the position of all target analyte, EIS, and NIS peaks shall be set using the midpoint standard of the ICAL curve when ICAL is performed. When an ICAL is not performed, the initial CCV retention times or the midpoint standard of the ICAL curve can be used to establish the RT window position.

The RTs for the target analytes, EIS, and NIS compounds must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. All branched isomer peaks identified in either the calibration standard or the qualitative (technical grade) standard also must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV. For all target analytes with exact corresponding isotopically labeled analogs, target analytes must elute within 0.1 minutes of the associated EIS compound.

When establishing the chromatographic conditions, it is important to consider the potential interference of bile salts (i.e. TDCA) during analyses of samples. Analytical conditions must be set to allow a separation of at least 1 minute between TDCA and the retention time window of PFOS. The method requires this evaluation when establishing the chromatographic conditions, regardless of the sample matrices to be analyzed.

9.1.2 Support Equipment

Refer to laboratory SOP (ENV-SOP-WEST-0036 Balance Calibration Verification, ENV-SOP-WEST-0123 Pipette and Bottle Top Verification), or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.2 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.2.1 Calibration Frequency

Prior to the analysis of samples, and after a successful mass calibration check, each LC-MS/MS system must be calibrated at a minimum of 6 standard concentrations (Section 8.3.3.1 and Appendix A, Table 5). This method procedure calibrates and quantifies 40 PFAS target analytes, using the isotopically labeled compounds added to the sample prior to extraction, by one of two approaches (see Appendix A, Table 4 for quantitation associations):

- Isotope Dilution quantification (ID), whereby the response of the target compound is compared to the response of its isotopically labeled analog; twenty-four target compounds are quantified in this way.
- Extracted Internal Standard quantification (EIS), whereby the response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities; sixteen target compounds are quantified in this way.

Each LC-MS/MS system must be calibrated whenever the laboratory takes corrective action that might change or affect the initial calibration criteria, or if either the CCV or ISC acceptance criteria have not been met.

Each time a modification is made to this method, the laboratory is required to repeat the procedure in Sections 11.3.1 and 11.3.2. If calibration will be affected by the change, the instrument must be recalibrated.

9.2.2 Calibration Levels

Calibration standards are stored in plastic containers under refrigerated conditions (0-6°C).

Concentrations for calibration solutions are presented in Appendix A, Table 5. A minimum of six contiguous calibration standards are required for a valid analysis when using a linear calibration model, with at least five of the six calibration standards being within the quantitation range (e.g., from the LOQ to the highest calibration standard). If a second-order calibration model is used, then a minimum of seven calibration standards are required, with at least six of the seven calibration standards within the quantitation range. The lowest level calibration standard must be at a concentration less than or equal to the Limit of Quantitation (LOQ) and must meet a signal-to-noise ratio of 3:1 for the quantitation and confirmation ions that exist and must meet ion ratio requirements described in Section 10.1.1.3. If the analyte has no confirmation ion, then a 10:1 signal to noise ratio is required. All initial calibration requirements listed in Section 9.2.4 and 9.2.5 must be met.

Note: Additional calibration standards, at levels lower than the lowest calibration standard listed in the method, may be added to accommodate a lower limit of quantitation if the instrument sensitivity allows. Calibration standards at the high end of the calibration may be eliminated if the linearity of the instrument is exceeded or at the low end if those calibration standards do not meet the S/N ratio criterion of 3:1 (for quantitation and confirmation ions that exist; 10:1 for analytes with no confirmation ion), so long as the required number of calibration points is met. All analytes with commercially available stable isotope analogues must be quantified using isotope dilution.

9.2.3 Calibration Sequence

Calibration standards must be analyzed in sequence from lowest to highest concentration to minimize the chance that carryover from a higher concentration standard will boost the area of a lower concentration standard. A typical sequence for days when calibration is required is shown below.

Description	Comment
ICAL L1	

Description	Comment
ICAL L2	Also used as ISC (Section 9.2.4.4)
ICAL L3	
ICAL L4	
ICAL L5	Also used as bracketing/closing CCV (Section 9.2.4.5)
ICAL L6	
ICAL L7	
ICAL L8	
ICAL L9	
IBLK	Any detections must be <MDL
ICV	%R must be 70 – 130%
CCV (ISC)	%R must be 70-130%; begins and ends Analytical Sequence

9.2.4 Calibration Evaluation

If the criteria for initial calibration are not met, inspect the system for problems and take corrective actions to achieve the criteria. This may require the preparation and analysis of fresh calibration standards. All initial calibration criteria must be met before any samples or required blanks are analyzed.

9.2.4.1 Curve Fit

One of the following two approaches must be used to evaluate the linearity of the instrument calibration. Weighting (typically 1/x or 1/x2) is allowed for linear and non-linear regressions.

- Option 1: Calculate the relative standard deviation (RSD) of the Relative Response (RR) or Response Factor (RF) values of the initial calibration standards for each native compound and isotopically labeled compound. See Section 10.2.1 for calculation of RR and RF. The RSD must be ≤ 20% to establish instrument linearity.

- Option 2: Calculate the relative standard error (RSE) for each native compound and EIS compound for all the initial calibration standards that were analyzed. The RSE for all method analytes must be ≤ 20% to establish instrument linearity.

If these criteria cannot be met, corrective action should be taken to restrict the range of calibration, reanalyze and/or reprepare the ICAL standards, or perform instrument maintenance and/or re-optimization.

If more than the minimum number of standards are analyzed and levels are excluded from the calibration, only the lowest or highest standards may be excluded, except as noted here. The removal of calibration levels from the interior of the curve is allowed only when there is sound technical reason for doing so and when the level is removed for all analytes; for example, when it can be proven that the wrong standard was analyzed for the calibration level or there is obvious evidence that the instrument malfunctioned during injection of the standard. The removal of any calibration level from the interior of the curve must be approved by the department supervisor/manager. Management approval and the rationale for the level removal must be documented and kept with the technical record.

9.2.4.2 Relative Error (% RE)

Although not required by the method, it may be useful to compare the actual responses for each standard to the calibration model; percent error of >30% between the calculated and expected concentrations of an analyte in any standard may be cause for concern.

9.2.4.3 Initial Calibration Verification (ICV)

As part of the IDOC and once after each ICAL, analyze an ICV sample prepared from a second source (different from the source of the ICAL standards). If a second vendor is not available, then a different lot of the standard from the same vendor should be used. The ICV should be prepared and analyzed just like a CCV. Acceptance criteria for the ICV are identical to the CCVs: the calculated concentration for each analyte must be within ± 30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, correct the problem and rerun the ICV. If the problem persists, repeat the ICAL. Samples are not to be analyzed until the ICAL has been verified by acceptable ICV accuracy.

9.2.4.4 Instrument Sensitivity Check (ISC)

The lowest calibration standard within the quantitation range must be analyzed at the beginning of the analytical sequence. The signal-to-noise ratio of the ISC must be ≥ 3:1 for the quantification ions and the confirmation ions, or ≥ 10:1 if the analyte only has a quantification ion. Recovery of the native and EIS compounds for the ISC must be within 70-130%. If the requirements cannot be met, the problem should be corrected before analyses can proceed.

The lowest calibration standard within the quantitation range must be analyzed at the beginning of the analytical sequence. The signal-to-noise ratio of the ISC must be ≥ 3:1 for the quantification ions and the confirmation ions, or ≥ 10:1 if the analyte only has a quantification ion. Recovery of the native and EIS compounds for the ISC must be within 70-130%. If the requirements cannot be met, the problem should be corrected before analyses can proceed.

9.2.4.5 Continuing Calibration Verification (CCV)

After a passing MS resolution and a successful initial calibration is achieved and prior to the analysis of any samples, the calibration is verified by injecting an aliquot of the appropriate concentration ICAL standard, analyzed with the same conditions used during the ICAL. CCV is performed at the beginning of each analytical sequence, after every ten samples, and at the end of the analytical sequence. In this context, a “sample” is defined as a field sample: MBs, CCVs, LCSs, MSs, FDs, TBs and MSDs are not counted as samples. All CCV analyses are performed using a mid-level ICAL standard, except for the daily Instrument Sensitivity Check, as noted above.

Calculate concentration for each native and EIS compound in the CCV; the recovery of native and EIS compounds for the CCVs must be within 70 – 130%. If the CCV criteria are not met, take corrective action (possibly including recalibration) and reanalyze any extracts that were analyzed between the last passing CCV and the one that failed. Alternately, the analyst may immediately analyze two CCVs for confirmation. If both confirmation CCV analyses meet the recovery criteria, analysis may proceed; however, the analyst must rerun any samples that were analyzed after the failing CCV and before the 2 passing CCVs. If either of the 2 confirmation CCV analyses fails to meet the acceptance criteria take corrective action and recalibrate the LC-MS/MS.

If an individual target compound recovery in a CCV is above the upper control limit and all associated samples are ND for that compound, the data for those samples may be reported. In such cases, a narrative statement must be included in the report indicating the specific compound result that was biased high in the CCV, and that samples were ND for that compound and thus reportable.

9.2.5 Initial Calibration Blank (ICB) / Continuing Calibration Blank (CCB)

One instrument blank (IBLK) is analyzed immediately following the highest ICAL standard analyzed (ICB), each analysis day prior to sample analysis, and following each bracketing CCV in a sequence (CCB), to check for carryover and instrument contamination. The concentration of each analyte must be ≤ the MDL-equivalent concentration in each IBLK/ICB/CCB. If the IBLK does not pass this requirement after the highest ICAL standard, the acquisition method should be adjusted to reduce the amount of carryover observed. Alternately, the calibration should be performed using a lower concentration for the highest standard until the acceptance criteria is met.

If unacceptable contamination is persistent in blanks, analyze additional instrument blanks until the response of the analyte is no longer detectable, or perform additional troubleshooting steps to identify and minimize other potential sources of PFAS contamination.

9.3 Sample Preparation

This section describes the sample preparation procedures for aqueous samples (Section 9.3.3), solid samples (soil, sediment or biosolid; Section 9.3.6), and tissue samples (Section 9.3.9). For solid samples, percent solids are determined using the procedures in Section 9.3.2. This section also describes the solid phase extraction (SPE) and extract cleanup protocols for all matrices.

Note: The laboratory may choose to pre-screen some samples prior to performing the analysis, following the protocol described in Appendix D. For aqueous samples, use the smaller secondary container to perform the pre-screening. If high levels of PFAS are present in the sample, a lower volume is required for analysis.

Do not use any fluoropolymer articles or task wipes in these extraction procedures. Use only HDPE or polypropylene wash bottles and centrifuge tubes. Reagents and solvents for cleaning may be kept in glass containers.

9.3.1 Homogenization & Subsampling

Refer to laboratory SWI ENV-SWI-WEST-0128, Subsampling of Soil / Solid Samples, or however named, for information regarding the handling, homogenization, and splitting of samples to ensure that a representative aliquot is used for preparation.

The laboratory may subsample the aqueous samples as described in Appendix E; however, subsampling must meet project-specific requirements. The laboratory must notify the client that subsampling has occurred. Subsampling is acceptable for samples which require greater than a 10X dilution for over-range detections (or are known/expected to be highly contaminated), and for samples which fail the acceptance criteria for EIS compounds (see Appendix B, Tables 10-12). Other sample matrix characteristics which may require subsampling are described in Appendix G. When subsampling is required to manage high concentrations, no less than 250 µL of aqueous or leachate samples may be subsampled - if greater dilution is required, serial dilution must be employed. When subsampling is required to manage challenging matrices, no less than 1 mL of samples may be subsampled. For solid and tissue samples, no less than 10% of the target sample mass should be used for reduced-mass extractions, to help ensure the extracted mass is representative of the bulk sample. This means no less than 0.5 g for solids and no less than 0.2 g for tissues may be used for sample preparation.

Tissue sample homogenization will be performed in the Pace Green Bay facility, following SOP ENV-SOP-GBAY-0129 v05 *Sample Homogenization Compositing and Sub-Sampling*.

9.3.2 Determination of Percent Solids

Aqueous samples received with visually observable solids will be handled following the decision tree presented in Appendix G. No TSS pre-test will be performed on aqueous samples prior to preparation.

Percent solids analysis must be performed on all solid samples (excluding tissues) prior to preparation and analysis. All solid samples will be logged in for both 1633 and percent solids analysis. The percent solids analysis will follow the Method SM2540G protocol.

9.3.3 Aqueous Sample Processing

Per the parent method, this protocol is applicable to aqueous samples containing up to 100 mg/L solids per sample, and the procedure requires the preparation of the entire sample where possible. Smaller sample volumes may be analyzed for samples containing solids greater than specified for this method, or when unavoidable due to high levels of PFAS. The typical sample size is 500 mL; however, sample size may vary, depending on project requirements, applicable regulations, and sample characteristics. The sample is to be analyzed in its entirety and should not be filtered.

Leachate samples are analyzed using a 100 mL sample volume. Therefore, they must not be included in the same sample preparation batch as aqueous samples analyzed using 500 mL sample volumes. Otherwise, leachate samples are handled identically to all other aqueous samples.

1) Visually inspect each sample and note any matrix characteristics which may pose challenges during SPE and require additional processing; see Appendix G for more information.

2) Weigh each sample bottle (with the lid) to the nearest 0.1 g. The volume of the aqueous sample analyzed is determined by weighing the full sample bottle and then the empty sample bottle after extraction is complete.

3) Prepare a method blank and two LCSs using PFAS-free water in HDPE bottles. Select a volume of water that is typical of the samples in the batch (i.e., 500 mL; 100 mL for leachate samples). Spike one LCS sample with native standard solution at 2x the LOQ (64 µL of STK-10X mix). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (40 µL of EPA-1633STK). This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples in the same manner as the LCS.

4) Spike 20 µL of EIS solution (Section 8.2.3) directly into the sample in the original bottle (or subsampled bottle) as well as to the bottles prepared for the QC samples. Mix by capping and inverting the sample containers.

5) Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The sample is now ready for solid phase extraction (SPE) and cleanup.

9.3.4 Solid Phase Extraction of Aqueous Samples

Note: Carbon cleanup is required. Carbon cleanup may remove analytes if the sample has a very low organic carbon content (this is unusual for non-drinking water environmental samples). This will be apparent if the isotope dilution standard recoveries are significantly higher on the reanalysis.

1) Pack clean silanized glass wool to half the height of a WAX SPE cartridge barrel; repeat for the total number of samples in the batch.

2) For each sample and QC aliquot, set up the vacuum manifold with one WAX SPE cartridge plus a reservoir adaptor and reservoir for each cartridge; label each reservoir with the associated sample ID. If using plastic transfer lines instead of reservoirs, ensure the connecting caps are snug in each cartridge and the transfer lines are placed within the appropriate sample; label each cartridge tube with the associated sample ID.

3) Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid. Perform each rinse separately. Do not allow the WAX SPE to go dry. Discard the wash solvents.

4) Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading; or, if using transfer lines, begin opening the stopcocks on the vacuum manifold. Adjust the vacuum/stopcocks to pass each sample through

the cartridge at approximately 5-10 mL/min; discard the eluate. Retain the empty sample bottle for later rinsing (Section 9.3.5).

Note: In the event the SPE cartridge begins to clog during aqueous sample loading, abandon the loading step and attempt to rinse and dry the clogged cartridge, following the protocol below. The cartridge is then ready for elution. If the clogging prevents the rinse from passing through the cartridge, it will not be possible to collect an extract for the associated sample. See Appendix G for more information.

5) Rinse the walls of the reservoir with 5 mL reagent water twice, followed by 5 mL of 1:1 0.1M formic acid/methanol and pass those rinses through the cartridge using vacuum. If using sample transfer lines for loading, add the 3 rinses to the bottle and load through the transfer lines to the cartridge, one reagent at a time. Dry the cartridge by pulling air through for approximately 5 minutes. Discard the rinse solution.

6) After the WAX cartridges are sufficiently dry, rinse the GCB cartridges with 5 mL of 1% methanolic ammonium hydroxide; discard the rinsate. Do not allow the GCB to go completely dry.

7) Connect the outlet of the WAX cartridges to the inlet of the GCB cartridges to stack them on the manifold and allow for cleanup of the extract as part of elution. Ensure that the WAX cartridges are returned to their original locations on the manifold to avoid cross contamination. Continue to the elution steps in the next section.

9.3.5 Elution of Aqueous Sample Extracts

1) Place clean collection tubes inside the manifold, ensuring that the extract delivery tips do not touch the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

2) Add 5 mL of 1% methanolic ammonium hydroxide to each empty sample bottle. Cap the bottle and rotate to ensure all internal surfaces of each bottle are rinsed; avoid vigorous shaking when rinsing the 500 mL aqueous sample bottles with only 5 mL of methanol – any evaporation/vaporization will contribute to loss of extract here. After rinsing the inside of the sample bottle, pour the rinse from the bottle or use a plastic transfer pipette to transfer the rinse to the SPE reservoir, using it to wash the walls of the reservoir. If using sample transfer lines, simply transfer this rinse from each sample container to its associated cartridge using vacuum. Allow the elution solvent to soak the SPE sorbent for 2 minutes before using vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

3) Air dry the empty sample bottle after the rinse is transferred. Weigh the empty bottle with the cap on and subtract that from the weight of the bottle with sample, determined in Section 9.3.3, step 2.

4) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

9.3.6 Solid Sample (excluding tissues) Processing

Any solid sample received containing <50% solids (>50% moisture; >10 g target mass for 5 g dry weight) should be re-logged and prepared as a biosolid, using a target dry weight of 0.5 g. Any solid or biosolid sample received containing <5% solids (>95% moisture; >10 g target mass for 0.5 g dry weight) should be re-logged and prepared as a leachate sample, using no more than 100 mL of sample for extraction.

1) Mix the sample in its original jar. If it is impractical to mix the sample within its container, transfer the sample to a larger container. Mix the sample thoroughly, stirring from the bottom to the top and in a circular motion along the sides of the jar, breaking particles up by pressing against the side of the container. The homogenized sample should be even in color and have no separate layers. Store the homogenized material in its original container or in multiple smaller containers.

2) Determine the percent solids as per Section 9.3.2.

Note: The target sample weight for sediment or soil is 5 g dry weight. The target sample weight for biosolids is 0.5 g dry weight. Small amounts of reagent-free water used for method blanks (10% of sample weight or less) can be added to unusually dry samples. This is an option, not a requirement.

3) Check the LIMS system for the percent solids data associated with the samples to be prepared. Using the percent solids data and the calculation below, weigh out an aliquot of each solid sample, not dried, into a 50 mL polypropylene centrifuge tube. Sample mass should be within ±0.2 g of target mass for soil and sediment samples, and within ±0.02 g of target mass for biosolids samples. Sample aliquot should provide 5 g dry weight (Wi_{Dry} below) for soil and sediment or 0.5 g dry weight for biosolids. Because biosolid samples are analyzed with a 0.5 g sample mass, they must not be included in the same sample preparation batch as solid samples analyzed with 5 g sample masses. Any solid sample received containing <50% solids (>50% moisture; >10 g target mass for 5 g dry weight) should be re-logged and prepared as a biosolid, using a target dry weight of 0.5 g. Any solid or biosolid sample received containing <5% solids (>95% moisture; >10 g target mass for 0.5 g dry weight) should be re-logged and prepared as a leachate sample, using no more than 100 mL of sample for extraction.

$$Solid\ Sample\ Target\ Mass\ (g) = \frac{Wi_{Dry}\ (g)}{\%\ solids\ (decimal)}$$

4) Prepare batch QC samples using 5 g of reference solid wetted with 2.5 g of reagent water for the method blank and two LCSs (use 0.5 g of reference solid with 0.25 g of reagent water for biosolid extraction batches). The addition of reagent water to the sand provides a matrix closer in composition to real-world samples. Spike one LCS sample with native standard solution at 2x the LOQ (80 µL of STK-10X mix). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (40 µL of EPA-1633STK). This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples in the same manner as the LCS.

5) Spike 20 µL of EIS solution (Section 8.2.3) directly into each centrifuge tube containing the aliquoted field and QC samples. Vortex or shake the sample to disperse the standard and allow to equilibrate for approximately 30 minutes.

6) Add 15 mL of 0.3% methanolic ammonium hydroxide to each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and transfer the supernatant to a clean, labeled 50 mL polypropylene centrifuge tube.

7) Add 15 mL of 0.3% methanolic ammonium hydroxide to the remaining solid sample in each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and decant the supernatant from the second extraction into the centrifuge tube with the supernatant from the first extraction.

8) Dilute to approximately 40 mL with reagent water. A separate centrifuge tube marked at the 40 mL level may be kept for a visual reference to get the approximate volume. Samples containing excess water may yield extracts that are greater than 40 mL in volume; therefore, do not add water to these.

9) Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The extract is now ready for solid phase extraction (SPE) and cleanup.

9.3.7 Solid Phase Extraction of Solid Samples

1) Pack clean silanized glass wool to half the height of a WAX SPE cartridge barrel; repeat for the total number of samples in the batch.

2) For each sample and QC aliquot, set up the vacuum manifold with one WAX SPE cartridge plus a reservoir adaptor and reservoir for each cartridge; label each reservoir with the associated sample ID. If using plastic transfer lines instead of reservoirs, ensure the connecting caps are snug in each cartridge and the transfer lines are placed within the appropriate sample; label each cartridge tube with the associated sample ID.

3) Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid. Perform each rinse separately. Do not allow the WAX SPE to go dry. Discard the wash solvents.

4) Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading; or, if using transfer lines, begin opening the stopcocks on the vacuum manifold. Adjust the vacuum/stopcocks to pass each sample through the cartridge at approximately 5-10 mL/min; discard the eluate. Retain the empty sample bottle for later rinsing (Section 9.3.8).

5) Rinse the walls of the reservoir with 5 mL reagent water twice, followed by 5 mL of 1:1 0.1M formic acid/methanol and pass those rinses through the cartridge using

vacuum. If using sample transfer lines for loading, add the 3 rinses to the bottle and load through the transfer lines to the cartridge, one reagent at a time. Dry the cartridge by pulling air through for approximately 5 minutes. Discard the rinse solution.

6) After the WAX cartridges are sufficiently dry, rinse the GCB cartridges with 5 mL of 1% methanolic ammonium hydroxide; discard the rinsate. Do not allow the GCB to go completely dry.

7) Connect the outlet of the WAX cartridges to the inlet of the GCB cartridges to stack them on the manifold and allow for cleanup of the extract as part of elution. Ensure that the WAX cartridges are returned to their original locations on the manifold to avoid cross contamination. Continue to the elution steps in the next section.

9.3.8 Elution of Solid Sample Extracts

1) Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

2) Rinse the inside of each sample's centrifuge tube using 5 mL of 1% methanolic ammonium hydroxide. Then pour the rinse from each bottle (or use a plastic transfer pipette) to transfer the rinse to the associated SPE reservoir, washing the walls of the reservoir. If using sample transfer lines, simply transfer this rinse from each sample container to its associated cartridge using vacuum. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

3) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

9.3.9 Tissue Sample Processing

Prior to processing tissue samples, the laboratory must determine the exact tissue to be analyzed. Common requests for analysis of fish tissue include whole fish with the skin on, whole fish with the skin removed, edible fish fillets (filleted in the field or by the laboratory), specific organs, and other portions. Once the appropriate tissue has been determined, the samples must be prepared and homogenized.

Pace utilizes the Green Bay location for tissue homogenization, following ENV-SOP-GBAY-0129 (Sample Homogenization, Compositing, and Subsampling; specifically, Section 9.4).

1) For each sample, weigh a 2 g aliquot of homogenized tissue into a 50 mL polypropylene centrifuge tube. Reseal the container with the remaining homogenized portion of the sample and return it to frozen storage in case it needs to be used for reanalysis. The default sample weight for tissue is 2 g wet weight; however, a 1 g sample may be used. Higher sample weights are not recommended for this method.

2) Prepare the batch QC samples using 2 g of reference tissue matrix for the method blank and two LCSs. Spike one LCS sample with native standard solutions at 2x the LOQ (80 µL of STK-10X mix). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (40 µL of EPA1633-STK). This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples in the same manner as the LCS.

3) Spike 20 µL of EIS solution (Section 8.2.3) directly into each field and QC sample. Vortex and allow to equilibrate for approximately 30 minutes.

4) Add 15 mL of 0.05M KOH in methanol to each sample. Vortex to disperse the tissue then place tubes on a variable speed mixing table to shake for 1 hour. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and collect the supernatant in a 125mL sample bottle.

5) Add 10 mL of acetonitrile to remaining tissue in the centrifuge tube, vortex to mix and disperse the tissue. Sonicate for 30 minutes. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and collect the supernatant, adding it to the 125mL bottle containing the initial extract.

6) Dilute to approximately 75 mL with reagent water. A separate bottle marked at the 75 mL level may be used to get the approximate volume.

7) Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The extract is now ready for solid phase extraction (SPE) and cleanup.

9.3.10 Solid Phase Extraction of Tissue Samples

1) Pack clean silanized glass wool to half the height of a WAX SPE cartridge barrel; repeat for the total number of samples in the batch.

2) For each sample and QC aliquot, set up the vacuum manifold with one WAX SPE cartridge plus a reservoir adaptor and reservoir for each cartridge; label each reservoir with the associated sample ID. If using plastic transfer lines instead of reservoirs, ensure the connecting caps are snug in each cartridge and the transfer lines are placed within the appropriate sample; label each cartridge tube with the associated sample ID.

3) Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid. Perform each rinse separately. Do not allow the WAX SPE to go dry. Discard the wash solvents.

4) Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading; or, if using transfer lines, begin opening the stopcocks on the vacuum manifold. Adjust the vacuum/stopcocks to pass each sample through the cartridge at approximately 5-10 mL/min; discard the eluate. Retain the empty sample bottle for later rinsing (Section 9.3.8).

5) Rinse the walls of the reservoir with 5 mL reagent water twice, followed by 5 mL of 1:1 0.1M formic acid/methanol and pass those rinses through the cartridge using vacuum. If using sample transfer lines for loading, add the 3 rinses to the bottle and load through the transfer lines to the cartridge, one reagent at a time. Dry the cartridge by pulling air through for approximately 5 minutes. Discard the rinse solution.

6) After the WAX cartridges are sufficiently dry, rinse the GCB cartridges with 5 mL of 1% methanolic ammonium hydroxide; discard the rinsate. Do not allow the GCB to go completely dry.

7) Connect the outlet of the WAX cartridges to the inlet of the GCB cartridges to stack them on the manifold and allow for cleanup of the extract as part of elution. Ensure that the WAX cartridges are returned to their original locations on the manifold to avoid cross contamination. Continue to the elution steps in the next section.

9.3.11 Elution of Tissue Sample Extracts

1) Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

2) Rinse the inside of each sample's centrifuge tube using 5 mL of 1% methanolic ammonium hydroxide. Then pour the rinse from each bottle (or use a plastic transfer pipette) to transfer the rinse to the associated SPE reservoir, washing the walls of the reservoir. If using sample transfer lines, simply transfer this rinse from each sample container to its associated cartridge using vacuum. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

3) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

9.4 Analysis

9.4.1 Sequence Preparation

Analysis of sample extracts for PFAS by LC-MS/MS is performed running manufacturer's data acquisition software. The mass spectrometer is run with unit mass resolution in the multiple reaction monitoring (MRM) mode.

1) Perform mass calibration and mass calibration verification, establish the operating conditions, and perform an initial calibration prior to analyzing samples. Only after all performance criteria are met may blanks, MDLs, IDOC/LCS, and samples be analyzed.

2) Each day of analysis, the column must be thoroughly flushed with 100% Acetonitrile for at least 30 minutes to clear any accumulated impurities and interferences from the sample pathway and equilibrate the system. It is also good practice to open the purge valve(s) on the pumps for the first ~1 minute of flush time and/or use the "purge"

function available as part of the pump functionality. Additionally, it is good practice to purge the autosampler injector flow path daily prior to analysis by using the “purge” function, if available. The column should then be equilibrated to the analysis starting conditions by flushing for approximately 15 mins with 50:50 Mobile Phase A: Mobile Phase B and finally approximately 15 mins with 80:20 Mobile Phase A: Mobile Phase B (acquisition starting conditions). Ensure that system pressure is stable.

3) Following any initial priming injections on days when a calibration is not needed, an ISC and an instrument blank will be analyzed to demonstrate system suitability and the absence of system contamination prior to sample analysis.

4) After acceptable ISC and IBLK results are confirmed, load and submit extracted samples for analysis, typically starting with batch QC with field samples following. A CCV and CCB must be analyzed after every 10 (or fewer) field samples.

9.4.2 Routine Analytical Sequence

After a successful initial calibration has been completed, samples may be analyzed; an example analytical sequence is provided below. The volume injected for samples and QCs must be identical to the volume used for calibration. Standards and sample extracts must be brought to room temperature and vortexed prior to aliquoting into an instrument vial to ensure homogeneity of the extract.

- ISC
- CCV
- Instrument Blank
- Method Blank
- LLLCS
- LCS
- Samples (10 or fewer)
- CCV
- CCB
- Samples (10 or fewer)
- CCV

If the results are acceptable, the closing CCV analysis may be used as the opening solution for the next analytical sequence.

If the response exceeds the calibration range for any sample, extracts are diluted as per Section 9.4.3 to bring all target responses within the calibration range.

Note: If the analytes that exceed the calibration range in the original analysis are known to not be of concern for the specific project (e.g., are not listed in a discharge permit), then the laboratory may consult with the client regarding the possibility of reporting that sample from the undiluted analysis.

9.4.3 Sample Dilutions

If the measured concentration for any compound exceeds the calibration range of the system, dilute an aliquot of the sample extract with the IBLK mix solution by a factor no greater than 10x, refortify the NIS compounds to initial concentration, and analyze the diluted extract. If the responses for each applicable EIS in the diluted extract meet the S/N and retention time requirements in Section 10.1.1, and the EIS recoveries from the analysis of the diluted extract, corrected for the dilution, are within the limits presented in Table 10, 11 or 12 (according to sample matrix), then the compounds associated with those EISs may be quantified. The EIS recoveries, compound concentrations, detection limits, and LOQs are adjusted to account for the dilution.

If the EIS responses in the diluted extract do not meet the S/N and retention time requirements listed in Section 10.1.1, then the compound cannot be measured reliably in the diluted extract. In such cases, subsample a smaller aliquot of any affected aqueous sample and dilute it to 500 mL with reagent water and re-extract the sample. For solid sample matrices, prepare a smaller aliquot of soil, biosolid, sediment, or tissue and re-extract the sample. The reduced sample volume (or mass) chosen for the re-extraction should reflect the dilution applied to the original extract (i.e., if the original aqueous sample extract was analyzed at a 10X dilution, 50 mL should be subsampled for the re-extraction). See Section 9.3.1 for more guidance. The reported compound concentrations, detection limits, and LOQs are adjusted to account for the reduced sample volume (or mass) that is extracted.

If the recovery of any isotopically labeled compound is outside of the acceptance limits (Appendix B) in the original, undiluted analysis, a diluted aqueous sample or smaller aliquot (for solids and tissue) should be prepared and analyzed.

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

10.1.1 Qualitative Identification

A native, EIS, or NIS compound is positively identified in a standard, blank, sample, or QC sample when all criteria in Sections 10.1.1.1 through 10.1.1.3 are met.

10.1.1.1 Signal-to-Noise Ratio (S/N)

Peak responses of the quantitation and confirmation ions must be at least three times the background noise level (S/N 3:1). The quantitation ion must have a S/N ≥ 10:1 if there is no confirmation ion. If the S/N ratio is not met in a standard or QC sample due to high background noise, the laboratory must correct the issue (e.g., perform instrument troubleshooting). If the S/N ratio is not met in a blank or sample, then the analyte is to be considered a non-detect.

10.1.1.2 RT Criteria

Target analyte, EIS analyte, and NIS analyte RTs must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. The retention time window used must be of sufficient width to detect earlier-eluting branched isomers. For all method analytes with exact corresponding isotopically labeled analogs, method analytes must elute within 0.1 minutes of the associated EIS.

10.1.1.3 Ion Ratio Criteria

For any reported compound detection, the ratio of the total (branched and linear isomer) quantification ion response to the total (branched and linear isomer) confirmation ion response – referred to as the Ion Ratio – must fall within ± 50% of the ratio observed in the mid-point ICAL standard. The ion ratio requirement does not apply for PFBA, PFPeA, NMeFOSE, NEtFOSE, PFMPA, and PFMBA because suitable secondary transitions are unavailable (not detectable or inadequate S/N).

10.1.2 Manual Integration

Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are justified and proper all manual integrations must be performed, documented, reviewed, and approved in accordance with corporate SOP ENV-SOP-CORQ-0006, *Manual Integration*. Refer to this SOP for guidance on manual integration techniques and required procedures.

10.1.2.1 Branched Isomer Integration

The response of all isomers in the quantitative standards should be used to define integration parameters and ion ratios. In samples, the total integrated response should include the branched isomer peaks that have been identified in the quantitative standard, if present. For compounds with identified branched and linear isomer peaks, the reported concentration is the sum of all isomers. If standards (either quantitative or qualitative) containing a mix of isomers are not available for purchase for a particular compound, only the linear isomer can be identified and quantitated in samples.

10.1.2.2 Qualification

If the field sample result does not meet all criteria stated in Section 10.1.1, and all sample preparation avenues (e.g., extract cleanup, sample dilution, etc.) have been exhausted, the result may only be reported with a data qualifier alerting the data user that the result could not be confirmed because it did not meet the method-required criteria and therefore should be considered an estimated value. If the criteria listed above are not met for the standards, the laboratory must stop analysis of samples and correct the issue.

10.2 Calculations

Refer to laboratory SOP (ENV-SOP-WEST-0124, Common Laboratory Calculations), or however named, for equations used to perform common calculations.

10.2.1 ICAL Relative Response (RR) and Response Factor (RF)

The response ratio (RR) for each native compound calibrated by isotope dilution is calculated according to the equation below, separately for each of the calibration standards, using the areas of the quantification ions shown in Table 4. RR is used for the 24 compounds measured by true isotope dilution quantification.

$$RR = \frac{Area_t M_{EIS}}{Area_{EIS} M_t}$$

Where:

$Area_t$ = Measured area of the quantitation ion for the target analyte.

$Area_{EIS}$ = Measured area of the quantitation ion for the corresponding labeled PFAS used as the EIS in the calibration standards.

M_{EIS} = Concentration of the isotopically labeled PFAS uses as the EIS in the calibration standards (ng/L)

M_t = Concentration of the target analyte in the calibration standard (ng/L)

Similarly, the response factor (RF) for each native compound calibrated by extracted internal standard is calculated according to the equation below. RF is used for the 16 compounds measured by extracted internal standard quantification.

$$RF = \frac{Area_t M_{EIS}}{Area_{EIS} M_t}$$

Where:

$Area_t$ = Measured area of the quantitation ion for the target analyte.

$Area_{EIS}$ = Measured area of the quantitation ion for the corresponding labeled PFAS used as the EIS in the calibration standards.

M_{EIS} = Concentration of the isotopically labeled PFAS uses as the EIS in the calibration standards (ng/L)

M_t = Concentration of the target analyte in the calibration standard (ng/L)

A response factor (RF_S) is calculated for each EIS compound in the calibration standard using the equation below. RF_S is used for the 24 isotopically labeled compounds measured by non-extracted internal standard quantification.

$$RF_S = \frac{Area_{EIS} M_{NIS}}{Area_{NIS} M_{EIS}}$$

Where:

$Area_{EIS}$ = Measured area of the quantitation ion for the EIS compound added to the sample before extraction.

$Area_{NIS}$ = Measured area of the quantitation ion for the NIS compound in the calibration standard.

M_{NIS} = Concentration of the NIS compound in the calibration standard (ng/L).

M_{EIS} = Concentration of the EIS compound in the calibration standard (ng/L).

10.2.2 Target Analyte Concentration

Concentrations of the target analytes are determined with respect to the extracted internal standard (EIS) which is added to the sample prior to extraction (see Table 4). Other equations may be used if the laboratory demonstrates that those equations produce the same numerical result as produced by the equation below.

$$\boldsymbol{Concentration\ (ng/L or ng/g) = \frac{Area_N M_{EIS}}{Area_{EIS}(\overline{RR}\ or\ \overline{RF})}\ x\ DF\ x\ \frac{Vf}{Vi}}$$

Where:

$Area_N$ = The measured area of the quantitation ion for the native (unlabeled) PFAS.

$Area_{EIS}$ = The measured area of the quantitation ion for the EIS.

M_{EIS} = The expected concentration of the EIS in the extract (ng/L)

$\boldsymbol{\overline{RR}}$ = Average response ratio used to quantify target compounds by the isotope dilution method.

$\boldsymbol{\overline{RF}}$ = Average response ratio used to quantify target compounds by the extracted internal standard method.

DF = Dilution Factor. If no extract dilution was performed, then DF=1.

Vf = Final extract volume (L)

Vi = Initial sample volume (L) or weight (g)

10.2.3 EIS Concentration

The EIS compounds are quantitated with respect to an NIS, as shown in Table 4, using the response ratios or response factors from the most recent initial calibration. Other equations may be used if the laboratory demonstrates that those equations produce the same numerical result as produced by the equation below.

$$Concentration\ (ng/L\ or\ ng/g) = \frac{Area_{EIS} M_{NIS}}{Area_{NIS}\overline{RF}_S}\ x\ DF\ x\ \frac{Vf}{Vi}$$

Where:

$Area_{EIS}$ = The measured area of the quantitation ion for the EIS.

$Area_{NIS}$ = The measured area of the quantitation ion for the associated NIS.

M_{NIS} = The expected concentration of the NIS in the extract (ng/L)

$\overline{\boldsymbol{RF_S}}$ = Average response factor used to quantify the EIS compound by the non-extracted internal standard method**.**

DF = Dilution Factor. If no extract dilution was performed, then DF=1.

Vf = Final extract volume (L)

Vi = Initial sample volume (L) or weight (g)

10.2.4 Relative Error (%RE)

$$\%\ Relative\ Error = \left(\frac{x^{'}i - xi}{xi}\right) x\ 100$$

Where:

xi = True value of the calibration standard

x'i = Measured concentration of the calibration standard

10.2.5 Percent Relative Standard Deviation

$$\%\ Relative\ Standard\ Deviation = \left(\frac{S}{\bar{x}}\right) x\ 100$$

Where:

S = Standard Deviation

X = Mean

10.2.6 Standard Deviation

$$S = \left(\frac{\sum (x_i - \bar{x})^2}{(n-1)}\right)$$

Where:

S = standard deviation

n = size of the population

x_i = each value of the population

$\bar{x}$ = population mean

10.2.7 Mean

$$\bar{x} = \frac{\left(\sum_{i=1}^{n} x_i\right)}{n}$$

Where:

$\bar{x}$ = population mean

x_i = each value of the population

n = number of values in the population

10.3 Reporting

All results for aqueous samples will be reported in ng/L. All results for solid samples will be reported in ng/g, on a dry-weight basis, and the percent solids for each sample will be reported separately. All results for tissue samples will be reported in ng/g, on a wet-weight basis. All QC data will be reported with the sample results. See Appendix A for specific reporting limits in all matrices.

Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria are reported down to the concentration of the LOQ established by the laboratory.

Results for any analyte found in a sample or extract that has been diluted will be reported at the least dilute level for which the measured concentration is within the calibration range (e.g., above the LOQ for the analyte and below the highest calibration standard) and in which isotopically labeled compound recoveries are within their respective QC acceptance criteria. This may require reporting results for some analytes from different analyses.

Recoveries of all associated EIS compounds will be reported for all field samples and QC Quality Control & Method Performance

10.4 Quality Control

Prepare and analyze the following QC samples with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples.
Low Level Laboratory Control Sample	LLLCS	1 per batch of 20 or fewer samples.
Matrix Spike	MS	1 pair per batch of 20 or fewer samples (if required/requested)
MS Duplicate	MSD	
Sample Duplicate	DUP	1 per AFFF or F3 sample.
Extracted Internal Standard	EIS	All CAL standards, batch QC and field samples.
Non-extracted Internal Standard	NIS	All CAL standards, batch QC and field samples.

The minimum quality control requirements of this method consist of an initial demonstration of laboratory capability, analysis of samples spiked with isotopically labeled compounds to evaluate and document data quality, and analysis of standards and blanks as tests of continued performance. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

If the method is to be applied to a sample matrix other than water (e.g., soils, biosolids, tissue), the appropriate alternative reference matrix is substituted for the reagent water matrix in all performance tests.

The laboratory must make an initial demonstration of the ability to generate acceptable precision and recovery with this method. This demonstration is described in Section 11.3.2.

Analyses of method blanks (MBs) are required on an on-going basis to demonstrate the extent of background contamination in any reagents or equipment used to prepare and analyze field samples. The procedures and criteria for analyses of MBs are described in Section 11.1.1.

The laboratory must spike all samples with isotopically labeled compounds to monitor method performance. These evaluations are described in Sections 11.1.4 and 11.1.5. When results of these spikes indicate atypical method performance for samples, the samples are diluted to evaluate whether the performance issue is caused by the sample matrix. Procedures for dilution are given in Section 9.4.3.

The laboratory must, on an ongoing basis, demonstrate that the analytical system is in control through calibration verification (CCV) and the analysis of blanks and ongoing precision and recovery standards spiked at low (LLLCS) and mid-level concentrations (LCS). These procedures are given in Sections 9.2.4.5, 11.1.1 and 11.1.2.

10.4.1 Method Blank (MB)

A method blank is analyzed with each extraction batch to demonstrate freedom from contamination. The matrix for the method blank must be similar to the sample matrix for the batch (e.g., reagent water blank, solids matrix blank, or tissue blank [Section 7.3]).

Analyze the extract of the method blank aliquot before the analysis of the LCSs.

If any PFAS is found in the MB 1) at a concentration greater than the LOQ for the analyte, 2) at a concentration greater than one-third the regulatory compliance limit, or 3) at a concentration greater than one-tenth the concentration in a sample in the extraction batch, whichever is greatest, analysis of samples must be halted, and the problem corrected. Other project-specific requirements may apply; therefore, the laboratory may adopt more stringent acceptance limits for the method blank at their discretion. If the contamination is traceable to the extraction batch, samples affected by the blank must be re-extracted and analyzed along with a new MB and LCS/LLLCS, provided enough sample volume is available and the samples are still within holding time. Reanalysis or re-extraction is not required if the samples are not impacted. Samples are not impacted when the MB detection is not present in the sample, or the sample concentration is ≥10x the concentration of the detection in the MB.

If the new blank also exhibits contamination and additional volume of the associated sample(s) is not available for re-extraction and analysis, the laboratory must document and report the failures (e.g., as qualifiers on results), unless the failures are not required to be reported as determined by the regulatory/control authority.

10.4.2 Laboratory Control Sample (LCS) / Low-Level LCS (LLLCS)

Analyze the extract of the LCS and LLLCS to ensure the analytical process is under control.

Compute the percent recovery of the native compounds by the appropriate quantification method depending on the compound. Compute the percent recovery of each isotopically labeled compound by the non-extracted internal standard quantitation method.

For the target analytes and EIS compounds, compare the recovery to the LCS and LLLCS limits given in Tables 7 through 10 (or 12). LCS, LLLCS, and EIS results must meet the acceptance criteria in these tables. If all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and aqueous samples may proceed. If, however, any individual concentration falls outside of the given range, the extraction/concentration processes are not being performed properly for that compound. In this event correct the problem, re-extract all affected samples, including any QC samples, and repeat the analysis. Samples are unaffected if the LCS or LLLCS recovery is above the acceptance criteria and the sample is ND for the failing compound.

10.4.3 Matrix Spike (MS)

Matrix spikes generally are not required for methods that employ isotope dilution quantification because deleterious effects of the matrix should be evident in the recoveries of the EIS compounds spiked into every sample. The analysis of matrix spike samples may help diagnose the potential impact of matrix interferences for specific target analytes or sample matrices. See Appendix E for MS/MSD, MS/DUP sample selection guidance.

10.4.4 Extracted Internal Standard (EIS)

To assess method performance on the sample matrix, the laboratory must spike all samples with the EIS solution. Analyze each sample according to the procedures in this SOP. Compute the percent recovery of the EIS compound concentration using the NIS quantitation method and the equation in Section 10.2.3.

The recovery of each EIS compound in an aqueous sample must be within the limits in Table 10, which are the required QC acceptance limits for aqueous samples, including landfill leachates. The recovery of each EIS compound in soil, sediment, or biosolid samples must be within the limits in Table 11. The recovery of each EIS compound in tissue samples must be within the limits in Table 12. The limits presented in Tables 10, 11, and 12 are the required QC acceptance limits for these matrices derived from the multi-laboratory validation study. If the recovery of any EIS falls outside of these limits, method performance is unacceptable for that EIS in that sample. Additional cleanup procedures or limited dilution of the sample extract may be employed to attempt to bring the EIS recovery within the acceptance normal range.

If the recovery cannot be brought within the acceptance limits after extract dilution or additional cleanup procedures have been employed, then the laboratory must take a smaller aliquot of any affected aqueous sample, dilute it to 500 mL with reagent water and prepare and analyze the diluted sample, or must prepare and analyze a smaller aliquot of soil, sediment, biosolid, or tissue sample, per Section 9.4.3.

10.4.5 Non-extracted Internal Standard (NIS)

To assess method performance, the laboratory must spike all sample extracts with the NIS solution. Analyze each sample extract according to the procedures in this SOP. Percent recovery of the NIS compound is calculated by comparing the measured response in each analysis to the average response of the same compound measured in the ICAL.

Calculate the ratio of the NIS peak areas from the QC and field samples relative to the mean area of the corresponding NIS in the most recent initial calibration to check for possible bad injections of NIS solution or loss of instrument sensitivity.

The NIS areas in the field samples and QC samples must be within 50 to 200% of the mean area of the corresponding NIS in the most recent initial calibration (i.e., within a factor of 2). If the areas are low for all the field samples and QC samples in the batch, it suggests a loss of instrument sensitivity, while low areas in only some field or QC samples suggests a possible bad injection.

10.5 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix B for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Mass Calibration		Annually and on as-needed basis
Mass Calibration Verification		After mass calibration

Instrument Check	Acronym	Frequency
Initial Calibration	ICAL	Prior to analysis, and on as-needed basis
Initial Calibration Verification	ICV	Following each ICAL
Instrument Blank	IBLK/ICB	Daily prior to analysis and after high standards
Instrument Sensitivity Check	ISC	Daily prior to analysis
Continuing Calibration Verification	CCV	At the beginning (ISC) and every 10 samples
Continuing Calibration Blank	CCB	After each bracketing CCV
RT Window	RTW	During ICAL and at the beginning of each analytical sequence

10.6 Method Performance

10.6.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

Establish Detection Limit (DL) and limits of quantitation (LOQ) at initial method set up and verify the DL and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for DL and LOQ requirements and procedures.

10.6.2 Demonstration of Capability (DOC)

Refer to laboratory SOP ENV-SOP-WEST-0122 Demonstration of Capability, or however named, for information regarding the laboratory's procedures for initial and ongoing Demonstration of Capability.

Prior to unsupervised (independent) work on any client sample, analysts that prepare or analyze samples must have successful initial demonstration of capability (IDOC) and must successfully demonstrate on-going proficiency on an annual basis (see below for details). Successful means the initial or on-going DOC met criteria, documentation of the DOC is complete, and the DOC record is in the employee’s training file.

Each DOC requires the extraction and analysis of four aliquots of the reference matrix type to be tested, prepared in the same way as the mid-level LCS. At least one method blank, matching the matrix being analyzed, must be prepared with the DOC batch. If more than one MB was prepared and analyzed with the DOC batch, all blank results must be reported. All sample processing steps that are to be used for processing samples, including preparation and extraction, must be included in this test.

Using the results of the four analyses, compute the average percent recovery (%REC) and the relative standard deviation (RSD) of the concentration of each target compound. There are no mean or RSD criteria for EIS compounds in the DOC; %REC of each DOC sample should meet the criteria in Appendix B, Tables 10, 11, or 12, depending on the matrix.

For each target compound, compare RSD and %REC to the corresponding limits for initial precision and recovery in Appendix B, Tables 7, 8, or 9, depending on the matrix.

If RSD and %REC for all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin. If, however, any individual RSD exceeds the precision limit or any individual %REC falls outside the range for recovery, system performance is unacceptable for that compound. Correct the problem and repeat the test.

11.0 DATA REVIEW & CORRECTIVE ACTION

11.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed. This process, known as secondary review, is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified, documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SWI ENV-SWI-WEST-0087 SVOA Data Review Work Instructions for specific instructions and requirements for each step of the data review process.

11.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix B for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range. Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the working concentration range of the instrument calibration. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

12.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Refer to laboratory guide ENV-GUI-WEST-0020 Hazardous Waste Management and Disposal, or however named, for waste handling and management practices pertaining to the waste streams created at this facility.

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

13.0 MODIFICATIONS

The procedures in this SOP have been modified from the reference test method as follows:

Modification	Section of Reference Method Modified	Justification for Modification	Validation of Modification
Updated EIS quantitation matching for select compounds (PFMPA, 7:3FTCA, ADONA, 9Cl-PF3ONS, 11Cl-PF3OUdS)	Section 20, Table 10	Improved performance, more appropriate correlation	MDL, IDOC, PT
Updated product ion used for measurement of 13C4-PFOA from m/z 172 to m/z 372	Section 20, Table 10	Match ion transition used for EIS 13C8-PFOA and native PFOA	MDL, IDOC, PT
Increased SPE sorbent bed to 250mg, tube size to 20mL	Section 6.7.1	Wider cartridge improves sample loading, reduces chances of clogs	MDL, IDOC, PT
Increased allowable sample loading rate to 5-10 mL/min	Section 12.1.4	Reduced Sample processing time	MDL, IDOC, PT
Omit TSS for aqueous samples	Section 11.1 (11.1.1.5), 11.2.4	Reduced sample processing time	MDL, IDOC, PT
Solid matrix extraction: reduced liquid-solid shake/decant steps to 2; omitted concentration step	Section 11.3 (11.3.4, 11.3.6, 11.3.9)	Improved performance & reduced sample processing time	MDL, IDOC, PT
GCB cartridges: eliminated dGCB + syringe filtration	Section 11.3.7, 11.4.7, 12.1, 12.2.3, 12.2.4, 12.3.3, 12.4.3	Improved performance, reduced sample processing time, & ease of use	MDL, IDOC, PT

Modification	Section of Reference Method Modified	Justification for Modification	Validation of Modification
Tissue matrix extraction: reduced liquid-solid shake/decant steps to 2; reduced shake time; omitted concentration step	Section 11.4.4, 11.4.6, 11.4.8	Improved performance & reduced sample processing time	MDL, IDOC, PT
Clearly defined the characteristics used to distinguish Aqueous vs. Biosolid vs. Solid matrices	n/a	Increased clarity in process decision making, improved first-run performance	MDL, IDOC, PT

When applicable, comparability and/or equivalency studies necessary to validate the modification as required per corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, are retained by local quality personnel for historical reference.

14.0 RESPONSIBILITIES

- PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- PAS supervisors and managers, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Management* and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI.*

15.0 ATTACHMENTS

- Appendix A: Routine Analyte Limits (DL, LOQ), Analytical Parameters, and Calibration
- Appendix B: QC Summary & Corrective Action; Table: Method Acceptance Criteria
- Appendix C: State/Program Specific Requirements
- Appendix D: Sample Pre-screening Instructions
- Appendix E: Aqueous Sample Subsampling Instructions
- Appendix F: MS/MSD, MS/DUP Selection Protocols
- Appendix G: Aqueous Sample Management Decision Guide
- Appendix H: Aqueous Sample Centrifugation Protocol

- Appendix I: Separation and Analysis of Liquid-Solid Biphasic Matrices
- Appendix J: TCLP/SPLP by 1633
- Appendix K: Wipe Analysis by 1633
- Appendix L: Articles of Commerce Analysis via Cryomill Processing
- Appendix M: Procedure for Total Oxidizable Precursors (TOP)

16.0 REFERENCES

- ENV-POL-CORQ-0005, *Acceptable Calibration Practices*, current version.
- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *Standard Operating Procedures and Standard Work Instructions,* current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
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17.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
	N/A: new document

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
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Appendix A: Routine Analyte Limits (DL, LOQ), Analytical Parameters, and Calibration

DL and LOQ are always adjusted to account for actual amounts used and for dilution. Values listed are as of effective date of this SOP. DL and LOQ are subject to change. Contact quality personnel for current information. See Table 4 below for more information regarding analyte detection and quantitation.

Table 1: Standard Analyte List – Aqueous and Landfill Leachate Matrices

Analyte Abbreviation	CAS #	Aqueous (ng/L)		Leachate (ng/L)	
		DL	LOQ	DL	LOQ
PFBA	375-73-5	0.527	6.4	2.64	32
PFPeA	2706-91-4	0.359	3.2	1.79	16
PFHxA	355-46-4	0.245	1.6	1.22	8
PFHpA	375-92-8	0.238	1.6	1.19	8
PFOA	1763-23-1	0.263	1.6	1.31	8
PFNA	68259-12-1	0.266	1.6	1.33	8
PFDA	335-77-3	0.210	1.6	1.05	8
PFUnA	79780-39-5	0.178	1.6	0.892	8
PFDoA	375-73-5	0.214	1.6	1.07	8
PFTrDA	2706-91-4	0.187	1.6	0.934	8
PFTeDA	355-46-4	0.160	1.6	0.801	8
PFBS	375-73-5	0.402	1.6	2.01	8
PFPeS	2706-91-4	0.206	1.6	1.03	8
PFHxS	355-46-4	0.133	1.6	0.665	8
PFHpS	375-92-8	0.201	1.6	1.00	8
PFOS	1763-23-1	0.264	1.6	1.32	8
PFNS	68259-12-1	0.203	1.6	1.02	8
PFDS	335-77-3	0.140	1.6	0.699	8
PFDoS	79780-39-5	0.242	1.6	1.21	8
4:2 FTS	757124-72-4	0.910	6.4	4.55	32
6:2 FTS	27619-97-2	4.82	6.4	24.1	32
8:2 FTS	39108-34-4	1.22	6.4	6.11	32
PFOSA	754-91-6	0.097	1.6	.484	8
NMeFOSA	31506-32-8	0.226	1.6	1.13	8
NEtFOSA	4151-50-2	0.351	1.6	1.76	8

Analyte Abbreviation	CAS #	Aqueous (ng/L)		Leachate (ng/L)	
		DL	LOQ	DL	LOQ
NMeFOSAA	2355-31-9	0.483	1.6	2.41	8
NEtFOSAA	2991-50-6	0.478	1.6	2.39	8
NMeFOSE	24448-09-7	1.30	16	6.52	80
NEtFOSE	1691-99-2	1.10	16	5.50	80
HFPO-DA	13252-13-6	1.60	6.4	8.02	32
ADONA	919005-14-4	0.376	6.4	1.88	32
PFMPA	377-73-1	0.244	3.2	1.22	16
PFMBA	863090-89-5	0.360	3.2	1.80	16
NFDHA	151772-58-6	0.541	3.2	2.71	16
9Cl-PF3ONS	756426-58-1	0.442	6.4	2.21	32
11Cl-PF3OUdS	763051-92-9	0.447	6.4	2.23	32
PFEESA	113507-82-7	0.330	3.2	1.65	16
3:3 FTCA	356-02-5	0.535	8	2.68	40
5:3 FTCA	914637-49-3	4.26	40	21.3	200
7:3 FTCA	812-70-4	3.18	40	15.9	200

Table 2: Standard Analyte List – Solid and Biosolid Matrices

Analyte Abbreviation	CAS #	Solid (ng/g)		Biosolid (ng/g)	
		DL	LOQ	DL	LOQ
PFBA	375-73-5	0.028	0.8	0.28	8
PFPeA	2706-91-4	0.038	0.4	0.38	4
PFHxA	355-46-4	0.016	0.2	0.16	2
PFHpA	375-92-8	0.012	0.2	0.12	2
PFOA	1763-23-1	0.026	0.2	0.26	2
PFNA	68259-12-1	0.012	0.2	0.12	2
PFDA	335-77-3	0.035	0.2	0.35	2
PFUnA	79780-39-5	0.013	0.2	0.13	2
PFDoA	375-73-5	0.021	0.2	0.21	2
PFTrDA	2706-91-4	0.016	0.2	0.16	2
PFTeDA	355-46-4	0.024	0.2	0.24	2
PFBS	375-73-5	0.020	0.2	0.20	2

Analyte Abbreviation	CAS #	Solid (ng/g)		Biosolid (ng/g)	
		DL	LOQ	DL	LOQ
PFPeS	2706-91-4	0.027	0.2	0.27	2
PFHxS	355-46-4	0.020	0.2	0.20	2
PFHpS	375-92-8	0.045	0.2	0.45	2
PFOS	1763-23-1	0.031	0.2	0.31	2
PFNS	68259-12-1	0.029	0.2	0.29	2
PFDS	335-77-3	0.015	0.2	0.15	2
PFDoS	79780-39-5	0.022	0.2	0.22	2
4:2 FTS	757124-72-4	0.078	0.8	0.78	8
6:2 FTS	27619-97-2	0.148	0.8	1.48	8
8:2 FTS	39108-34-4	0.259	0.8	2.59	8
PFOSA	754-91-6	0.011	0.2	0.11	2
NMeFOSA	31506-32-8	0.026	0.2	0.26	2
NEtFOSA	4151-50-2	0.022	0.2	0.22	2
NMeFOSAA	2355-31-9	0.086	0.2	0.86	2
NEtFOSAA	2991-50-6	0.044	0.2	0.44	2
NMeFOSE	24448-09-7	0.121	2.0	1.21	20
NEtFOSE	1691-99-2	0.081	2.0	0.81	20
HFPO-DA	13252-13-6	0.039	0.8	0.39	8
ADONA	919005-14-4	0.030	0.8	0.30	8
PFMPA	377-73-1	0.017	0.4	0.17	4
PFMBA	863090-89-5	0.024	0.4	0.24	4
NFDHA	151772-58-6	0.083	0.4	0.83	4
9Cl-PF3ONS	756426-58-1	0.029	0.8	0.29	8
11Cl-PF3OUdS	763051-92-9	0.040	0.8	0.40	8
PFEESA	113507-82-7	0.046	0.4	0.46	4
3:3 FTCA	356-02-5	0.092	1.0	0.92	10
5:3 FTCA	914637-49-3	0.236	5.0	2.36	50
7:3 FTCA	812-70-4	0.365	5.0	3.65	50

Table 3: Standard Analyte List – Tissue Matrices

Analyte Abbreviation	CAS #	DL (ng/g)	LOQ (ng/g)
PFBA	375-73-5	0.215	2.0
PFPeA	2706-91-4	0.088	1.0
PFHxA	355-46-4	0.044	0.5
PFHpA	375-92-8	0.062	0.5
PFOA	1763-23-1	0.070	0.5
PFNA	68259-12-1	0.099	0.5
PFDA	335-77-3	0.102	0.5
PFUnA	79780-39-5	0.093	0.5
PFDoA	375-73-5	0.052	0.5
PFTrDA	2706-91-4	0.067	0.5
PFTeDA	355-46-4	0.039	0.5
PFBS	375-73-5	0.044	0.5
PFPeS	2706-91-4	0.029	0.5
PFHxS	355-46-4	0.075	0.5
PFHpS	375-92-8	0.093	0.5
PFOS	1763-23-1	0.084	0.5
PFNS	68259-12-1	0.065	0.5
PFDS	335-77-3	0.056	0.5
PFDoS	79780-39-5	0.062	0.5
4:2 FTS	757124-72-4	0.222	2.0
6:2 FTS	27619-97-2	0.934	2.0
8:2 FTS	39108-34-4	0.249	2.0
PFOSA	754-91-6	0.051	0.5
NMeFOSA	31506-32-8	0.139	0.5
NEtFOSA	4151-50-2	0.115	0.5
NMeFOSAA	2355-31-9	0.089	0.5
NEtFOSAA	2991-50-6	0.106	0.5
NMeFOSE	24448-09-7	0.598	5.0
NEtFOSE	1691-99-2	0.410	5.0
HFPO-DA	13252-13-6	0.072	2.0

Analyte Abbreviation	CAS #	DL (ng/g)	LOQ (ng/g)
ADONA	919005-14-4	0.139	2.0
PFMPA	377-73-1	0.078	1.0
PFMBA	863090-89-5	0.086	1.0
NFDHA	151772-58-6	0.113	1.0
9Cl-PF3ONS	756426-58-1	0.179	2.0
11Cl-PF3OUdS	763051-92-9	0.228	2.0
PFEESA	113507-82-7	0.069	1.0
3:3 FTCA	356-02-5	0.145	2.5
5:3 FTCA	914637-49-3	1.54	12.5
7:3 FTCA	812-70-4	1.26	12.5

Table 4: Identification and Quantification Information for Target Analytes, Extracted Internal Standards and Non-extracted Internal Standards.

Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluorobutanoic acid	375-73-5	PFBA	213	169	NA	13C4-PFBA
Perfluoropentanoic acid	2706-91-4	PFPeA	263	219	69	13C5-PFPeA
Perfluorohexanoic acid	355-46-4	PFHxA	313	269	119	13C5-PFHxA
Perfluoroheptanoic acid	375-92-8	PFHpA	363	319	169	13C4-PFHpA
Perfluorooctanoic acid	1763-23-1	PFOA	413	369	169	13C8-PFOA
Perfluorononanoic acid	68259-12-1	PFNA	463	419	219	13C9-PFNA
Perfluorodecanoic acid	335-77-3	PFDA	513	469	219	13C6-PFDA
Perfluoroundecanoic acid	79780-39-5	PFUnA	563	519	269	13C7-PFUnA
Perfluorododecanoic acid	375-73-5	PFDoA	613	569	319	13C2-PFDoA
Perfluorotridecanoic acid	2706-91-4	PFTrDA	663	619	169	13C2-PFDoA
Perfluorotetradecanoic acid	355-46-4	PFTeDA	713	669	169	13C2-PFTeDA
Perfluorobutanesulfonic acid	375-73-5	PFBS	299	80	99	13C3-PFBS
Perfluoropentansulfonic acid	2706-91-4	PFPeS	349	80	99	13C3-PFHxS
Perfluorohexanesulfonic acid	355-46-4	PFHxS	399	80	99	13C3-PFHxS

Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluoroheptanesulfonic acid	375-92-8	PFHpS	449	80	99	13C8-PFOS
Perfluorooctanesulfonic acid	1763-23-1	PFOS	499	80	99	13C8-PFOS
Perfluorononanesulfonic acid	68259-12-1	PFNS	549	80	99	13C8-PFOS
Perfluorodecanesulfonic acid	335-77-3	PFDS	599	80	99	13C8-PFOS
Perfluorododecanesulfonic acid	79780-39-5	PFDoS	699	80	99	13C8-PFOS
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	757124-72-4	4:2 FTS	327	307	81	13C2-4:2FTS
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	27619-97-2	6:2 FTS	427	407	81	13C2-6:2FTS
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	39108-34-4	8:2 FTS	527	507	81	13C2-8:2FTS
Perfluorooctanesulfonamide	754-91-6	PFOSA	498	78	478	13C8-PFOSA
N-methyl perfluorooctanesulfonamide	31506-32-8	NMeFOSA	512	219	169	D3-NMeFOSA
N-ethyl perfluorooctanesulfonamide	4151-50-2	NEtFOSA	526	219	169	D5-NEtFOSA
N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9	NMeFOSAA	570	419	483	D3-NMeFOSAA
N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6	NEtFOSAA	584	419	526	D5-NEtFOSAA
N-methyl perfluorooctanesulfonamidoethanol	24448-09-7	NMeFOSE	616	59	NA	D7-NMeFOSE
N-ethyl perfluorooctanesulfonamidoethanol	1691-99-2	NEtFOSE	630	59	NA	D9-NEtFOSE
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	HFPO-DA	285	169	185	13C3-HFPODA
4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	ADONA	377	251	85	13C4-PFHpA
Perfluoro-3-methoxypropanoic acid	377-73-1	PFMPA	229	85	NA	13C4-PFBA
Perfluoro-4-methoxybutanoic acid	863090-89-5	PFMBA	279	85	NA	13C5-PFPeA
Nonafluoro-3,6-dioxaheptanoic acid	151772-58-6	NFDHA	295	201	85	13C5-PFHxA

Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	9Cl-PF3ONS	531	351	533→353	13C8-PFOS
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	11Cl-PF3OUdS	631	451	633→453	13C8-PFOS
Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7	PFEESA	315	135	83	13C5-PFHxA
3-Perfluoropropyl propanoic acid (FPrPA)	356-02-5	3:3FTCA	241	177	117	13C5-PFPeA
2H,2H,3H,3H-Perfluorooctanoic acid (FPePA)	914637-49-3	5:3FTCA	341	237	217	13C5-PFHxA
3-Perfluoroheptyl propanoic acid (FHpPA)	812-70-4	7:3FTCA	441	337	317	13C9-PFNA
Extracted Internal Standard Compounds (EIS)						
Perfluoro-n-[13C4] butanoic acid	NA	13C4-PFBA	217	172	NA	13C3-PFBA
Perfluoro-n-[13C5] pentanoic acid	NA	13C5-PFPeA	268	223	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4,6-13C5] hexanoic acid	NA	13C5-PFHxA	318	273	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4-13C4] heptanoic acid	NA	13C4-PFHpA	367	322	NA	13C2-PFHxA
Perfluoro-n-[13C8] octanoic acid	NA	13C8-PFOA	421	376	NA	13C4-PFOA
Perfluoro-n-[13C9] nonanoic acid	NA	13C9-PFNA	472	427	NA	13C5-PFNA
Perfluoro-n-[1,2,3,4,5,6-13C6] decanoic acid	NA	13C6-PFDA	519	474	NA	13C2-PFDA
Perfluoro-n-[1,2,3,4,5,6,7-13C7] undecanoic acid	NA	13C7-PFUnA	570	525	NA	13C2-PFDA
Perfluoro-n-[1,2-13C2] dodecanoic acid	NA	13C2-PFDoA	615	570	NA	13C2-PFDA
Perfluoro-n-[1,2-13C2] tetradecanoic acid	NA	13C2-PFTeDA	715	670	NA	13C2-PFDA
Perfluoro-1-[2,3,4-13C3] butanesulfonic acid	NA	13C3-PFBS	302	80	NA	18O2-PFHxS
Perfluoro-1-[1,2,3-13C3] hexanesulfonic acid	NA	13C3-PFHxS	402	80	NA	18O2-PFHxS

Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluoro-1-[13C8] octanesulfonic acid	NA	13C8-PFOS	507	80	NA	13C4-PFOS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] hexanesulfonic acid	NA	13C2-4:2FTS	329	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] octanesulfonic acid	NA	13C2-6:2FTS	429	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] decanesulfonic acid	NA	13C2-8:2FTS	529	81	NA	18O2-PFHxS
Perfluoro-1-[13C8] octanesulfonamide	NA	13C8-PFOSA	506	78	NA	13C4-PFOS
N-methyl-D3-perfluoro-1-octanesulfonamide	NA	D3-NMeFOSA	515	219	NA	13C4-PFOS
N-ethyl-D5-perfluoro-1-octanesulfonamide	NA	D5-NEtFOSA	531	219	NA	13C4-PFOS
N-methyl-D3-perfluoro-1-octanesulfonamidoacetic acid	NA	D3-NMeFOSAA	573	419	NA	13C4-PFOS
N-ethyl-D5-perfluoro-1-octanesulfonamidoacetic acid	NA	D5-NEtFOSAA	589	419	NA	13C4-PFOS
N-methyl-D7-perfluorooctanesulfonamidoethanol	NA	D7-NMeFOSE	623	59	NA	13C4-PFOS
N-ethyl-D9-perfluorooctanesulfonamidoethanol	NA	D9-NEtFOSE	639	59	NA	13C4-PFOS
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	NA	13C3-HFPO-DA	287	169	NA	13C2-PFHxA
Non-extracted Internal Standard Compounds (NIS)						
Perfluoro-n-[2,3,4-13C3] butanoic acid	NA	13C3-PFBA	216	172	NA	NA
Perfluoro-n-[1,2-13C2]hexanoic acid	NA	13C2-PFHxA	315	270	NA	NA
Perfluoro-n-[1,2,3,4-13C4]octanoic acid	NA	13C4-PFOA	417	172	NA	NA
Perfluoro-n-[1,2,3,4,5-13C5] nonanoic acid	NA	13C5-PFNA	468	423	NA	NA

Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluoro-n-[1,2-13C2]decanoic acid	NA	13C2-PFDA	515	470	NA	NA
Perfluoro-1-hexane[18O2]sulfonic acid	NA	18O2-PFHxS	403	84	NA	NA
Perfluoro-n-[1,2,3,4-13C4] octanesulfonic acid	NA	13C4-PFOS	503	80	NA	NA

Table 5: Calibration Standard Concentrations (ng/mL)

Compound	L1	L2 (ISC)	L3	L4	L5 (CCV)	L6	L7	L8	L9
Perfluoroalkyl carboxylic acids									
PFBA	0.4	0.8	2	10	20	50	100	200	250
PFPeA	0.2	0.4	1	5	10	25	50	100	125
PFHxA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFHpA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFOA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFNA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFDA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFUnA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFDoA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFTrDA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFTeDA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
Perfluoroalkyl sulfonic acids									
PFBS	0.089	0.178	0.444	2.22	4.44	11.1	22.2	44.4	55.5
PFPeS	0.094	0.188	0.470	2.35	4.70	11.8	23.5	47.0	58.8
PFHxS	0.091	0.182	0.456	2.28	4.56	11.4	22.8	45.6	57.0
PFHpS	0.095	0.190	0.476	2.38	4.76	11.9	23.8	47.6	59.5
PFOS	0.093	0.186	0.464	2.32	4.64	11.6	23.2	46.4	58.0
PFNS	0.096	0.192	0.480	2.40	4.80	12.0	24.0	48.0	60.0
PFDS	0.096	0.193	0.482	2.41	4.82	12.1	24.1	48.2	60.3
PFDoS	0.097	0.194	0.484	2.42	4.84	12.1	24.2	48.4	60.5
Fluorotelomer sulfonic acids									
4:2FTS	0.375	0.750	1.87	9.37	18.7	46.9	93.7	187	234
6:2FTS	0.380	0.761	1.90	9.51	19.0	47.6	95.1	190	238
8:2FTS	0.384	0.768	1.92	9.6	19.2	48	96	192	240
Perfluorooctane sulfonamides									

Compound	L1	L2 (ISC)	L3	L4	L5 (CCV)	L6	L7	L8	L9
PFOSA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
NMeFOSA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
NEtFOSA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamidoacetic acids									
NMeFOSAA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
NEtFOSAA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamide ethanols									
NMeFOSE	1	2	5	25	50	125	250	500	625
NEtFOSE	1	2	5	25	50	125	250	500	625
Per- and polyfluoroether carboxylic acids									
HFPO-DA	0.4	0.8	2	10	20	50	100	200	250
ADONA	0.378	0.756	1.89	9.45	18.9	47.25	94.5	189	236.25
PFMPA	0.2	0.4	1	5	10	25	50	100	125
PFMBA	0.2	0.4	1	5	10	25	50	100	125
NFDHA	0.2	0.4	1	5	10	25	50	100	125
Ether sulfonic acids									
9Cl-PF3ONS	0.373	0.746	1.87	9.33	18.7	46.7	93.3	187	233
11Cl-PF3OUdS	0.377	0.754	1.89	9.43	18.9	47.2	94.3	189	236
PFEESA	0.178	0.357	0.892	4.46	8.92	22.3	44.6	89.2	112
Fluorotelomer Carboxylic Acids									
3:3FTCA	0.5	1	2.5	12.5	25	62.5	125	250	312.5
5:3FTCA	2.5	5	12.5	62.5	125	312.5	625	1250	1560
7:3FTCA	2.5	5	12.5	62.5	125	312.5	625	1250	1560
Extracted Internal Standards (EIS)									
13C4-PFBA	10	10	10	10	10	10	10	10	10
13C5-PFPeA	5	5	5	5	5	5	5	5	5
13C5-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C9-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C6-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C7-PFUnA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C3-PFBS	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
13C3-PFHxS	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
13C8-PFOS	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
13C2-4:2FTS	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69

Compound	L1	L2 (ISC)	L3	L4	L5 (CCV)	L6	L7	L8	L9
13C2-6:2FTS	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
13C2-8:2FTS	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
13C8-PFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D5-NEtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSAA	5	5	5	5	5	5	5	5	5
D5-NEtFOSAA	5	5	5	5	5	5	5	5	5
D7-NMeFOSE	25	25	25	25	25	25	25	25	25
D9-NEtFOSE	25	25	25	25	25	25	25	25	25
13C3-HFPODA	10	10	10	10	10	10	10	10	10
Non-Extracted Internal Standards (NIS)									
13C3-PFBA	5	5	5	5	5	5	5	5	5
13C2-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C5-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2-PFHxS	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
13C4-PFOS	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40

Appendix B: QC Summary & Corrective Action Table; Method Acceptance Criteria

Table 6: QC Summary & Corrective Action

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Demonstration of Capability (DOC)	Initially, prior to analyzing field samples and annually thereafter.	See Method Acceptance Criteria for each matrix in the Tables below.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Mass Calibration	Annually and on as-needed basis.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Mass Calibration Verification	After each Mass Calibration performed.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat Mass Calibration.	None. Do not proceed with analysis.
Initial Calibration (ICAL)	At instrument set up, after CCV failure and/or major maintenance.	Must meet one of the curve fit options presented in Section 9.2.4.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Initial Calibration Verification (ICV)	After Each ICAL.	All analytes must be within ± 30% of their true values. (%R)	Identify and correct source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	Qualify analytes with ICV out of criteria when results are unaffected; otherwise, correct the problem and repeat ICV.
Initial Calibration Blank (ICB)	After highest concentration ICAL standard.	Must meet criteria specified in Section 9.2.5: all detections ≤MDL concentration.	Identify and correct source of contamination or performance issue. Alternately, calibrate using a lower concentration standard for the highest point.	No samples shall be analyzed until ICB has met acceptance criteria.
RT Window Position	Once per ICAL and at the beginning of the analytical window.	Position is set using the mid-point of the ICAL on the day ICAL is performed; otherwise, opening CCV is used. RT Window is ± 60 secs from RT position.	NA	NA
Instrument Sensitivity Check (ISC)	Daily before sample analysis.	All native and isotopically labelled compounds within ± 30% recovery.	Identify and correct source of problem and reanalyze ISC. If problem persists, repeat ICAL.	No samples shall be analyzed until ISC has met acceptance

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
				criteria. See Section 9.2.4.5 for exceptions.
Bile Salts Check	With each ICAL and daily with each CCV	Bile Salt peak detected >1 min outside RT window for PFOS.	Identify and correct source of problem, then reevaluate Bile Salts separation from PFOS.	No samples shall be analyzed until Bile Salts Check has met acceptance criteria.
Continuing Calibration Verification (CCV)	Daily before sample analysis, after every 10 samples, and at end of analytical sequence.	All native and isotopically labelled compounds within ±30% recovery.	See Section 9.2.4.5 for required corrective actions based on circumstance.	Qualify analytes with CCV out of criteria.
Instrument Blank (IBLK) / Continuing Calibration Blank (CCB)	Daily prior to analysis and after high standards, including CCV.	Must meet criteria specified in Section 9.2.5: all detections ≤MDL concentration.	Identify and correct source of contamination or performance issue. Reanalyze IBLK.	No samples shall be analyzed until IBLK has met acceptance criteria.
Extracted Internal Standards (EIS)	Every field sample, standard and QC sample.	See Method Acceptance Criteria for each matrix in the Tables below.	If batch QC is acceptable, reanalyze to confirm. If confirmed, re-extract and reanalyze samples. If reprep is within acceptance, report reprep data. If failure is confirmed by reprep, qualify as matrix impacted.	Qualify outages and explain in case narrative.
Non-extracted Internal Standards (NIS)	Every field sample, standard and QC sample.	NIS areas in all samples must be within 50 – 200% of the average area of the corresponding NIS in the ICAL.	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Method Blank (MB)	1 per batch of 20 or fewer samples.	Must meet criteria specified in Section 10.4.1: all detections ≤MDL concentration.	If IBLK is acceptable, reanalyze MB to confirm. If confirmed, re-extract and reanalyze associated impacted samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated with unacceptable MB. See Section 10.4.1 for more details.	Qualify outages and explain in case narrative.

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
LCS/LLLCS	1 pair per batch of 20 or fewer samples.	See Method Acceptance Criteria for each matrix in the Tables below; must meet criteria specified in Section 10.4.2.	If most recent ISC/CCV is acceptable, reanalyze LCS to confirm. If low-failure results are confirmed, re-extract and reanalyze associated samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated with low-failure LCS. If high-failure results are confirmed and sample(s) is ND for failing compound, narrate and report sample data.	Qualify outages and explain in case narrative.
MS/MSD	1 pair per batch of 20 or fewer samples. (If requested)	RSD ≤30% between MS/MSD	If possible, reprep to confirm.	Qualify outages and explain in case narrative.
Laboratory Duplicate	1 per AFFF sample; 1 per prep batch for all other matrices (if requested).	RSD ≤30% between parent/DUP	If possible, reprep to confirm.	Qualify outages and explain in case narrative.

Table 7: DOC/LCS/LLLCS Acceptance Limits for Aqueous & Landfill Leachate Matrices

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-135	21	70-140
PFPeA	70-135	23	65-135
PFHxA	70-135	24	70-145
PFHpA	70-135	28	70-150
PFOA	65-155	27	70-150
PFNA	70-140	28	70-150
PFDA	65-140	26	70-140
PFUnA	70-135	29	70-145
PFDoA	70-130	21	70-140
PFTrDA	60-145	29	65-140
PFTeDA	70-145	27	60-140
PFBS	70-140	23	60-145
PFPeS	70-135	25	65-140
PFHxS	70-135	27	65-145
PFHpS	70-140	30	70-150
PFOS	70-140	29	55-150
PFNS	70-135	29	65-145
PFDS	70-135	30	60-145

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFDoS	45-135	35	50-145
4:2FTS	70-135	27	70-145
6:2FTS	70-135	32	65-155
8:2FTS	70-140	33	60-150
PFOSA	70-135	22	70-145
NMeFOSA	70-135	30	60-150
NEtFOSA	70-130	26	65-145
NMeFOSAA	65-140	32	50-140
NEtFOSAA	70-135	28	70-145
NMeFOSE	70-135	29	70-145
NEtFOSE	70-130	21	70-135
HFPO-DA	70-135	23	70-140
ADONA	70-135	23	65-145
PFMPA	60-140	23	55-140
PFMBA	65-145	27	60-150
NFDHA	65-140	37	50-150
9Cl-PF3ONS	70-145	30	70-155
11Cl-PF3OUdS	50-150	35	55-160
PFEESA	70-135	25	70-140
3:3FTCA	70-130	23	65-130
5:3FTCA	70-130	24	70-135
7:3FTCA	55-130	34	50-145

Table 8: DOC/LCS/LLLCS Acceptance Limits for Solid & Biosolid Matrices

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-140	17	70-140
PFPeA	70-140	26	60-150
PFHxA	70-135	23	65-140
PFHpA	70-140	21	65-145
PFOA	70-140	23	70-150
PFNA	65-145	24	70-155
PFDA	70-145	26	70-155
PFUnA	70-145	26	70-155
PFDoA	70-145	25	70-150
PFTrDA	55-160	26	65-150
PFTeDA	70-145	24	65-150
PFBS	60-145	25	65-145
PFPeS	65-140	29	55-160
PFHxS	65-145	28	60-150
PFHpS	70-140	27	65-155
PFOS	70-135	27	65-160
PFNS	70-140	27	55-140

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFDS	50-150	31	40-155
PFDoS	40-140	40	25-160
4:2FTS	70-135	27	60-150
6:2FTS	60-160	50	55-200
8:2FTS	70-140	27	70-150
PFOSA	70-140	19	70-140
NMeFOSA	65-145	26	70-155
NEtFOSA	70-135	19	70-140
NMeFOSAA	65-145	31	65-155
NEtFOSAA	60-150	31	65-165
NMeFOSE	70-140	19	70-140
NEtFOSE	70-135	17	70-135
HFPO-DA	70-140	25	70-145
ADONA	70-155	26	70-160
PFMPA	70-140	25	30-140
PFMBA	55-145	33	60-150
NFDHA	45-145	27	60-155
9Cl-PF3ONS	65-135	23	70-150
11Cl-PF3OUdS	50-135	31	45-160
PFEESA	70-140	20	70-140
3:3FTCA	45-155	32	45-130
5:3FTCA	70-135	28	60-130
7:3FTCA	70-145	39	60-150

Table 9: DOC/LCS/LLLCS Acceptance Limits for Tissue Matrix

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-135	20	60-140
PFPeA	70-130	20	60-145
PFHxA	70-140	20	60-160
PFHpA	70-140	20	60-145
PFOA	70-130	25	60-150
PFNA	70-140	20	60-145
PFDA	70-135	20	60-150
PFUnA	70-135	20	60-155
PFDoA	70-135	20	60-140
PFTrDA	55-160	20	60-150
PFTeDA	70-140	25	60-140
PFBS	70-145	20	60-150
PFPeS	70-150	20	60-145
PFHxS	70-140	25	60-155
PFHpS	70-145	20	60-140
PFOS	70-135	30	60-160

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFNS	60-130	20	45-140
PFDS	55-135	20	50-140
PFDoS	25-145	45	25-140
4:2FTS	65-140	30	55-150
6:2FTS	70-140	25	60-150
8:2FTS	70-150	25	60-170
PFOSA	70-140	20	60-150
NMeFOSA	70-140	30	60-160
NEtFOSA	70-140	40	60-150
NMeFOSAA	70-140	20	60-145
NEtFOSAA	70-140	25	60-145
NMeFOSE	60-150	20	40-180
NEtFOSE	70-145	40	60-205
HFPO-DA	70-140	25	60-145
ADONA	70-145	20	55-165
PFMPA	70-145	40	25-145
PFMBA	70-140	20	60-150
NFDHA	70-155	30	60-180
9Cl-PF3ONS	70-140	20	60-170
11Cl-PF3OUdS	65-140	20	50-170
PFEESA	70-145	25	50-150
3:3FTCA	55-130	25	30-140
5:3FTCA	70-145	20	60-160
7:3FTCA	70-155	20	60-200

Table 10: Acceptance Limits for EIS and NIS Compounds in Aqueous & Landfill Leachate Matrices

Labeled Compound	Aqueous Recovery (%)	Landfill Leachate Recovery (%)
13C4-PFBA	5-130	5-130
13C5-PFPeA	40-130	40-130
13C5-PFHxA	40-130	40-130
13C4-PFHpA	40-130	40-130
13C8-PFOA	40-130	40-130
13C9-PFNA	40-130	40-130
13C6-PFDA	40-130	40-130
13C7-PFUnA	30-130	40-130
13C2-PFDoA	10-130	35-130
13C2-PFTeDA	10-130	25-130
13C3-PFBS	40-135	40-130
13C3-PFHxS	40-130	40-130
13C8-PFOS	40-130	40-130

Labeled Compound	Aqueous Recovery (%)	Landfill Leachate Recovery (%)
13C2-4:2FTS	40-200	40-220
13C2-6:2FTS	40-200	40-170
13C2-8:2FTS	40-300	40-145
13C8-PFOSA	40-130	40-130
D3-NMeFOSA	10-130	40-130
D5-NEtFOSA	10-130	35-130
D3-NMeFOSAA	40-170	35-130
D5-NEtFOSAA	25-135	30-130
D7-NMeFOSE	10-130	20-130
D9-NEtFOSE	10-130	20-130
13C3-HFPODA	40-130	40-130
13C3-PFBA	50-200	50-200
13C2-PFHxA	50-200	50-200
13C4-PFOA	50-200	50-200
13C5-PFNA	50-200	50-200
13C2-PFDA	50-200	50-200
18O2-PFHxS	50-200	50-200
13C4-PFOS	50-200	50-200

Table 11: Acceptance Limits for EIS and NIS Compounds in Solid & Biosolid Matrices

Labeled Compound	Solids Recovery (%)	Biosolids Recovery (%)
13C4-PFBA	8-130	5-130
13C5-PFPeA	35-130	35-130
13C5-PFHxA	40-130	40-130
13C4-PFHpA	40-130	40-130
13C8-PFOA	40-130	40-130
13C9-PFNA	40-130	40-145
13C6-PFDA	40-130	40-130
13C7-PFUnA	40-130	40-130
13C2-PFDoA	40-130	40-130
13C2-PFTeDA	20-130	10-160
13C3-PFBS	40-135	40-150
13C3-PFHxS	40-130	40-140
13C8-PFOS	40-130	40-130
13C2-4:2FTS	40-165	40-300
13C2-6:2FTS	40-215	40-300
13C2-8:2FTS	40-275	40-300

Labeled Compound	Solids Recovery (%)	Biosolids Recovery (%)
13C8-PFOSA	40-130	20-140
D3-NMeFOSA	10-130	20-130
D5-NEtFOSA	10-130	20-130
D3-NMeFOSAA	40-135	30-150
D5-NEtFOSAA	40-150	20-140
D7-NMeFOSE	20-130	25-130
D9-NEtFOSE	15-130	20-130
13C3-HFPODA	40-130	40-130
13C3-PFBA	50-200	50-200
13C2-PFHxA	50-200	50-200
13C4-PFOA	50-200	50-200
13C5-PFNA	50-200	50-200
13C2-PFDA	50-200	50-200
18O2-PFHxS	50-200	50-200
13C4-PFOS	50-200	50-200

Table 12: Acceptance Limits for EIS and NIS Compounds in Tissue Matrices

Labeled Compound	Tissue Recovery (%)
13C4-PFBA	5-130
13C5-PFPeA	10-185
13C5-PFHxA	25-170
13C4-PFHpA	25-150
13C8-PFOA	25-150
13C9-PFNA	35-185
13C6-PFDA	30-150
13C7-PFUnA	30-180
13C2-PFDoA	35-180
13C2-PFTeDA	20-160
13C3-PFBS	25-190
13C3-PFHxS	35-175
13C8-PFOS	40-160
13C2-4:2FTS	30-300
13C2-6:2FTS	35-300
13C2-8:2FTS	40-365
13C8-PFOSA	25-180
D3-NMeFOSA	5-130
D5-NEtFOSA	5-130

Labeled Compound	Tissue Recovery (%)
D3-NMeFOSAA	30-250
D5-NEtFOSAA	30-235
D7-NMeFOSE	5-160
D9-NEtFOSE	5-130
13C3-HFPODA	20-185
13C3-PFBA	50-200
13C2-PFHxA	50-200
13C4-PFOA	50-200
13C5-PFNA	50-200
13C2-PFDA	50-200
18O2-PFHxS	50-200
13C4-PFOS	50-200

Appendix C: State/Program Specific Requirements

This appendix provides program specific requirements that supersede or supplement the main body of the SOP. When analyzing samples under DoD compliance, these requirements are applicable.

QC Item	SOP Section	Requirement
Instrument Blank	9.2.5	No analytes detected > ½ LOQ.
Method Blank	11.1.1	No analytes detected > ½ LOQ.
AFFF Sample Duplicate	Appendix E	All AFFF samples shall be prepared and analyzed in duplicate in the same manner as aqueous samples (e.g., solid phase extraction, extracted internal standards, carbon cleanup, etc.).
Laboratory Duplicate	Appendices B & F	One per preparatory batch. RPD of all analytes should be ≤ 30% between sample and DUP. RPD criterion does not apply if both results are below the LOQ.

Appendix D: Sample Pre-screening Instructions

Samples that are known or suspected to contain high levels of analytes may be pre-screened using the following procedure. These are example procedures using smaller sample aliquots spiked with EIS and NIS and no clean up procedures. Other pre-screening procedures may be used.

Aqueous Samples

1) Weight out 10 (±0.1) g of sample into a 50-mL centrifuge tube.
2) Add 50 µL of EIS to the sample and vortex to mix.
3) Filter 1 mL of the sample through 0.2-µm membrane filter into a microvial. Sample is ready for instrumental analysis.

Solid and Tissue Samples

1) Weigh 1.0 (±0.1) g sample into 50-mL polypropylene centrifuge tubes.
2) Add 20 mL of 0.3% methanolic ammonium hydroxide to the sample. Vortex and mix on a shaker table (or equivalent) for 10 min. Allow to settle and/or centrifuge to produce a clear extract.
3) Filter using a filter vial:
    a. Add 20 µL of EIS to a clean filter vial (chamber).
    b. Add 400 µL of clear extract from step 2 (e.g., by adding extract until it reaches the fill line), carefully vortex to mix.
    c. Use filter/plunger part and filter.
4) Transfer 30 µL of filtrate to a ~300 µL polypropylene microvial and dilute to 300 µL with 0.3% methanolic ammonium hydroxide. Add NIS (1.5 µL) to the resulting solution.
5) The extract is now a 10x dilution.
6) Sample is ready for instrumental screening analysis.
7) Calculate results using the equivalent sample weight computed as follows:

$$Equivalent\ Weight = Sample\ weight\ (g)x\,\frac{0.4\ mL}{20\ mL}$$

Appendix E: Aqueous Sample Subsampling Instructions

Note: Because some target analytes may be stratified within the sample (e.g., AFFF-contaminated media, surfactants), or adhere to the walls of the sample container, subsampling may only be done on a project-specific basis. Subsampling has been shown to increase uncertainty in PFAS analysis, especially on foaming samples.

If a reduced sample size is required, transfer a weighed subsample using the following subsampling procedure to a 60-mL HDPE bottle and dilute to approximately 60 mL using reagent water. This container is now considered the “sample bottle.”

1) Gently invert sample 3-4 times being careful to avoid foam formation and subsample immediately (do not let stand).
2) If foam forms and more than 5 mL is required – pour sample, avoiding any foam.
3) If foaming forms and a volume less than 5 mL is required – pipette from ½ cm below the foam.
4) If no foam forms – pour or pipette based on volume required.

Required Protocol for AFFF and FFF (F3) Concentrates

Samples composed of AFFF or F3 will be subsampled consistently, with approximately **0.02 g of AFFF/F3 material** aliquoted for each discrete sample preparation/analysis; each AFFF or F3 concentrate sample analyzed under DoD direction **must be prepared in duplicate**. After creating and documenting the subsample aliquot, add approximately 60 mL of reagent water, cap the vessel, and shake vigorously by hand for 20-30 seconds. After adding the reagent water and agitating, allow **at least 3 hours** for the subsample aliquot to fully dissolve in the water. If dissolution is incomplete after 3 hours, agitate again and wait another 3 hours; consider applying continuous agitation (orbital shaker) if full dissolution of the aliquot into water requires extended time. Following the extended dissolution time, prepared AFFF/F3 samples should be prepared and analyzed following the routine protocols for aqueous sample processing. Aqueous reporting limits (MDL/LOD/LOQ) will be used, with values adjusted to account for the actual sample aliquot, assuming 1 g/mL; this constitutes a 25,000X nominal adjustment factor for AFFF/F3 reporting limits, relative to nominal aqueous reporting limits.

Pace **STRONGLY DISCOURAGES** clients from sending AFFF concentrate material for analysis; this protocol is designed for “as-prepared” AFFF materials (i.e. pre-diluted to application concentration) and newer generation ‘Fluorine Free Foam’ (F3) concentrates. If F3 material (concentrate or as-prepared) or as-prepared AFFF material is received, follow the normal routines described in the first paragraph above. If an AFFF concentrate material (usually of a thick gel-like consistency) is received for analysis, the lab shall prepare a 3% (w/w) aqueous solution from the received sample (in the smallest volume feasible) prior to subsampling and diluting 0.02 g for extraction. Handling of AFFF concentrate should ideally be done in an isolated area outside of the PFAS processing area to prevent gross lab contamination. Following the two dilution steps, the nominal adjustment factor for AFFF concentrate material is 833,333X (8.33×10^5) relative to nominal aqueous reporting limits.

Appendix F: MS/MSD, MS/DUP SAMPLE SELECTION PROTOCOL

Project-specific requirements may include that matrix spikes (MS), matrix spike duplicates (MSD), and/or laboratory duplicates (DUP) be prepared and analyzed with project samples. The client/field team should identify those samples which are designated for these additional QC procedures and provide additional sample material for them. In the event that samples are received for such a project without additional containers for MS/MSD/DUP, prep analysts will select samples to be used for this purpose following a hierarchy of preference, as defined below.

Note: Any kind of blank (Field Blank, Trip Blank, Equipment Blank, Rinsate Blank, etc.) will not be used for MS/MSD/DUP analysis.

1) First preference is to use client-designated samples as MS/MSD samples. This designation should show up on the prep worklist, in the comments. It is possible that SR will miss adding this comment to the sample, but this designation will be present in the COC from the client, on the right side of the COC under “Comments/Remarks/Cooler ID.” When a client designates a sample to be used for MS/MSD analysis, they will typically provide us with more than 2 bottles (often 4, sometimes as many as 6).

2) Lacking a client-designated MS/MSD sample, the next preference is to use any sample received with more than 2 bottles provided. If an analyst selects a set of samples for prep in which none of the samples are client-designated for MS/MSD, the analyst should check for any samples in the set that were received with 3 or more bottles. If there is a sample with 3 or more bottles, pull 3 of them and use one for the parent sample and spike the other two for analysis as MS/MSD samples.

3) Lacking any samples received with 3 or more bottles, the prep analyst must use two different parent samples to create an MS/DUP pair. Find two samples out of the set of samples selected for prep which were received with 2 bottles and pull both bottles for each sample. Pick one sample (pair of bottles) to be used for parent/MS prep and the other sample (pair of bottles) to be used for parent/DUP. The sample selected for parent/MS will have one bottle spiked with targets and one prepped as normal, with no added spiking. The bottle which is spiked should be identified in the LIMS as MS. The sample selected for parent/DUP will have both bottles prepared following normal procedures but one of the two should be identified in the LIMS as DUP.

4) If all samples in a particular prep batch were all received in just one bottle, analysis of an MS/MSD or MS/DUP pair will not be possible. This should be an uncommon occurrence, as prep analysts will attempt to adjust batching to ensure that every prep batch contains an MS/MSD or MS/DUP for projects which require the additional QC.

Appendix G: Aqueous Sample Management Decision Guide

NOTE: No TSS pre-test will be performed on aqueous samples received for 1633 analysis.

Per Method 1633, Section 11.1.1.5, "laboratories may utilize other documented strategies for minimizing the disruptions due to SPE clogging and slow extractions." Follow the guide below to evaluate aqueous sample matrices for solid material and determine the appropriate preparation approach; a matching decision tree is included at the end of this appendix.

If potential interferences other than settled solids are observed, take action to mitigate the impacts on data quality. Examples of other sample characteristics that could lead the lab to take precautionary measures with a field sample (i.e., prepare from reduced volume) include: presence of standing foam in the sample after shaking, thick/viscous matrix, collected from a known highly contaminated site/project, client notes indicating potential high concentrations, and knowledge of potential hazards to safety, equipment performance, or process integrity due to sample composition. Consider any visible indications of particulate matter including settled solids collected on the bottom of the container, cloudiness and/or dark color of the sample, suspended solids within the sample, increased viscosity, etc. If uncertain, seek a second opinion from another analyst, supervisor, or operations director; these matrix characteristics may require reduced-volume extraction. The lab will attempt to use the largest volume possible (i.e., the smallest reduction possible) when performing a reduced-volume extraction to manage challenging matrix characteristics, and no less than 1 mL of sample will be used in this case.

1) Allow samples to sit for at least 15 minutes to allow solids in the matrix to settle to the bottom of the container.
2) Visually inspect each sample for settled solids collected in the bottom of the container and follow the appropriate protocol based on observation:
    a. If no solids are observed in the bottom of the container, proceed to step 3.
    b. If solids are observed in the bottom of the container with an approximate depth <1/2 cm (<5 mm), proceed to step 5.
    c. If solids are observed in the bottom of the container with an approximate depth >1/2 cm (>5 mm), proceed to step 7.
    d. If solids observed in the container make up approximately 5% or more of the total sample volume, proceed to step 9.

<u>No Settled Solids Observed:</u>

3) Do not take any additional action to prepare for extraction and follow routine protocols.
4) If the SPE cartridge begins to clog during sample loading (see Identifying Cartridge Clogging section below), abandon loading of the remaining sample volume and proceed to the cartridge rinsing and drying described in step 10 of Section 9.3.4.

   a. Document the inability to load the entire sample volume due to cartridge clogging. If the resulting EIS recoveries are below the method acceptance ranges, this documentation provides the rationale for re-extraction from reduced volume.

   b. The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.

   c. If the cartridge clog prevents the cartridge rinses or elution solvent from passing through the cartridge, document that an extract could not be collected for that sample. Submit the sample for re-extraction from reduced volume. Notify the group leader and prep team of this necessity and, based on the total volume loaded in the first extraction attempt, provide a suggested reduction factor (i.e., reduce volume 5X, 10X, 20X, etc.).

<u>Settled Solids Depth <1/2 cm Observed:</u>

5) Do not take any additional action to prepare for extraction and follow routine protocols; however, be aware that there is a higher probability that the SPE cartridge will clog, and care must be taken in sample loading to attempt to pass the entire sample through the sorbent.

6) If the SPE cartridge begins to clog during sample loading (see Identifying Cartridge Clogging section below), abandon loading of the remaining sample volume and proceed to the cartridge rinsing and drying described in step 10 of Section 9.3.4.

   a. The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.

   b. Document the inability to load the entire sample volume due to cartridge clogging. If the resulting EIS recoveries are below the method acceptance ranges, this documentation provides the rationale for re-extraction following centrifugation; however,

   c. If the cartridge clog prevents the cartridge rinses or elution solvent from passing through the cartridge, document that an extract could not be collected for that sample. Submit the sample for re-extraction with sample centrifugation (See Aqueous Sample Centrifugation Protocol in Appendix H). Notify the group leader and prep team of this necessity.

      i. If, in the judgment of an experienced analyst, the nature of the solids present in the sample is of a nature that would preclude successful centrifugation and decantation, the decision should be confirmed with the group supervisor and/or another experienced analyst; once confirmed, the sample is submitted for re-extraction from reduced volume. Notify the group of this necessity and, based on the total volume loaded in the first extraction attempt, provide a suggested reduction factor (i.e., reduce volume 5X, 10X, 20X, etc.).
      ii. If the centrifuged sample clogs the cartridge in the second extraction, see step 6 above; if there is sufficient sample remaining for another re-extraction, submit the sample for re-extraction from reduced volume as described in (i) above. If there is not sufficient sample remaining for another re-extraction, narrate any quality exceedances and report data for all runs.

Settled Solids Depth >1/2 cm Observed:

7) The sample will need to be centrifuged before performing SPE. Instead of following the routine sample extraction procedures, refer to Appendix H for the Aqueous Sample Centrifugation Protocol.

8) Document the decision to centrifuge the sample prior to SPE.

   a. If resulting EIS recoveries are below the method acceptance ranges, this documentation provides evidence that the results are impacted by matrix interference.

      i. Report the data with a narrative statement explaining that the results are matrix-impacted.

      ii. Alternately, submit the sample for re-extraction from reduced volume to attempt to provide data with compliant EIS recoveries.

   b. If the decanted sample clogs the SPE and prevents successful collection of the extract, document that detail and submit the sample for re-extraction from reduced volume. Notify the group of this necessity and, based on the total volume loaded in the first extraction attempt, provide a suggested reduction factor (i.e., reduce volume 5X, 10X, 20X, etc.) for the re-extraction.

Settled Solids Observed to be ≥ 5% of Total Volume:

9) Shake the sample to thoroughly homogenize it, then immediately subsample 1 mL into a pre-labeled 50mL centrifuge tube and add reagent water to approximately 40 mL. At 5% solids, a sample contains 50,000 mg/L, so 1 mL contains 50 mg of solid material.

10) Spike the diluted subsample with EIS as normal and proceed with extraction.

11) If the SPE cartridge begins to clog during sample loading (see Identifying Cartridge Clogging section below), abandon loading of the remaining sample volume and proceed to the cartridge rinsing and drying described in step 10 of Section 9.3.4.

   a. Document the inability to load the entire sample volume due to cartridge clogging.

   b. The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.

   c. If the cartridge clog prevents the cartridge rinses or elution solvent from passing through the cartridge, document that an extract could not be collected for that sample.

12) If the cartridge clogs during extraction and causes failing results, the lab will contact the client and notify them that sample extraction failed due to the nature of the matrix, and that they must decide between two options for reprocessing the sample:

   a. Apply biosolid matrix protocols, following Sections 9.3.6 through 9.3.8 of this SOP. Use 0.5 g of sample for extraction; do not submit for % solids analysis and report results as ng/g, on a wet weight basis.

b. Attempt to separate and analyze the aqueous and solid phases separately. If the client selects this option, follow the protocol detailed in Appendix I.

Identifying Cartridge Clogging

During the loading phase of the SPE process, some samples may cause their cartridges to clog, preventing the entire sample from being loaded through, and sometimes preventing an extract from being collected. If you have a sample that slows down considerably during the loading process, you may need to abandon loading the remainder of the sample. The goal is to stop the process before the cartridge seizes up completely, so that a sample extract can still be collected from the cartridge.

When Clogs Start

Some of the first visual indications of a cartridge becoming clogged include: discoloration of the cartridge frit and/or sorbent bed, reduced drip rate of the sample through the cartridge, and coloration or sedimentation on the bottom of the reservoir.

When a cartridge starts to clog, it is important to stop the process before the cartridge seizes up completely. Take the actions listed below; an evaluation must be made to decide whether each cartridge can reasonably be used further without seizing up completely.

- Do not continue to add any more sample volume to the reservoir of the clogging cartridge.
- If there is substantial volume remaining in the reservoir (i.e., > 10 mL) and the cartridge is in apparent imminent danger of seizing completely, close the manifold port to stop sample loading. Carefully remove the cartridge-adaptor-reservoir assembly for the sample in question and pour whatever sample volume remains in the reservoir back into the original sample bottle. This volume will be included in the evaluation of extracted sample volume (initial volume).
- If the reservoir on the clogging cartridge empties before the other samples have finished loading, close the manifold port to prevent the cartridge from drying.
- If sample volume remains in any of the slowed cartridges after the loading of the other samples is finished, close all the manifold ports and focus pressure on the slowed cartridge in an attempt to load the volume remaining in the reservoir. (Do this one at a time for multiple clogs.) If the cartridge appears to be in imminent danger of seizing up completely, do not attempt to load the volume remaining in the reservoir; follow the steps in the second bullet of this section.

Abandoning Sample Loading

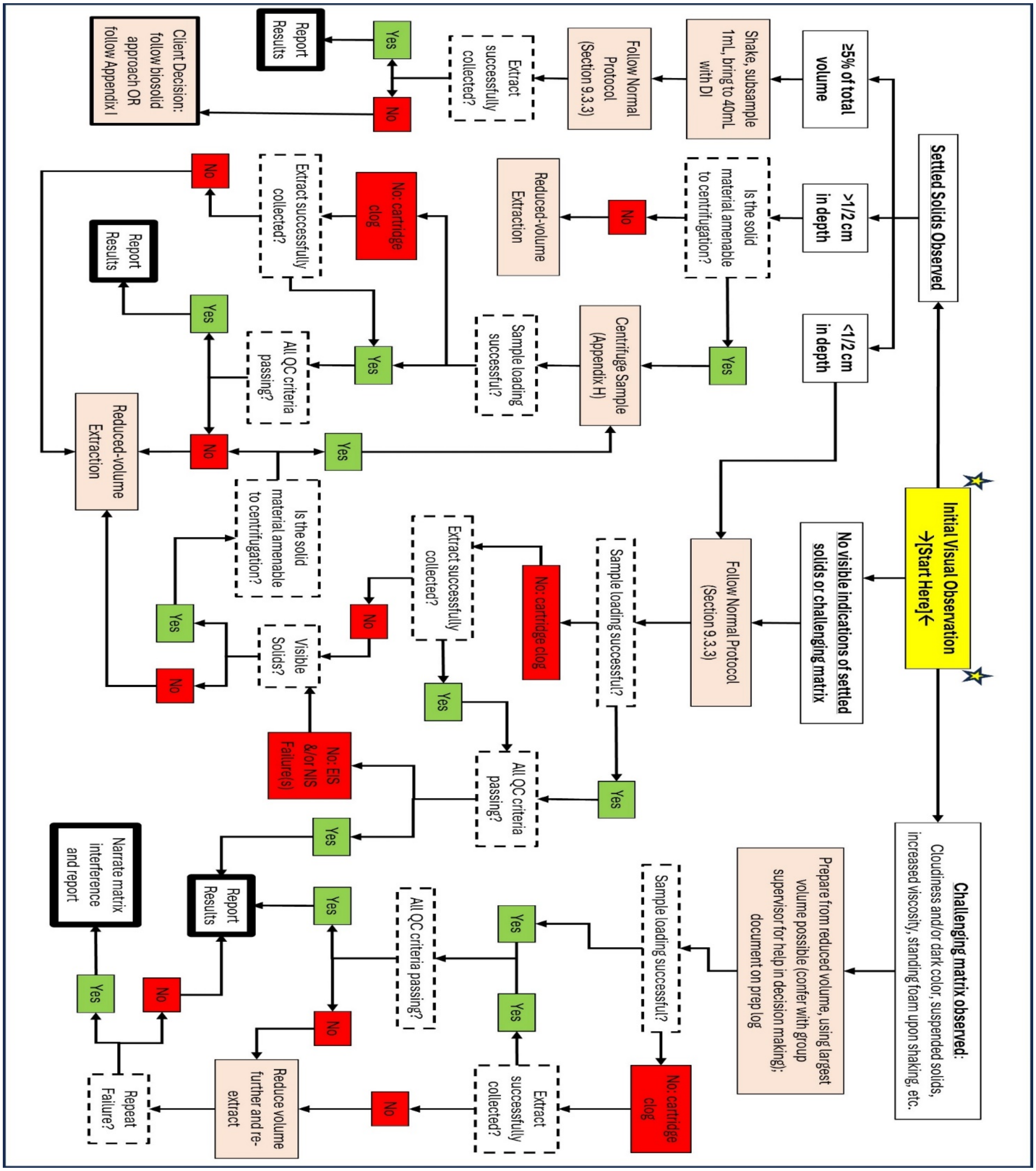
If the decision is made to abandon sample loading, take the following actions. Some of these are partial duplicates of the actions listed in the section above.

- If any sample remains in the reservoir, carefully remove the cartridge-adaptor-reservoir assembly for the sample in question and pour whatever sample volume remains in the reservoir back into the original sample bottle. This volume will be included in the evaluation of extracted sample volume (initial volume).

- Use the cartridge from the abandoned sample and finish the SPE process to collect what extract is available.
- The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.
- Weigh the sample in its original bottle to establish the “empty bottle” weight (aka post-extraction weight).

Fully Clogged Cartridges

Samples will have to be re-extracted when cartridges clog so fully that the extraction process cannot be taken to completion to collect a sample extract. Based on the total volume loaded in the failed extraction attempt, provide a suggested reduction factor for the re-extraction (i.e., reduce volume 5X, 10X, 20X, etc.) The sample should be shaken up before subsampling for the reduced volume re-extraction. However, for samples containing solids that are very fine and easily suspended, the analyst may consider allowing the sample to settle before subsampling an aliquot for reduced volume re-extraction; this may help prevent cartridge clogging in the re-extraction process.


Initial Visual Observation →[Start Here]←
Settled Solids Observed
≥5% of total volume
>1/2 cm in depth
<1/2 cm in depth
Shake, subsample 1mL, bring to 40mL with DI
Follow Normal Protocol (Section 9.3.3)
Extract successfully collected?
Yes
Report Results
No
Client Decision: follow biosolid approach OR follow Appendix I
Is the solid material amenable to centrifugation?
No
Reduced-volume Extraction
Yes
Centrifuge Sample (Appendix H)
Sample loading successful?
No: cartridge clog
Extract successfully collected?
No
Yes
All QC criteria passing?
Yes
Report Results
No
Reduced-volume Extraction
Yes
Is the solid material amenable to centrifugation?
No visible indications of settled solids or challenging matrix
Follow Normal Protocol (Section 9.3.3)
Sample loading successful?
No: cartridge clog
Extract successfully collected?
No
Yes
Visible Solids?
Yes
No
Yes
All QC criteria passing?
No: EIS &/or NIS Failure(s)
Yes
Report Results
Challenging matrix observed: Cloudiness and/or dark color, suspended solids, increased viscosity, standing foam upon shaking, etc.
Prepare from reduced volume, using largest volume possible (confer with group supervisor for help in decision making); document on prep log
Sample loading successful?
Yes
No: cartridge clog
Extract successfully collected?
Yes
All QC criteria passing?
Yes
No
No
Reduce volume further and re-extract
Repeat Failure?
No
Yes
Narrate matrix interference and report

Appendix H: Aqueous Sample Centrifugation Protocol

Method 1633 states “laboratories may utilize other documented strategies for minimizing the disruptions due to SPE clogging and slow extractions,” and “a trained analyst should be able to distinguish samples with very low TSS and focus…on only those samples that might present a risk of clogging.” Therefore, whether an individual sample will require centrifugation for proper preparation will be determined and documented by the preparation analyst, following the guidance in Appendix G. Additionally, the method states “If centrifugation is used to prevent samples with high TSS from clogging the SPE, the EIS compounds must be spiked into the original sample container prior to centrifugation.” This protocol complies with that dictate.

1) Follow Appendix G to evaluate the sample for the presence of solids. Inspect the sample and consider the necessity of centrifuging.
2) If the sample is determined to require centrifugation/decantation, contemporaneously make a note on the prep batch log indicating this fact.
3) Spike samples requiring centrifugation in the same manner and with the same standard volume as samples which will not be centrifuged.
4) Label a 500mL conical centrifuge bottle with the sample ID for each sample that will be centrifuged. Set them in an appropriate rack with the caps removed.
5) Vigorously shake the spiked sample and then quickly pour it into the appropriately labeled centrifuge bottle. Try to ensure that the original sample bottle is devoid of any solid material after the transfer. Be careful to avoid spilling sample during the transfer process. Tightly cap each centrifuge bottle after transfers are complete.
6) Transfer capped centrifuge bottles to the centrifuge rotor, ensuring that the carousel is symmetrically balanced. Close the top and centrifuge at 3000 RPM (~2000 RCF) for 6 minutes.
7) Remove centrifuge bottles and decant the centrifuged liquid from the condensed solids by transferring it back into the original sample bottle. Try to avoid transferring any of the condensed solids from the centrifuge bottle back to the original sample bottle, while maximizing the amount of liquid collected in the sample bottle.
8) Weigh the full, decanted original sample bottle and document in the prep batch log.
9) Extract the decanted sample as normal alongside un-centrifuged samples, through the cartridge rinsing and drying (step 10 of Section 9.3.4).
10) When the SPE cartridges have been dried, rinse the original sample bottle following the protocol in step 12 of Section 9.3.5. Additionally, add 5mL of 1% methanolic ammonium hydroxide (1%-MeOH) to each centrifuge bottle to rinse the inside of them as well as the solids they contain. If the condensed solids become re-suspended while rinsing the bottles, centrifugation may be required. Using a transfer pipet or mechanical pipet, transfer the 1%-MeOH rinse from the centrifuge bottle into the reservoir/SPE cartridge and elute with the original sample bottle rinse into a 15mL conical centrifuge tube.

11) Add 5 mL of additional 1%-MeOH directly to the SPE reservoir of all batch QC samples (MB/LCS/LLLCS) and elute with the normal bottle rinse. This is to match the volume used for elution of centrifuged field samples in the prep batch.

12) After elution, all sample extracts (client and QC) with additional elution volume shall be concentrated to ~3.5 mL and brought to a final volume of ~4 mL with 1%-MeOH. Concentrate each extract at approximately 55 ºC with N2 flow of approximately 1.2 L/min. Use a reference elution tube to reconstitute to the appropriate volume, like the protocol in step 8 of Section 9.3.6 of this SOP. This extract concentration and reconstitution must be done BEFORE adding acetic acid and NIS to the extracts, as directed in step 14 of Section 9.3.5.

13) Weigh the empty bottle with the cap on and subtract that from the weight of the bottle with sample, determined in step 8 of this appendix, to determine initial sample volume.

14) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

15) Generate a narrative statement noting which samples in the prep batch included centrifugation in the extraction process. Include any additional observations and/or deficiencies that were noted during the centrifugation or extraction process, particularly if any issues were encountered during the sample loading step of the SPE process.

Appendix I: Separation & Analysis of Liquid-Solid Biphasic Matrices

Method 1633 states "laboratories may utilize other documented strategies for minimizing the disruptions due to SPE clogging and slow extractions, including centrifuging the sample before adding the EIS and treating the supernatant aqueous phase and the solid phase as separate samples." This will be done only according to client direction or project requirement; see Appendix G for more information regarding management of solids in aqueous samples.

1) If the client has requested to have the sample separated into aqueous and solid phases for analysis, the sample must be logged into the LIMS system separately for both matrices. The resulting solid phase will be reported on a wet weight basis and will not be analyzed for percent solids (aka percent moisture).

NOTE: The LOQ for the resulting solid analysis will depend on the amount of solid material available after decanting – the lab will use ~5 g of material if available, but any reduction in available solids will result in an increase in the reported LOQ.

2) Label a 500mL conical centrifuge bottle with the sample ID for each sample that will be centrifuged. Set them in an appropriate rack with the caps removed.
3) Vigorously shake the sample and then quickly pour it into the appropriately labeled centrifuge bottle. Try to ensure that the original sample bottle is devoid of any solid material after the transfer. Be careful to avoid spilling sample during the transfer process. Tightly cap each centrifuge bottle after transfers are complete.
4) Transfer capped centrifuge bottles to the centrifuge rotor, ensuring that the carousel is symmetrically balanced. Close the top and centrifuge at 3000 RPM (~2000 RCF) for 6 minutes.
5) Remove centrifuge bottles and decant the centrifuged liquid from the condensed solids by transferring it back into the original sample bottle. Try to avoid transferring any of the condensed solids from the centrifuge bottle back to the original sample bottle, while maximizing the amount of liquid collected in the sample bottle.
6) Weigh the full, decanted original sample bottle and document in the prep batch log.
7) Extract the decanted aqueous sample as normal alongside un-centrifuged samples, starting with EIS addition.
8) Label a 50 mL centrifuge tube with the sample ID for each solid phase sample generated from phase separation. Using a wooden tongue depressor or a pre-cleaned metal scoopula, transfer the solid material from the decanted 500 mL centrifuge bottle to the labeled 50 mL tube, targeting 5 g of total sample mass. Record the sample mass transferred to the 50 mL tube – this will be the extracted sample mass used for calculations and reporting. In many cases, re-extraction will not be possible due to limited solid material.
9) Spike the collected solid material with EIS and extract as normal alongside solid samples which were not generated from phase separation.

Appendix J: TCLP/SPLP by 1633

Clients may submit samples (solid or aqueous) for PFAS following TCLP or SPLP procedures. For solid samples, the TCLP and SPLP procedures are used to simulate the leaching of environmental contaminants over extended periods of time from a solid material into the environment. A subsample of the client's sample is weighed out and combined with a leaching solution and mechanically tumbled for a set period. Each leachate prep method (TCLP: Method 1311 or SPLP: Method 1312) employs a unique leaching solution dictated by the parent methods. After the sample has been tumbled/leached by the Organic prep department, the leachate is filtered by the Organic Prep department and delivered to the PFAS sample holding area. The PFAS department is notified by email when the leachate solutions are ready for PFAS prep. The filtered leachate solutions are prepared by the PFAS prep analysts using the 1633 aqueous prep method, at a 1:5 dilution (100 mL of leachate solution).

1) Samples requested for PFAS by SPLP/TCLP analysis will be batched and leached by the normal SPLP/TCLP procedures used by the Westborough Alpha Organic Prep department. Organic Prep will be the initial responsible party for samples analyzed for PFAS by SPLP/TCLP.
2) When the leaching process is complete, Organic Prep will collect approximately 500mL (at minimum 100mL) of the leachate solutions in clean HDPE containers provided by the Emerging Contaminants department.
3) After collecting the leachate solution, an Organic Prep analyst will filter approximately 500 mL (at minimum 100mL) of each leachate solution using a Flipmate apparatus, using normal protocols for Flipmate filtration.
4) After filtering the leachates, the Organic Prep analyst will deliver the filtrates to the Sample management department for transport to the Emerging Contaminants Department (EC) at the Alpha Mansfield Facility. Leachates will be transferred to the EC department's designated sample storage refrigerator.
5) Samples to be analyzed for PFAS following TCLP/SPLP will appear on a separate PFAS prep worklist, the title of which will contain "SPLP" or "TCLP." From these worklists, PFAS analysts will select the samples to be extracted.
6) Pour ~100 mL of filtrate solution into a pre-labeled HDPE PFAS sample bottle, using the gradations marked on the bottle as a guide. Record the actual amount of filtrate by weighing the sample bottle. LOQs for samples prepared in this way will be ~5X higher than normal Aqueous matrix LOQs.
7) Following the instructions in step 7, use the leachate blank solution (typically has sample ID L0000000-01) to prepare three bottles for use as batch QC. Volume for the leachate blank, LLLCS, and LCS will be recorded as 100 mL.
8) Label and fill a clean 125 mL HDPE bottle with ~125 mL of pre-tested reagent water for use as a typical 1633 MB sample. Volume for the 1633 MB sample will be recorded as 100 mL.
9) After preparing the diluted filtrate, filtrate batch QC, and 1633 MB bottles, follow the normal extraction steps for aqueous matrices. Each sample will be spiked with EIS as normal. The filtrate

LLLCS and LCS will be spiked with target analytes according to the routine aqueous protocol for LLLCS and LCS target spiking.

10) Leachate batch QC (MB/LLLCS/MS/MSD) are documented in LIMS as leachate blank (MB), and LLLCS (LCS).

11) Following the SPE process, the instrumental analyst will analyze the extracts by the 1633 method, as normal.

12) After processing, reviewing, generating reports for the data, and importing the data into LIMS, the TCLP/SPLP tumble date must be input into the analytical results from the leachate logs.

Appendix K: Surface Wipe PFAS Analysis by 1633

Clients may submit wipe samples for PFAS analysis by 1633; wipes can be used as a proxy measurement of surface contamination in production facilities, labs, etc. The lab provides sampling kits for users which consist of a 50 mL centrifuge tube paired with a packaged ghost wipe for each surface to be sampled (ghost wipes: Environmental Express Part# SC5000). The wipe is used to swab a defined area of the surface or item of interest and is placed in the accompanying centrifuge tube, which is then capped, labeled, and shipped back to the lab for preparation and analysis.

Used wipe samples are prepared directly in the container in which they are received, following the protocols for solid matrices described in Sections 9.3.6 through 9.3.8; analysis follows normal 1633 routines. No correction will be made for percent solids, and results are reported as ng/wipe.

Appendix L: Articles of Commerce Analysis via Cryomill Processing

Clients may submit samples of various consumer product materials and 'articles of commerce' for analysis of PFAS contained in the products. To effectively mobilize any PFAS that may be present within the structure of the material, samples must be milled to a fine powder using a cryogenic mill (or Cryomill).

This appendix provides strategies for processing samples obtained from an article of commerce. Common techniques are covered for mechanical size reduction of articles and their sub-units or portions thereof prior to the determination of PFAS in the article or article components via extraction and quantitative analysis. Polymer powders, nanomaterials, fibers, pastes, fluorinated ionomers etc. may not require size reduction if they are known to be sufficiently homogenous and more than 95% of the material passes a 250 μm sieve. Examples of common articles requiring milling prior to extraction and analysis are compacted cakes, melt extruded pellets and molded articles, elastomers and agglomerates, coated wire, textiles, paper, leather, food, and LDPE and polypropylene.

The user shall elect to apply one or more of the approaches, or compendium of approaches, to create homogenous samples suitable for extraction and analysis. Selection of the appropriate technique(s) depends on the article. Alternative methods of mechanical sample preparation can be used, provided that the required particle size (avg. particle size approx. 100 μm) of the sample is achieved without contaminating or compromising the sample.

Sample Processing Equipment and Materials

The following sample processing equipment and materials are required, subject to the type of material being prepared. Conditions for cryogenic fine milling are provided for the Retsch CryoMill, however, alternative cryomilling equipment like the SPEX ® Freezer/Mill may be used for most products.

1) Scissors, heavy plate shears or RetschTM ZM 200 Grinding Mill (Centrifugal Mill) with 6 or 12 tooth stainless steel (SS) rotor and 1 mm stainless steel bottom sieve.
2) Retsch CryoMill (Ball Mill), with SS grinding cartridge and 25 mm grinding ball (50 mL grinding cartridge, 5 g fill), or equivalent cryogenic mill capable of grinding to approximately 100 μm particles.
3) Cleaning brushes (different sizes) and polishing cloths, or cotton balls/swabs
4) Liquid nitrogen (LN2)
5) High purity methanol and ASTM Type I water for cleaning mill parts
6) Ventilated hood, to minimize exposure to fine particles/dusts/aerosols and chemical vapors
7) Ventilated drying oven capable of > 200°C
8) Precision sieves and accessories, nickel mesh, 50 μm and 150 μm sizes

Manual Cutting

If possible, manual cutting with pre-cleaned shears or scissors is suitable for rough cutting and preparation of samples for further reduction by grinding, etc. Recommended maximum sample size is 10 x 10 mm but will depend on the specification of the equipment used in the subsequent preparation processes.

Fine Grinding by Cryomill

Fine grinding via cryomill is suitable for further mechanical breakdown of samples, grinding material to pieces ~100 µm in diameter. Be careful not to allow the LN2 to come into direct contact with the sample to prevent spattering and sample loss. Thorough cleaning of the mill components between samples is crucial to avoid cross-contamination; see steps 7-11 below for details.

Cryomilling will be performed using a Retsch CryoMill (ball mill) with automatic LN2 feed, as described below:

Sample Type[1]	Cycles	Preset	Frequency (Hz)	PCT (minutes)	MT (minutes)	ICT (minutes)
Elastomers (FKM, FFKM, FEPM, and agglomerates)	1	1	30	Auto	2	NA
Compacted Cake	5	NA	30	Auto	2	2
Melt Extruded Pellets and Molded Articles	7	2	30	Auto	4	2
Coated Wire	3	3	30	Auto	2	2
Textiles, Paper, Leather	3	4	25	10	2.5	0
Food (meat, cheese)	1	5	25	8	2	NA
LDPE and PP	2	6	25	10	2	2

[1] *In most applications, a feed mass of 5 g is used.*
PCT: Precooling time (automatic set)
MT: Milling time
ICT: In-between cooling time

1) In the case of FFKM compounds and articles, care must be taken to avoid excessive energy input as it may lead to cryo-mechanical degradation of the polymer and the creation of mechanoradicals, which can inflate the amount of target substance detected. Filling levels will impact the energy applied in the grinding process and can inflate test results as well.

2) In the case of cured FFKM elastomeric articles, pulverizing the product in a 2-roll mill as commonly used for compounding of elastomers can be an alternate sample preparation method to avoid or reduce the risk of mechanical degradation. Alternative methods for FFKM compounds and articles that do not require cryo-grinding are being investigated.

3) Cryogenically mill the sample powder and sweep out the milled material to collect all the powder. The collected plastic-based sample material should be precision sieved to obtain a sufficiently homogeneous portion of known particle size range of 50 µm to 150 µm, by first sieving material

through the 150 µm sieve, then the 50 µm sieve (keep contents captured on 50 µm sieve). Size range is 100 + 50 µm (i.e. ~ 100 µm).

4) The collected FKM-, FFKM- and FEPM-based samples are visually inspected for homogenous size, verification via light-scattering is beneficial. Sieving of the samples is not recommended due to materials' elastomeric nature and the potential for particles to re-agglomerate into larger segments over time.

NOTE: Freshly cryomilled samples should either be extracted ASAP (same day) OR placed under frozen conditions (-10° C) ASAP and held under frozen conditions until ready to extract.

5) Make sure to follow the User Manual for installing and removing the grinding jar. This includes the two lock rings on the left side of the mechanism.
    a. Make sure outer LOCK RINGS are loosened.
    b. Screw in the grinding jar (from the right side of the mechanism). Tighten with black plastic tightening aid.
    c. TIGHTEN TWO LOCK RINGS: Outside ring tightened first (hand-tighten only); inner ring tightened second (snug), using the tool.
    d. Perform grinding cycle.
    e. LOOSEN THOSE TWO LOCK RINGS: Inside ring loosened first, outer ring loosened second. To loosen either ring, the tool will be needed because of icing.
    f. Unscrew grinding jar.
    g. When cryomill is not in use, make sure to replace the cooling jacket seal.
6) For extraction of cryomilled materials, follow the solid matrix extraction protocol listed in Sections 9.3.6-9.3.8, using 2 g as the target sample mass instead of 5 g. Sample results will be reported as ng/g, with no moisture correction.

Cleaning Procedure for Mill Components

Thorough cleaning of the mill components between samples is crucial to avoid cross-contamination. The following cleaning procedure is recommended.

7) Remove residual polymer thoroughly with DI water and brush.
8) If necessary, wipe away last polymer residue with clean polish cloth or cotton ball/swab.
9) Rinse all parts with methanol, use an ultrasonic bath as needed.
10) Rinse all parts with DI Water, use an ultrasonic bath as needed.
11) Repeat steps 7-10 as needed.

Analysis and Holding Time

Matrix	Routine Container	Minimum Sample Amount	Preservation	Holding Time
Fluoropolymers, molded articles, coated wire, pellets, or other Articles of Commerce[1]	Any container or packaging that does not contain PFAS. Target container is a 125 mL PFAS container; however, clients will often send in Ziploc bags or other packaging.	5 g (target weight for clients to send is 20 g).	Can be shipped at any temperature (being an Article of Commerce). Once received in the lab: <6°C (prior to cryomill) Once cryomilled: Frozen Extract storage: <6°C	Sample receipt (or dated collected)[2] to cryomill: 1 year From cryomilling to extraction: 14 days Once extracted: 30 days

[1] Almost any “solid” material is applicable to this approach, as long as it can be manually coarse cut to approximately 5-10 mm in size (half a pea). If the matrix is soft (e.g., gummy bear), a larger feed size can be used.

[2] Often clients do not include “date collected.” If none provided, “date collected” becomes “date received.”

Appendix M: Procedure for Total Oxidizable Precursors (TOP)

The following modifications to the referenced SOP are as follows:

Section 7: Water Bath – Capable of monitoring recording to .1 C maintaining 85 C.

Section 8.1: Sodium Hydroxide (NaOH, CAS#: 1310-73-2) – High purity, demonstrated to be free of analytes and interferences.

Potassium Persulfate ($K_2S_2O_8$, CAS#: 7727-21-1) - High purity, demonstrated to be free of analytes and interferences.

Hydrochloric Acid (HCl, CAS#: 7647-01-0) - High purity, demonstrated to be free of analytes and interferences.

Additional table to be added to Section 8

Table 1

Isotope Labeled Standard	**Conc. Top Surr Stock (ng/mL)**	**Vol. of Top Surr Stock (µl)**	**Final Vol. of Top Surr PDS (mL)**	**Final Conc. of Top Surr PDS (ng/mL)**
$^{13}C_2$-PFOA	50,000	40	4.0	500
$^{13}C_2D_4$-4:2FTS	50,000	80	4.0	1000

For Aqueous samples, prior to Section 10 of SOP 45852, add to each 125 ml sample with Potassium Persulfate until 60 mM (about 2 grams). Add Sodium Hydroxide until the sample is 125 mM (about .625 grams).

Sample should have a pH >12.

Fortify each sample with 20 µl of TOP pre-assay surrogate containing 1 negative control surrogates and 1 positive control surrogates from table 1.

Place sample in a water bath at 85 C for 6 hours.

Remove sample from water bath and adjust pH 6-8 with Hydrochloric Acid.

Following pre-treatment, follow the aqueous extraction protocol from section 10 of SOP 45852 unaltered.

Section 11, An additional calculation is added for the final reporting of the TOP assay results.

TOP Assay = Result of Post TOP assay extraction – Result of analysis from Pre-Top Assay extraction.

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PFAAs via EPA 1633 (SOIL)

Holding Time: 90 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	0.8	0.2664	ng/g	70-140	30	70-140	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	0.4	0.1336	ng/g	60-150	30	60-150	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	0.2	0.06664	ng/g	65-145	30	65-145	30	30			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	0.8	0.2664	ng/g	60-150	30	60-150	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	0.2	0.06664	ng/g	65-140	30	65-140	30	30			
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	0.2	0.06664	ng/g	55-160	30	55-160	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	0.2	0.06664	ng/g	65-145	30	65-145	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	0.2	0.06664	ng/g	60-150	30	60-150	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	0.2	0.06664	ng/g	70-150	30	70-150	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	0.8	0.2664	ng/g	55-200	30	55-200	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	0.2	0.06664	ng/g	65-155	30	65-155	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	0.2	0.06664	ng/g	70-155	30	70-155	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	0.2	0.06664	ng/g	65-160	30	65-160	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	0.2	0.06664	ng/g	70-155	30	70-155	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	0.8	0.2664	ng/g	70-150	30	70-150	30	30			
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	0.2	0.06664	ng/g	55-140	30	55-140	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSA	2355-31-9	0.2	0.0856	ng/g	65-155	30	65-155	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	0.2	0.06664	ng/g	70-155	30	70-155	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	0.2	0.06664	ng/g	40-155	30	40-155	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	0.2	0.06664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	0.2	0.06664	ng/g	65-165	30	65-165	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	0.2	0.06664	ng/g	70-150	30	70-150	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	0.2	0.06664	ng/g	65-150	30	65-150	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	0.2	0.06664	ng/g	65-150	30	65-150	30	30			
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Pr	13252-13-6	0.8	0.2664	ng/g	70-145	30	70-145	30	30			
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	0.8	0.2664	ng/g	70-160	30	70-160	30	30			
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	0.2	0.06664	ng/g	25-160	30	25-160	30	30			
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF	756426-58-1	0.8	0.2664	ng/g	70-150	30	70-150	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl	763051-92-9	0.8	0.2664	ng/g	45-160	30	45-160	30	30			
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	0.2	0.06664	ng/g	70-155	30	70-155	30	30			
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	0.2	0.06664	ng/g	70-140	30	70-140	30	30			
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	2	0.6664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	2	0.6664	ng/g	70-135	30	70-135	30	30			
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	0.4	0.1336	ng/g	30-140	30	30-140	30	30			
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	0.4	0.1336	ng/g	60-150	30	60-150	30	30			
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	0.4	0.1336	ng/g	70-140	30	70-140	30	30			
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	0.4	0.1336	ng/g	60-155	30	60-155	30	30			
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	1	0.3336	ng/g	45-130	30	45-130	30	30			
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	5	1.664	ng/g	60-130	30	60-130	30	30			
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	5	1.664	ng/g	60-150	30	60-150	30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*8-130*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*35-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor (Soil/Solids only)

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PFAAs via EPA 1633 (SOIL)

Holding Time: 90 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*40-135*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-	*NONE*									*40-165*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*40-130*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*40-130*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-	*NONE*									*40-215*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*40-130*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-	*NONE*									*40-275*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid	*NONE*									*40-135*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*40-130*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*40-150*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*40-130*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*20-130*		
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-1	*NONE*									*40-130*		
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA	*NONE*									*10-130*		
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-130*		
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-o	*1265205-95-5*									*20-130*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (	*NONE*									*15-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor ***(Soil/Solids only)***
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PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	6.4	2.136	ng/l	70-140	30	70-140	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	3.2	1.064	ng/l	65-135	30	65-135	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	1.6	0.536	ng/l	60-145	30	60-145	30	30			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	6.4	2.136	ng/l	70-145	30	70-145	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	1.6	0.536	ng/l	65-140	30	65-140	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	1.6	0.536	ng/l	65-145	30	65-145	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	1.6	0.536	ng/l	70-150	30	70-150	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	6.4	4.816	ng/l	65-155	30	65-155	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	1.6	0.536	ng/l	55-150	30	55-150	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	1.6	0.536	ng/l	70-140	30	70-140	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	6.4	2.136	ng/l	60-150	30	60-150	30	30			
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	1.6	0.536	ng/l	65-145	30	65-145	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSA	2355-31-9	1.6	0.536	ng/l	50-140	30	50-140	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	1.6	0.536	ng/l	60-145	30	60-145	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	1.6	0.536	ng/l	70-145	30	70-145	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	1.6	0.536	ng/l	70-140	30	70-140	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	1.6	0.536	ng/l	65-140	30	65-140	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	1.6	0.536	ng/l	60-140	30	60-140	30	30			
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Pr	13252-13-6	6.4	2.136	ng/l	70-140	30	70-140	30	30			
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	6.4	2.136	ng/l	65-145	30	65-145	30	30			
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	1.6	0.536	ng/l	50-145	30	50-145	30	30			
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3	756426-58-1	6.4	2.136	ng/l	70-155	30	70-155	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl	763051-92-9	6.4	2.136	ng/l	55-160	30	55-160	30	30			
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	1.6	0.536	ng/l	60-150	30	60-150	30	30			
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	1.6	0.536	ng/l	65-145	30	65-145	30	30			
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	16	5.36	ng/l	70-145	30	70-145	30	30			
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	16	5.36	ng/l	70-135	30	70-135	30	30			
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	3.2	1.064	ng/l	55-140	30	55-140	30	30			
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	3.2	1.064	ng/l	60-150	30	60-150	30	30			
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	3.2	1.064	ng/l	70-140	30	70-140	30	30			
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	3.2	1.064	ng/l	50-150	30	50-150	30	30			
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	8	2.664	ng/l	65-130	30	65-130	30	30			
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	40	13.36	ng/l	70-135	30	70-135	30	30			
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	40	13.36	ng/l	50-145	30	50-145	30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*5-130*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*40-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor (Soil/Solids only)

Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, Inc

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PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*40-135*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-	*NONE*									*40-200*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*40-130*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*40-130*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-	*NONE*									*40-200*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*40-130*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-	*NONE*									*40-300*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid	*NONE*									*40-170*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*30-130*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*40-130*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*25-135*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*10-130*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*10-130*		
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-1	*NONE*									*40-130*		
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA	*NONE*									*10-130*		
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-130*		
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-o	*1265205-95-5*									*10-130*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (	*NONE*									*10-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor ***(Soil/Solids only)***

Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, Inc

Appendix C

Site-Specific Health and Safety Plan

Health and Safety Plan

Elmwood Preserve, NYSDEC BCP Site No. C360239

850 Dobbs Ferry Road, White Plains, New York

Prepared for

Ridgewood Elmwood Owner, L.L.C.
25A Hanover Road, Suite 310
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Prepared by

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January 20, 2025

Project Number CV04.001.004

carsonvoci
engineering and geology dpc
an affiliate of Terraphase Engineering Inc.

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Acronyms and Abbreviations

ANSI	American National Standards Institute
APR	air-purifying respirator
bgs	below ground surface
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
COPCs	chemicals of potential concern
COVID-19	coronavirus
dBA	Decibels
eV	electron volts
°F	Degrees Fahrenheit
ft	feet
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
kV	kilovolts
OSHA	Occupational Safety and Health Administration
Participant	Ridgewood Elmwood Owner, L.L.C.
PCB	polychlorinated biphenyls
PFAS	per- and polyfluoroalkyl substances
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	parts per million
QA/QC	quality assurance/quality control
Roux	Roux Environmental Engineering and Geology, D.P.C.
SCOs	Soil Cleanup Objectives
the Site	850 Dobbs Ferry Road, White Plains, New York
SPF	Sun Protective Factor
SSHO	Site Safety and Health Officer
SVOC	semi volatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
Terraphase	Terraphase Engineering Inc.
UV	Ultraviolet
VOCs	volatile organic compounds

Signature Sheet

This section provides a detailed listing of the individuals responsible for drafting, reviewing, implementing, and approving this HASP.

Plan Prepared By:

12/10/2024

Kesli Kruzel, GIT, Staff II Geologist

Date

Project Manager:

1/21/2025

Nicholas Krasnecky, PE, Senior Associate Engineer

Date

Corporate Health and Safety Officer Approval:

Daren C Roth

1/20/25

Daren Roth, Associate H&S Director

Date

1 Introduction

This Health and Safety Plan (HASP) was developed for the supplemental remedial investigation (RI) activities to be conducted at the New York State (NYS) Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program Site No. C203162 identified as Elmwood Preserve at 850 Dobbs Ferry Road, White Plains, New York (“the Site”). The HASP was prepared by Carson Voci Engineering and Geology D.P.C. an affiliate of Terraphase Engineering Inc. (herein referred to as “Carson Voci” or “Terraphase”) for the field work to be conducted on behalf of Ridgewood Elmwood Owner, L.L.C. (the “Participant”).

This document constitutes the HASP, which is central to the safety and health program for the project. This document is considered a living document and can be amended as needed. A hardcopy of this HASP will remain on Site at all times during the field investigation activities.

1.1 Field Work Activities

Prior to intrusive sampling, a private utility detection company will be employed to verify the location of utilities and subsurface structures and to ensure clearance for proposed boring and sample locations requiring GeoProbe® direct-push sampling methods. Soil will be collected either with hand tools (i.e., hand auger) or a direct push drill rig. The majority of the proposed boring locations are in landscaped areas, however, some may have asphalt or concrete surface cover. Concrete areas will be cored or hammer-drilled prior to soil core collection. Approximately 59 soil borings will be installed to a variety of depths, with a maximum depth of 8 feet (ft) below ground surface (bgs; Figure 2). Soil samples will be collected from various depths and analyzed for a combination of contaminants including volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), per- and polyfluoroalkyl substances (PFAS), target compound list (TCL) pesticides/herbicides, and target analyte list (TAL) metals.

1.2 Corporate Policy

Safety should take the highest priority in any Terraphase project; as evident in Terraphase’s corporate motto “Safety First.” It is Terraphase’s policy that its personnel and its sub-contractor(s) on site shall assume full responsibility and liability for compliance with all applicable Federal, State and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the Site, and persons occupying areas adjacent to the Site. Terraphase’s hard-earned reputation as a successful consulting company directly correlates to our high standards for safety during our projects. The goal for safety is no illness or injuries with zero lost work days due to work conditions.

1.3 Purpose and Regulatory Compliance

The HASP covers each of the required elements as specified in 29 CFR 1910.120. When combined with the Terraphase Health and Safety Program, this site-specific plan meets all applicable regulatory requirements. This HASP will be made available to all personnel and subcontractors involved for this project. The HASP has been reviewed by the Corporate Health and Safety Officer. By signing the documentation form provided with this plan (Attachment 2), project workers also certify their agreement to comply with the HASP. For subcontractors, this HASP represents minimum safety procedures. Subcontractors are responsible for their own HASP and safety protocols while present onsite or conducting work for this project. Both Terraphase and its subcontractors are independently responsible for the health and safety of their own employees on the project.

2 Site Background

The Site was first developed in 1924 as the Pelhamhurst Golf & Country Club golf course. In 1946, the ownership transferred to John C. Von Glahn, a Trustee, to Elmwood Country Club Inc. The property continued to be managed as a private club and golf course from 1946 until its closure in 2017. The property was purchased by the Participant in 2017.

Roux Environmental Engineering and Geology, D.P.C. (Roux) conducted a remedial investigation from May through July 2024 to assess the nature and extent of contamination associated with the former Site use as a golf course and country club and the presence of metals and pesticide exceedances across the Site. The investigation evaluated soil, groundwater, soil vapor, surface water, and sediment to determine the nature and extent of impacted media at the Site.

The investigation results determined that soil across the Site is primarily impacted by pesticides and metals. Other chemicals, including polyaromatic hydrocarbons (PAHs) and PCBs associated with historical fill, and potential petroleum hydrocarbon VOCs and SVOCs were also found to be present, or are potentially present, at levels above the applicable Soil Cleanup Objectives (SCOs) in localized areas and to a much lesser extent. The RI data demonstrates that contamination generally decreases with depth (i.e., the higher concentrations were found closer to the surface), which is consistent with a historical surficial application of pesticides. However, soil data collected during the RI investigation insufficiently characterizes the vertical distribution of contamination due to the broader 2 ft bgs sampling intervals selected after the 0 to 0.2 ft bgs sampling interval. Additional sampling is warranted to obtain a more refined characterization of contaminant concentrations in soil as compared to the applicable SCOs.

3 Hazards

Hazards that could be encountered include chemical hazards, environmental hazards, biological hazards, and/or physical hazards. The sub-categories of these four types of hazards are explained in further detail below.

3.1 Chemical Hazards

Chemical hazards may be encountered during the field activities to be conducted at the Site. These hazards may be encountered through inhalation, absorption (dermal contact), or ingestion. Based on historical site usage and investigation activities, the following COCs may be encountered during surveying, boring activities, and the collection of soil samples:

- VOCs, primarily BTEX compounds
- SVOCs
- PCBs
- PFAS
- Pesticides/herbicides
- Metals, primarily arsenic and mercury

Silica dust may also be encountered when coring, drilling or saw cutting into the concrete, and metals dust may be encountered due to the nature of the work done at the Site.

3.1.1 Absorption and Ingestion Risk

The anticipated concentrations of contaminants of potential concern (COPCs) in soil are such that the absorption and ingestion risk can be minimized by proper personal hygiene and use of personal protective equipment (PPE). The PPE requirements are discussed further in Section 8.0. If work is anticipated in areas where one or more of the COPCs exceed acceptable risk-based screening levels; the work practices, engineering controls, and required PPE will be assessed and modified as necessary in an addendum to this HASP.

3.1.2 Inhalation Risk

3.1.2.1 VOCs and SVOCs

Inhalation risk associated with VOCs and select SVOCs is possible when disturbing the subsurface (e.g., well installation). During the periods of field activities when the subsurface is disturbed, real-time air monitoring of the worker breathing zone will be conducted. Air monitoring is discussed further in section 9.0. If field personnel experience short-term health effects such as headaches, nausea, or eye and respiratory irritation that are often associated with these compounds, they will take a break to relieve symptoms and further assess the risk to other personnel in the immediate area.

3.1.2.2 Other COPCs

The inhalation risk associated with other COPCs at the Site (select SVOCs, PCBs, pesticides/herbicides, and metals) can be minimized with proper dust control during the proposed field activities. The proposed drilling and sampling activities are anticipated to produce minimal dust. The need for air monitoring for dust or metals will be assessed prior to changes in site activities and action levels will be developed as necessary based on soil analytical data in the proposed work areas.

3.1.2.3 Per- and Polyfluoroalkyl Substances (PFAS)

With the exception of workers involved in the making, handling, or processing PFAS and PFAS-containing materials, there is minimal inhalation risk associated with PFAS, especially in soil and groundwater. Similar to metals and PCBs, the risk will be further reduced by minimizing dust generation.

3.1.2.4 Silica Dust

Silica dust may be generated during the coring, drilling, or sawing of concrete prior to the advancement of soil borings or excavations. OSHA recommends engineering controls be implemented during all concrete coring/demolition to minimize inhalation risk to field personnel from silica dust, as outlined in 29 CFR 1926.1153. Engineering controls can substantially reduce the potential for exposure from silica dust.

The required engineering controls, in accordance with Table 1 in 29 CFR 1926.1153, include the following:

- Core saws will be equipped with an integrated water delivery system with water flow rates sufficient to minimize the release of visible dust. The resulting slurry will be cleaned up (most likely with a wet/dry vacuum) to prevent the slurry from drying and releasing silica dust into the air.
- When using a handheld drill (e.g., rotary hammer, hammer drill, etc.), a vacuum dust collection system (e.g., hammer drill collection attachment) will be used to reduce exposure to silica dust. The vacuum must provide adequate airflow to remove dust at the drilling point and be equipped with a HEPA filter.

3.2 Environmental Hazards

In White Plains, New York, the maximum average high temperature occurs in July at around 83 degrees Fahrenheit and the minimum average low temperature occurs in January at around 24 degrees Fahrenheit (^{o}F). The average annual precipitation is approximately 38.6 inches of rain and 27.5 inches of snow. As such, all field personnel should be prepared for a change in weather conditions.

3.2.1 Heat Stress

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. All employees must be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress disorders.

Heat stress monitoring and work rest cycle implementation must commence when the ambient temperatures exceed 80°F. The site safety and health officer (SSHO), project manager, and/or task manager should monitor the anticipated high temperatures prior to the start of work, as well and monitor real-time temperatures during the work day using a reputable website (i.e. http://www.weather.gov/) or onsite weather station.

Employees shall be allowed and encouraged to take a preventative cool-down rest in the shade at a time when they feel the need to do so to protect themselves from overheating. Such access to shade shall be permitted at all times. An individual employee who takes a preventative cool-down rest (A) shall be monitored and asked if he or she is experiencing symptoms of heat illness; (B) shall be encouraged to remain in the shade; and (C) shall not be ordered back to work until any signs or symptoms of heat illness have abated, but in no event less than 5 minutes in addition to the time needed to access the shade.

High Heat Procedures will be implemented in accordance with the OSHA heat illness prevention regulations if the temperature at the Site equals or exceeds 95°F. This must include the following:

1. Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if reception in the area is reliable.
2. Observing employees for alertness and signs or symptoms of heat illness. The employer shall ensure effective employee observation/monitoring by implementing one or more of the following:
    a. (A) Supervisor or designee observation of 20 or fewer employees, or
    b. (B) Mandatory buddy system, or
    c. (C) Regular communication with sole employee such as by radio or cellular phone, or
    d. (D) Other effective means of observation.
3. Designating one or more employees on each worksite as authorized to call for emergency medical services, and allowing other employees to call for emergency services when no designated employee is available.
4. Reminding employees throughout the work shift to drink plenty of water.

Pre-shift meetings before the commencement of work to review the high heat procedures, encourage employees to drink plenty of water, and remind employees of their right to take a cool-down rest when necessary.

3.2.2 Hypothermia

Hypothermia can result from abnormal cooling of the core body temperature. It is caused by exposure to a cold environment and wind-chill. Wetness or water immersion can also play a significant role. Typical warning signs of hypothermia include fatigue, weakness, lack of coordination, apathy, and drowsiness. A confused state is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink. Body temperatures below 90°F require immediate treatment to restore temperature to normal. Current medical practice recommends slow re-warming as treatment for hypothermia, followed by professional medical care. This can be accomplished by moving the person into a sheltered area and wrapping with blankets in a warm room. In emergency situations, where body temperature falls below 90°F and heated shelter is not available, use a sleeping bag, blankets, and body heat from another individual to help restore normal body temperature.

3.2.3 Ultraviolet (UV) Radiation (Sunlight)

Moderate to high potential for overexposure to UV light exists for field personnel. To prevent erythema (sunburn), workers will be provided Sun Protection Factor (SPF) 30 or greater sunscreen to apply to areas not covered with clothing or PPE. Workers will be encouraged to seek shade whenever possible.

3.2.4 Rain/Thunder/Lightning

Due to the site's location, foul weather including rain storms can occur frequently. Monitor local weather through available media or a weather radio. Although not as frequent, electrical storms can potentially be very hazardous to field personnel. During lightning and thunderstorms, the following is necessary:

- Equipment shutdown;
- Seek shelter in a building or vehicle; and
- Await further instruction from Project Leader.

A 30-minute STAND DOWN period is required after encountering Lightning or Thunder in order to allow the storm to pass.

3.3 Physical Hazards

Physical hazards discussed under this section include traffic hazards, underground and overhead utilities, drill rigs, machinery and moving parts, electrical hazards, confined space entry, noise, slips, trips, and falls, motor vehicle and heavy equipment operation, and ergonomic hazards.

3.3.1 Underground and Overhead Utilities

Reasonable efforts will be made to identify the location(s) of underground utilities (e.g., pipes, electrical conductors, fuel lines, and water and sewer lines) before soil intrusive work is performed. The state underground utility notification authority UDig NY (New York 811) will be notified at least 3 full business days prior to starting field activities. UDig NY in turn will notify representatives of the utility companies who will mark the location of underground services entering the property. UDig NY markings will be noted prior to drilling to prevent damage to utility lines. In addition, Terraphase will have a private utility locate conducted a geophysical survey at all proposed excavation and soil boring installation locations prior to the initiation of intrusive excavation/drilling activities.

The Project Manager is responsible to ensure that underground utility locations are identified prior to the commencement of any subsurface activities. Resources include site plans, utility companies, and regional utility locating services. The proper utility company personnel should certify the deactivation of utilities, and the certification should be retained in the permanent log. Only qualified persons shall perform subsurface installation locating activities, and all such activities shall be performed.

When soil borings approach the approximate location of subsurface installations, the exact location of the installations shall be determined by safe and acceptable means that will prevent damage to the subsurface installation, as provided by 29 CFR 1926.650-652.

If a utility strike presents an immediate danger to the work crew or general public (i.e., electrical, gas, high pressure water line), then the crew should evacuate to a safe distance, contact 911 immediately, and cordon off the area to prevent public access.

All utility strikes should be reported out to the PM and/or SSHO as soon as it is safe to do so, and then a plan will be made for reporting to the utility company and client. If a utility strike does occur refer to the accident reporting requirements in Section 7.0.

Prior to mechanized drilling, the following techniques will be employed to determine the location of subsurface structures:

- contracting the services of a qualified private utility locator, <u>and</u>
- prior to mechanized drilling, subsurface testing (i.e., hand auguring and/or potholing) to the expected depth of probable utilities (not less than 5 feet)

If utilities cannot be located and/or if unlocated utilities are suspected to be present, subsurface activities (i.e., borings, excavation) should not be conducted prior to confirming the location(s) or absence of underground utilities.

Equipment with articulated upright booms or masts shall not be permitted to pass within 20 feet of an overhead utility line (less than 50 kilovolts [kV]) while the boom is in the upright position. For transmission lines in excess of 50 kV, an additional distance of 4 inches for each 10 kV over 50 kV will be used.

Excavation, drilling, crane, or similar operations adjacent to overhead lines shall not be initiated until operations are coordinated with the utility officials. Operations adjacent to overhead lines are prohibited unless one of the following conditions is satisfied:

- Power has been shut off and positive means (e.g. lockout/tagout) have been taken to prevent lines from being energized. Wherever possible, the SSHO will observe power shut off and place a lock and tag on the switch. In all cases utility company personnel shall certify in writing to the Project Manager or SSHO the deactivation of overhead utilities, and the certification retained in the project files. The Site Manager or SSHO must also attempt to verify power shut off by checking that power is no longer available to the affected building or equipment.
- Equipment, or any part of the equipment, cannot come within the following minimum clearance from energized overhead lines (please note that Terraphase recommends that 10 feet be added to the minimum required clearances presented below):

Power Lines Nominal System (kv)	Minimum Required Clearance
0-50	10 feet
50- 75	11 feet
75-125	13 feet
125-175	15 feet
175-250	17 feet
250-370	21 feet
370-550	27 feet
550-1000	42 feet

3.3.2 Drill Rigs

The operator of the Drill Rig will comply with the precautions specified in the above section. In addition, the following precautions should be observed whenever a drill rig is in use:

- Workers must not wear loose clothing, nor leave long hair, boot laces, or jacket ties uncontrolled while operating moving equipment;
- Hard hats, hearing protection, safety footwear, and eye protections must be worn at all times;
- Prior to the start of daily operations, the drill rig operator should inspect the drill rig carefully to be sure that it is suitable for the day's work;
- The drill rig operator will ensure that there is adequate lighting on the rig to enable the job to be performed safely;
- The drill rig must be equipped with an operable kill switch and personnel must be aware of restarting procedures;
- All fittings, connections, and hydraulic hoses must be of a standard to operate in a safe manner;
- At no time will the operator of the drill rig operate the drill controls and add stem while alone, unless the drill rig is designed to operate as a single person operation;
- Repairs and service must not be attempted while rotary machinery is running; and
- If electrical storms can be seen or heard, drilling operation will be shut down until it is deemed safe by the SSHO.

3.3.3 Machinery/Moving Parts

Drilling and vacuum equipment may have various motors, booms, and other equipment. These present a general physical hazard from moving parts. Personnel will stand clear of machinery at all times unless specific instructions are given by the trained operator, or other person in authority. Steel toed shoes or boots will be worn at all times when on the site. When possible, appropriate guards will be in place during equipment use. Field personnel should be careful to keep loose clothing, hands, and feet away from vacuum hose inlets.

3.3.4 Hand and Power Tools

Use of power tools presents potential physical hazards (e.g., pinch points, electrical hazards, flying debris, and struck-by/caught-between hazards) to personnel operating them. The following safety rules must be implemented:

- Inspect tools frequently for defects. Turn in all tools which are burred, mushroomed, have split or loose handles, have worn or sprung jaws, have exposed wires, or are generally unsafe.
- Use hand tools properly and for their intended use only.
- Do not to operate power tools, machinery, or equipment without proper training or supervision.
- Do not operate equipment unless all guards and other protective devices are properly secured and correctly adjusted.
- Keep cords of electrical equipment coiled when not in use.
- When using electrical equipment, position its power cord to avoid its being run over by vehicles or equipment.
- Turn off, and if possible unplug, machinery before cleaning, oiling, adjusting, or repairing unless the equipment is designed or fitted with safeguards to protect the person performing the work.
- Do not wear loose or frayed clothing, dangling ties, finger rings, etc. when operating or working near moving machinery or other mechanical sources of entanglement.
- Do not lift or lower portable electric tools by means of a power cord; use a handline.
- Never throw tools, equipment, or material up or down from one working level to another; always use a handline. Do not disconnect air hoses at compressors until hose line has been bled.

3.3.5 Portable Generator Use

A portable generator is not expected to be required for the scope of work. However, if a generator is utilized on-site the following procedures will be observed.

Care shall be exercised while refueling generators to prevent fire and spills. A generator must be shut off prior to refueling. Personnel shall eliminate static electricity by grounding themselves (touching metal) prior to handling refueling hoses and or containers of petroleum liquids. Items being refueled shall be grounded or be located on the ground and not on a trailer, work bench or inside a truck bed. Equipment that is hot must be allowed to cool prior to refueling. Spill response materials shall be available when conducting refueling operations.

Proper ventilation shall be ensured during generator operation to prevent carbon monoxide poisoning. Portable generators shall never be used indoors or in enclosed spaces and shall maintain a minimum of 3 to 4 feet of clear space on all sides and above to ensure adequate ventilation. The portable generator will never be placed near doors, windows or vents that could allow carbon monoxide to enter a building.

3.3.6 Electrical Hazards

In order to prevent accidents caused by electrical shock, field personnel will inspect electrical equipment being used (e.g. power tools, electrical cords) on a daily basis for evidence of frayed or loose connections.

3.3.7 Lock-out/Tag-out

Lock-out/Tag-out procedures should be used on any pieces of equipment being worked on by field personnel. The only exception to this is equipment with a plug, which can be unplugged and remain in control of the worker. Proper lock-out/tag-out includes the identification and isolation of hazardous energy. The energy sources must be locked out so that only the worker(s) has the key to release the isolation point. Stored energy (e.g. air or water pressure) must also be released prior to conducting work on the equipment. If necessary, all provisions of the OSHA standard as stated in 29 CFR 1910.147 will be followed for controlling hazardous energy or locking out or tagging out electrical and utility hazards.

3.3.8 Confined Spaces

Confined space entry is not anticipated for this project. Terraphase field personnel will not enter any confined space without specific approval of the Project Manager. Subcontractors may need to conduct permit-required confined space entries and should notify Terraphase Project Leader prior to the entry.

If confined space entries are conducted, they will be in accordance with the subcontractor's confined space entry program. An attendant will be stationed above the confined space while the entrant(s) are in the confined space. A full-body harness with emergency retrieval equipment or another means of egress (e.g. ladder) shall be in use if necessary and if the confined space is greater than 6 feet deep.

Before conducting any work inside a confined space (e.g. tank), the personnel will conduct a visual inspection of the area from the opening to identify any hazards before proceeding. Gas measuring devices will be utilized to detect any presence of harmful or dangerous atmospheres. Any floating or rotating machinery that are in the confined space are turned off and locked out prior to beginning any work.

3.3.9 Noise

Appropriate hearing protection (ear muffs or ear plugs with a noise reduction rating of at least 20 decibels [dBA]) will be used if individuals work near high-noise generating equipment (> 85 dBA). Determination of the need for hearing protection will be made by the Project Leader and follow the Terraphase Hearing Conservation program document and 29 CFR 1910.95. The determination will be based on historical area noise surveys for similar tasks. If recent representative data is not available for specific noise producing equipment/tasks, then area noise surveys will be conducted. Personal noise dosimetry will also be conducted if area noise surveys indicate that employees may be exposed to noise in excess of 85 dBA over an 8-hour time-weighted average (8-hour TWA).

Hearing protection is further discussed in section 10.5.

3.3.10 Slips, Trips, and Falls

Slips, trips, and falls are a leading cause of injury on construction and remediation worksites. Water and slime collect on horizontal surfaces and stairs, posing a potential hazard. Proper housekeeping is the key to preventing injuries of this nature. To minimize potential for injuries, the following measures will be implemented:

- Site around open manholes, excavations, trenches, etc. will be kept clean and orderly.
- All potential trip and fall hazards will be clearly marked, modified to reduce the hazard, or engineered in a configuration to eliminate the hazard (if possible).
- All floors and stair treads will be kept clean of water, oil, and polymer.
- All hoses will be coiled and stored out of the way when not in use.
- There will be no running on the site.

As with all field work sites, caution will be exercised to prevent slips on rain slick surfaces, stepping on sharp objects, etc. Work will not be performed on elevated platforms without fall protection.

3.3.11 Heavy Equipment Operation

Physical hazards can arise from loading and off-loading heavy equipment from tractor-trailers and locating equipment to designated areas of use. Hazards will be mitigated by personnel avoiding close proximity to moving equipment and immovable objects.

Belts and rotating parts have the ability to injure, crush, or amputate body parts and limbs. Personnel will avoid contact with any moving part. Any loose items will be removed before working around moving or rotating equipment. Any moving parts that can be guarded will have an appropriate machine guard installed. Equipment will not be operated without the proper guards in place. Repairs/adjustments will be done with the equipment stopped and locked out as appropriate.

The following measures will be implemented for heavy equipment operation:

- The minimum required work uniform for all field personnel (e.g. Level D protection) shall be general work clothes, steel-toed construction boots American National Standards Institute (ANSI) approved, safety goggles or glasses, work gloves, high visibility vest, hearing protection, and a hard hat (ANSI approved).
- Adequate workspace shall be maintained during equipment operation.
- Equipment shall be inspected for proper working condition prior to use.
- Field personnel shall only approach operating equipment from the operator’s angle of view, and only after making eye contact with the equipment operator.
- A 10-foot perimeter will be maintained around all active equipment as a “Danger Zone”.
- Only trained and qualified persons shall operate individual equipment.

On-site haulage or earth-moving vehicles subject to the requirements of OSHA 1926.602 will have a functional audible alarm in compliance with the referenced standard. In addition, the warning sound shall be of such magnitude that it will normally be audible from a distance of 200 feet and will sound immediately on backing. In congested areas or areas with high ambient noise which may obscure the audible alarm, a signaler, in clear view of the operator, shall direct the backing operation.

3.3.12 Motor Vehicle Operation

Employees may be exposed to vehicle accident hazards associated with the operation of vehicles during the project. To control these hazards, the following safety requirements will be strictly enforced:

- Seat belts shall be worn anytime a vehicle is in motion, regardless of speed or distance to be traveled. Seat belt requirements also apply to the operation of backhoe and other construction equipment;
- The basic speed law shall be followed at all times; and
- Vehicles shall never be operated at a speed that is not safe for the conditions (i.e. road surface, traffic, visibility, weather, etc.).

3.3.13 Traffic Hazards

Although the proposed work is not anticipated to occur along active streets or in the public right-of-way, employees should always follow:

- The traffic control plan prepared for the work (if required).
- Park work vehicle between on-coming traffic and work zone to the extent feasible.
- Demarcate the work zone with high visibility traffic cones.
- Wear high visibility vest.
- Follow all laws regarding pedestrian crossing of streets.
- Traffic considerations should be made to minimize driver frustration and confusion.
- Provide as much barrier between work area and traffic lanes as practicable.
- When possible, employees should not walk between the traffic cones and the active lane of traffic.
- Equipment and supplies should be unloaded from the back of the vehicle or the sidewalk side of the vehicle to minimize the potential to travel in the active traffic lane.

A common hazard on all construction sites is being struck by a moving vehicle or large equipment. Every project is to be planned and organized to ensure vehicles, machines and equipment are not operated in reverse or are operated in reverse as little as possible. All heavy equipment must be equipped with an automatic audible alarm that signals when they are being operated in reverse.

3.3.14 Illumination

Proper illumination is important in the prevention of slips, trips, and falls. It is anticipated that work will be conducted during daylight hours and not within any structures. Therefore, no additional illumination will be required. If site activities are to occur during non-traditional hours (i.e., night-time), or inside the adjacent building, an addendum to this HASP will be prepared to specify auxiliary lighting requirements if necessary as outlined in the HAZWOPER standard.

3.3.15 Ergonomic Hazards

The initial site safety briefing given to all workers prior to the start of the project will cover the basics of ergonomics and focus on the following topics:

- Ergonomic injuries – their prevalence, causes, and significance
- Proper lifting procedures and planning all lifts
- Proper posture when standing, operating a motor vehicle or heavy equipment
- Avoiding overexertion
- Awareness of repetitive task and the hazards that they can pose

3.4 Biological Hazards

This section provides health and safety precautions against potential biological agents that might be encountered by field personnel during field activities. The biological hazards that may be encountered include: microbiological agents, insects and wild animals.

3.4.1 COVID-19

To help prevent infection from, or the spread of, the coronavirus (COVID-19), all staff should follow the recommendations from federal, state, and local experts, including mitigation strategies issued by the Centers for Disease Control and Prevention (CDC; https://www.cdc.gov/coronavirus/2019-ncov/community/index.html).

At a minimum, field staff should practice the following:

- Avoid touching your face, especially eyes, nose, and mouth.
- Cough/sneeze into a tissue or inside of elbow.
- Utilize good hygiene practices and wash hands regularly with soap and water for at least 20 seconds, especially before eating or getting into your field vehicle.
- Face coverings should be considered when working indoors in areas of high COVID transmission.
- Carry a jug of water and hand soap so you can wash hands when permanent or portable facilities are not available.
- Wear nitrile gloves when working in areas where handwashing is not readily available. Change your gloves often and use standard donning and doffing procedures.
- Utilize disposable barriers (e.g., visqueen) to cover work surfaces provided by or shared with contractors at a site.
- Thoroughly disinfect shared equipment and supplies at the end use.

- To the extent feasible, clean and disinfect frequently touched surfaces in Terraphase fleet vehicles prior to transferring the vehicle to another staff.
- If you are sick with any cold or flu-like symptoms, especially those listed by the CDC as potential symptoms of COVID, or expect that you have been exposed to someone with a confirmed case, please stay home, contact project managers so that alternative staffing/scheduling arrangements can be made, and contact Human Resources.
- Ensure complete and thorough documentation is kept of all Terraphase staff, subcontractors, and visitors (i.e. inspectors, vendors, etc.) that are present at the Site each day. This information will be used if contract tracing is necessary.
- Attempt to identify a point of contact for all other contractors and companies working in the general vicinity of Terraphase staff at the Site, and provide them Terraphase contact info should communication related to potential COVID-19 exposures be necessary in the future.
- Additional site-specific protocols may be posted at field sites or communicated by a client, contractor or other site-specific safety representative, especially at construction sites or active businesses and facilities.

3.4.2 Vermin

Feral cats, skunks, rats, mice, squirrels and rabbits may be carriers of disease. Where vermin are identified in work areas, the Project Leader shall be immediately notified. Bites will be immediately reported and medical care obtained. Infections may occur in humans associated with activities that bring humans into contact with rodents, rodent saliva, or rodent excreta. Disturbing rodent-infested areas may bring humans into contact with the etiologic agents causing infections.

Transmission of disease may occur through broken skin, contact with conjunctivae, ingestion of contaminated food or water, or inhalation of aerosols. Personal hygiene practices, such as frequent hand washing, will help prevent rodent-borne diseases as well as using caution in areas likely to be occupied by vermin.

Workers will be advised that if a fever or respiratory illness develops within 45 days of the potential exposure, they should seek medical attention and inform the physician of potential Hantavirus exposure. All precautions will be made to ensure Hantavirus exposure is eliminated in the field. Rodent-borne diseases, including Hantavirus, result in severe respiratory distress and plague.

3.4.3 Arthropods - Insects, Ticks, and Spiders

The work area does have biological hazards. Venomous spiders native to the area include the Black Widow and the Brown Recluse. The female black widow is normally shiny black, with a red hourglass marking on the underside of abdomen. Black widows can be found both outdoors and indoors. In indoor settings, black widows prefer undisturbed, cluttered areas, which may exist in the warehouse at the site. The same goes for the Brown Recluse. Field personal should wear long sleeves and work gloves if they need to move stored material or debris at the site to avoid Black Widow and Brown Recluse bites. If itching, visually assess the area for swelling, pain, and redness. It may take up to 8 hours for the pain to become intense. Ticks are very common to the area. Make sure to check yourself as tick bites are often painless and it can take over a week to see symptoms.

3.4.4 Snakes

The work area includes is a mix of pavement, grass, trees, and dirt areas and the potential exists for snakes to be present. Workers will be encouraged to be vigilant of the possibility of snakes on the site. Poisonous and nonpoisonous species of snakes including may be encountered at the Site. New York is home to three venomous snakes, which include the Northern Copperhead, Massasauga Rattlesnake, and Timber Rattlesnake.

Snakes typically do not attack people but will bite when provoked, accidentally injured, or stepped on or touched, so field personnel are encouraged to watch their footing. If a snake is encountered, one should avoid making quick, jerky motions and loud noises. Retreat must be accomplished slowly. If bitten, seek medical attention immediately.

Workers should take the following steps to prevent a snake bite:

- Do not try to handle the snake
- Wear boots and long pants when working outdoors
- Wear leather gloves when handling brush and debris
- Stay away from tall grass and piles of leaves when possible
- Be aware that snakes tend to be active at night and in warm weather

Workers should take the following steps if they are bitten by a snake:

- Seek Medical attention as soon as possible (dial 9-1-1 or call local EMS)
- Remain still and calm. This will slow the spread of venom.
- Try to remember the color and shape of the snake, which can help with treatment of the snake bite
- Inform your supervisor and others working at the site.

4 Roles and Responsibilities

The following section describes the roles and responsibilities of the personnel involved with the project. The roles and levels of authority are presented in schematic in Section 4.4 below. Appendix A has a list of contact names and phone numbers related to this project.

4.1 Project Manager

The project manager has the responsibilities to:

- staff the project with qualified personnel (including proper training and certifications);
- ensure proper documentation is being collected and maintained;
- provide adequate resources and equipment to field personnel;
- monitor the performance of field activities; and
- ensure company policy is in compliance with all applicable regulations.

4.2 Project Leader

The project leader will serve as the SSHO and will report to the Project Manager. The project leader has the responsibilities to:

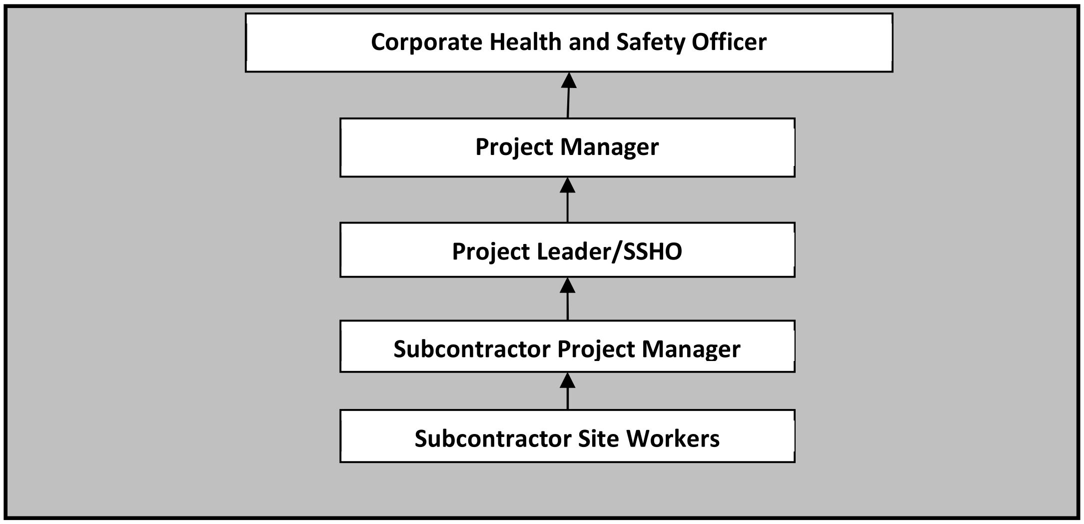
- act as the liaison between field personnel and the subcontractor(s);
- lead the daily and weekly safety meetings;
- ensure the HASP is being followed;
- provide adequate resources and equipment to field personnel; and
- monitor the performance of field activities.

4.3 Subcontractor(s)

Terraphase is responsible for the oversight and implementation of the project safety program. Each subcontractor will be required to designate one individual to work directly with and under the authority of the SSHO to ensure safety responsibilities are being met. Coordination and control of work flow will be achieved through frequent meetings (formal and informal) and job site inspection. The designated subcontractor safety designee (subcontractor project manager) must be granted stop work authority over persons from their company.

Subcontractor control and coordination will be through the chain of command identified in Figure 2. Although each subcontractor is ultimately responsible for the performance and actions of their employees, the SSHO has the authority to take action when a violation of safety guidelines is in question.

4.4 Chain of Command



4.5 Training

Field personnel engaged in project operations that potentially expose them to hazardous wastes, hazardous substances, or any combination of hazardous wastes or hazardous substances shall have satisfied the requirements of 29 CFR Part 1910.120 through completion of:

- Initial 40-hour HAZWOPER training, and
- Annual 8-hour HAZWOPER refresher training current within one year.

4.5.1 General Site-Specific Training

All potential field personnel will review this HASP before commencing work which will serve as site-specific training. The SSHO will review the HASP before field operations begin and the SSHO, or designee, will conduct daily tailgate safety meetings (i.e. pre-entry briefings) to bring up appropriate health and safety concerns and discuss any changes in field conditions. The SSHO will conduct additional pre-entry briefings with entrants to the site who are not present for the tailgate safety meeting. Field personnel will certify their review by signing a HASP acknowledgement form (Appendix B). Social distancing practices should be observed during all site meetings.

Any additional site-specific safety concerns such as, noise, heat illness prevention, or lock-out/tag-out will be addressed by the Project Manager and the SSHO will be provided with proper Site-specific training with accordance with any OSHA regulations prior to the start of the project, as applicable.

4.5.2 First Aid/CPR

Medical assistance is in near proximity to the Site, and therefore, per 29 CFR 1910.151, a designated first aid provider is not required. Personnel trained in first aid/CPR and bloodborne pathogens (29 CFR 1910.151 and 1910.1030) may administer first aid and CPR if needed.

4.5.3 Respiratory Protection

It is not anticipated that respiratory protective equipment will be required for this project. However, field personnel will be properly equipped with a PID to monitor the breathing zone. Should the PID indicate that respiratory protection be necessary, all site activities will halt and a respiratory plan will be enacted. In the case that respiratory protection is required, Terraphase will provide the appropriate mask style and filter type for the specific tasks as well as fit tested prior commencing work. Onsite workers will have successfully completed respiratory protection training in accordance with the requirements of OSHA 1910.134 should it be necessary. More information about breathing zone monitoring with a PID can be found in Section 9.0.

5 Personal Hygiene and Sanitation Facilities

The following personal hygiene requirements, as well as those outlined in Section 3.4.1, will be observed:

- Water Supply: a water supply meeting the following requirements will be utilized:
  - Potable Water: an adequate supply of potable water will be available for field personnel consumption. Potable water will be provided in the form of water bottles, canteens, or water coolers. Potable water containers will be properly identified in order to distinguish them from non-potable water sources.
  - Non-Potable Water: non-potable water may be used for hand washing and cleaning activities. Non-potable water will not be used for drinking purposes. All containers of non-potable water will be marked with a label stating: “Non-Potable Water; Not Intended for Drinking Water Consumption.”
- Toilet Facilities: Restrooms and sanitation facilities may not be available at the Site. The nearest public restroom is located at the Shell gas station at 425 Dobbs Ferry Rd, White Plains, NY 10607. For longer-duration investigations, i.e. at least a week, a portable toilet is expected to be furnished for the Site.

6 Safety Meetings

All workers permitted access to the site will receive a site orientation briefing and a review of pertinent aspects of the project and HASP before the start of work. Personnel will sign a form (Appendix B) documenting they have had an opportunity to review the HASP, understand the requirements, and agree willfully to adhere to the safety aspects of the plan.

The site orientation briefing will include the following aspects:

- Key personnel and responsibilities
- Site hazards (known and potential)
- PPE requirements
- Emergency procedures (including signals, evacuation locations, and what constitutes an emergency)
- Location and route to the nearest medical facility
- Incident reporting procedures

Meetings typically last no less than 10 minutes in time and attendance will be documented. Daily informal safety meeting will be conducted each morning before work commences. Daily meeting attendance will be documented. Sign in sheets for the safety meetings are included in Appendix C.

Personnel are encouraged to immediately report any unsafe work conditions or work practices observed to the SSHO.

7 Accident Reporting

Workers are required to immediately report all accidents, incidents, near-miss incidents, injuries, illnesses and injuries requiring first-aid (no matter how trivial) to their supervisor and/or the SSHO.

In the event of a worker injury or illness, the SSHO must be notified, who will in turn immediately report the incident to the Project Manager to assist with the coordination of required medical assistance and related workers compensation case management follow-up.

Should an incident such as a serious injury (requiring hospitalization), explosion, fire, or a spill or release of toxic materials occur, during the project, the SSHO will immediately report the incident to the project manager and appropriate government agencies. The written report must include the following information:

- Name, organization, telephone number, and location of the contractor
- Name and title of the person(s) reporting the incident
- Date and time of the incident
- Location of the incident
- Approximate chronological summary of details occurring before and at the time of the incident
- Cause of incident (if immediately known)
- Casualty information (fatalities or disabling injuries)
- Details of any existing chemical hazard or contamination
- Estimated property damage (if applicable)
- Nature of the damage and effect on the contract
- Actions taken to preserve safety and security
- Other damages or injuries sustained
- Witness statements

If a utility strike does occur, report this to the Project Manager and utility operator as soon as it is safe to do so. The contact info for potential utility operators near the Site are available in the One-Call ticket which is included in Appendix E.

8 Personal Protective Equipment

PPE in the form of protective footwear and appropriate work clothing are required for all field activities. PPE for specific field activities is listed below. **Additional specifications for PFAS-free PPE used to avoid cross-contamination during PFAS sampling events are outlined in Terraphase SOP 210-23-00-Low Flow Groundwater Sampling for PFAS.**

All Field Activities:

- Boots – chemical resistant, steel (or equivalent) toe and shank (ASTM F2412-18 and F2413-18, Safety Toe Footwear Classification 75). Boots shall be equipped with deep traction sole.
- Work clothing (e.g. long pants)
- Safety Vests (Yellow or orange with reflective strips)
- Safety Glasses (ANSI Z87.1)

Drilling/Excavation and Loading Operations:

- Hard Hat (ANSI Z89.1-2014 Type 1 Class E and G; if overhead hazards are present)
- Hearing Protection (foam inserts)
- Gloves – Chemical (Nitrile)
- Work Gloves (Leather or equivalent) – if splitting cores or other activities that require more resilient gloves

Soil Sampling:

- Gloves – Chemical (nitrile)
- Work Gloves (Leather or equivalent) – if splitting cores or other activities that require more resilient gloves

If necessary:

- Safety Face Shield (splash hazard)
- Tyvek® suit or similar coverall (splash hazard)
- Rubber boots or over boots (wet conditions or if wet boot decontamination is necessary)

PPE offers a high degree of protection, yet the equipment must be maintained and inspected on a regular basis to ensure its effectiveness. Hard hats should be discarded if cracked. Boots should be maintained (use waterproofing if necessary) to prevent injuries, disease (from wet conditions) and insect/snake bites.

Employees required to wear PPE will be trained to know at least the following:

- When PPE is necessary.
- What PPE is necessary.
- How to properly put on, take off, adjust and wear the PPE.

- The limitations of the PPE.
- Proper care, maintenance, useful life and disposal of PPE.

Changes in the workplace or in the type of required PPE that make prior training obsolete may require additional training or retraining of employees.

If air monitoring exceeds action levels identified Section 9.0, work will be modified to reduce vapors. If air monitoring indicates that an upgrade to level C PPE is necessary, Level C includes the PPE specified above plus the NIOSH-approved half- or full-face air-purifying respirator (APR) equipped with the appropriate filter cartridges for organic vapors. Personnel will be fit-tested for the specific make and model respirator that will be used. Note: safety glasses or goggles are not required when wearing a full-face APR.

9 Air Monitoring

Air monitoring will be conducted during intrusive activities as the potential exists to contact soil impacted with VOCs and select SVOCs. The work environment will be monitored using a PID.

9.1 Direct Reading Instruments

9.1.1 Photoionization Detector

A PID with a 10.6 electron volt (eV) lamp will be used to determine the presence and concentration of organic vapors. Contaminants such as petroleum hydrocarbons and associated VOCs are detectable with a PID. Air monitoring and actions will be implemented identified in 9.2 below.

9.2 Monitoring Strategy

Inhalation is one of the primary routes of exposure for VOCs. The following approach to air monitoring was selected based onsite conditions and background information presented in section 2.

9.2.1 Total Organic Vapor Monitoring

During intrusive and remediation activities, SVOCs and VOCs could potentially become airborne and result in exposure to employees. When intrusive activities are being conducted or when known or suspected contaminated soils or groundwater are encountered, total organic vapors will be monitored with a PID or a similar device. **Total organic vapor readings will be taken in the breathing zone approximately once per half hour or more frequently as Site conditions warrant.**

If the PID detects total organic vapors at concentrations greater than 5 parts per million (ppm), then sustained for at least 1 minute, additional controls will be implemented to prevent exposure. If possible, all personnel will evacuate the area and wait for vapors to dissipate to levels below 5 ppm before resuming work. If personnel must remain in an area where vapors above 5 ppm are present, air-purifying respirators will be worn to try to identify the source of contaminants, and implement engineering controls (e.g., portable fans with pre-staged power such as available onsite power or portable generator) to reduce the vapors to below occupational exposure limits (see below). If the PID readings exceed 50 ppm sustained (for greater than 1 minute), all work will be stopped and the project manager notified. Work may not resume until airborne total organic vapors readings are recorded below 50 ppm. Onsite personnel wearing C Level PPE should try to identify the source of the contaminants once readings fall to below 50 ppm.

Chemicals of Potential Concern (COPCs)		
Direct Reading Instrument Action Levels for Area Monitoring and Breathing Zone Monitoring		
Monitored Parameter	**Action Level**	**Response to Action Level**
VOCs in the work area will be monitored using a PID and colorimetric gas detection tubes (as needed).	≥ 5 ppm continuous reading in the breathing zone for 1 minute	The SSHO should: • Stop work • Don Level C (HEPA/OV cartridges) to identify source of airborne contamination • Initiate vapor suppression measures or other engineering controls (e.g. work upwind, blower fan) to maintain levels to less than 5 ppm
	≥ 50 ppm continuous reading in the breathing zone for 1 minute	The SSHO should: • Stop work • Contact PM if VOC levels cannot be controlled to less than 50 ppm total.

The Site action levels were derived using the following regulatory exposure limits:

Compound	**OSHA**		**ACGIH**	
	PEL	**STEL**	**TLV**	**TLV-STEL**
Benzene	1	5	0.5	2.5
Ethylbenzene	100	--	20	--
Toluene	200	300 (c)	20	--
Xylenes	100	--	20	--
Naphthalene	10	--	10	--

Concentrations presented in parts per million (ppm)
(c) = ceiling limit
PEL = permissible exposure limit, 8-hour time weighted average
STEL = short term exposure limit, 15-minute
TLV = threshold limit value, 8-hour time weighted average
ACGIH = American Conference of Governmental Industrial Hygienists

9.3 Quality Assurance/Quality Control

Adherence to a proper quality assurance and quality control (QA/QC) plan is essential for a meaningful air sampling effort. The major concerns of a QA/QC plan are calibration of equipment and document control.

9.3.1 Calibration and Maintenance Procedures

All direct reading instruments will be calibrated daily before work and checked against calibration gas at the end of the day. Calibration records will be kept that detail date, time span, gas or other standard, and the name of the person performing the calibration. The calibration gas for the PID is isobutylene. The SSHO will ensure that the instrument is kept clean and will follow manufacturer's directions for keeping the lamp clean. The SSHO will perform no other maintenance procedures unless approved by the Project Manager.

9.3.2 Documentation

Strict adherence to document and data control procedures is essential for good QA/QC. Data and calibration records must be accounted for and retrievable at all times. Types of documents that are essential include notes, logbooks, maps, data sheets, and reports. These must be placed in the project files. Copies of all field data reports and personal sampling records will be sent to the project manager for review.

Documentation of employee exposure monitoring results must be made available and maintained in compliance with 29 CFR 1910.1020.

10 Decontamination of Personnel and Equipment

Despite protective procedures, personnel and equipment may come in contact with potentially hazardous compounds while performing work tasks. If so, decontamination must occur using an Alconox or TSP wash (or other effective means), followed by a rinse with clean water. Standard decontamination procedures for levels C and D are as follows:

- equipment drop
- boot cover and outer glove wash and rinse
- boot cover and outer glove removal
- suit wash and rinse
- suit removal
- safety boot wash and rinse
- inner glove wash and rinse
- respirator removal
- inner glove removal
- field wash of hands and face

Additional decontamination specifications for PFAS compounds are detailed in Terraphase SOP 109-23-00-Field Equipment Decontamination. Workers should employ only applicable steps in accordance with level of PPE worn and extent of contamination present. The SSO shall maintain adequate quantities of clean water to be used for personal decontamination (i.e., field wash of hands and face) whenever a suitable washing facility is not located in the immediate vicinity of the work area. Disposable items will be disposed of in an appropriate container. Wash and rinse water generated from decontamination activities will be handled and disposed of properly. Non-disposable items may need to be sanitized before reuse. Each site worker is responsible for the maintenance, decontamination, and sanitizing of his/her own PPE.

Used equipment may be decontaminated as follows:

- An Alconox or TSP and water solution will be used to wash the equipment.
- The equipment will then be rinsed with clean water.

Each person must follow these procedures to reduce the potential for transferring chemically affected materials off site.

11 Medical Surveillance

Any field personnel engaged in project operations that expose them to hazardous wastes, hazardous substances, or any combination of hazardous wastes or hazardous substances shall be participants in a Medical Surveillance program that meet the OSHA requirements. These persons must be medically evaluated and cleared for use of respiratory protection devices and protective clothing for working with hazardous materials by the examining physicians. The medical clearance shall be current within one year through at least the last day of field operations. The applicable requirements under the OSHA standards for HAZWOPER and Respiratory Protection Program will be observed. Current copies of training certificates and statements of medical program participation for all Terraphase personnel are maintained by the Terraphase headquarters office.

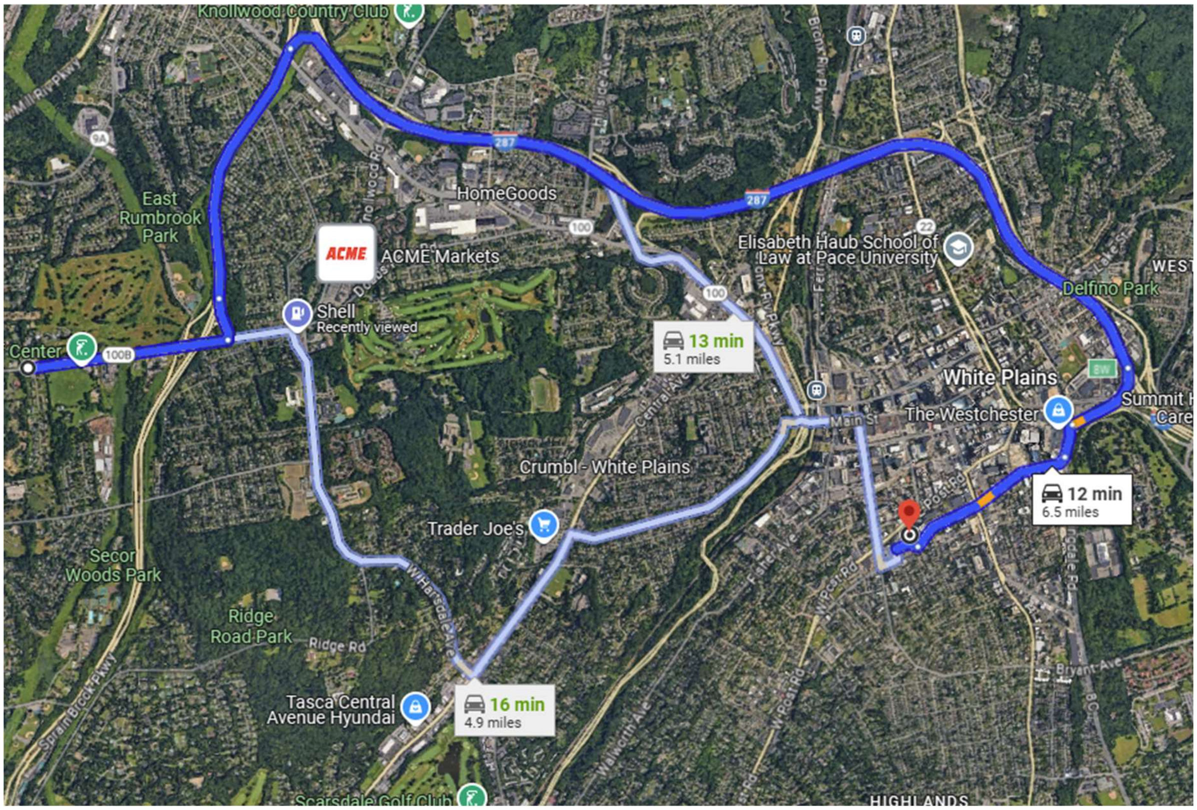
12 First Aid and Medical Treatment

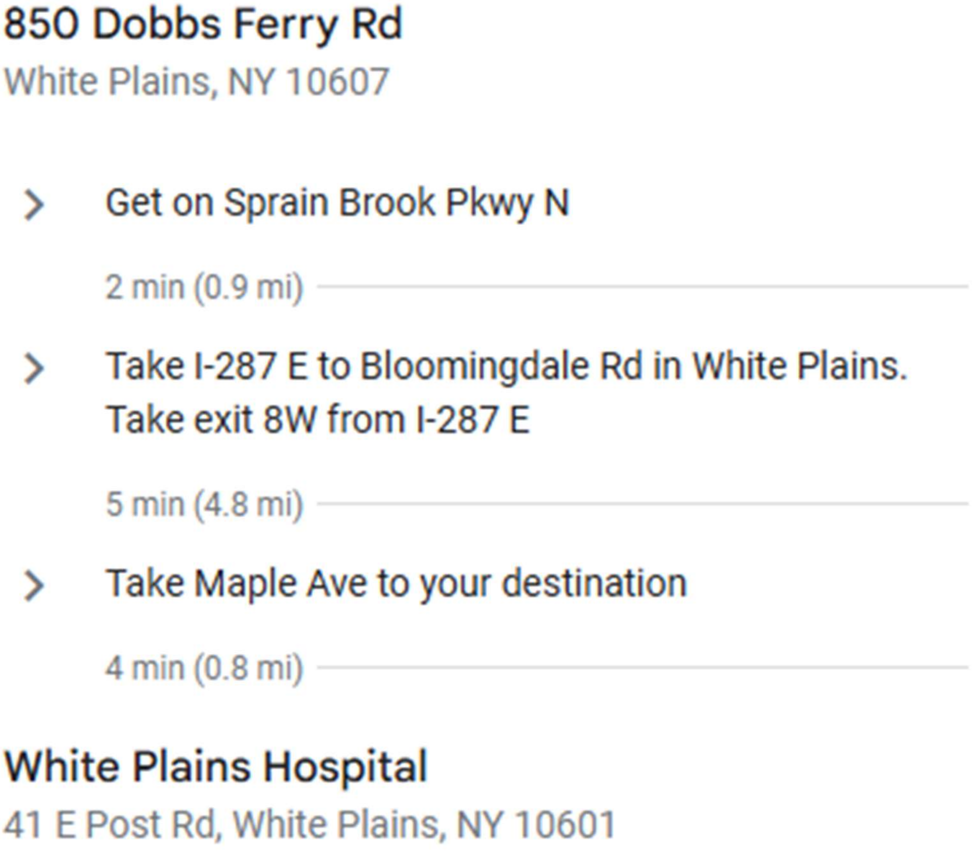
All persons on site must report any near-miss incident, accident, injury, or illness to the SSHO. A trained site first aid provider will provide first aid. Injuries and illnesses requiring medical treatment must be documented. The SSHO must conduct an accident investigation as soon as emergency conditions no longer exist and first aid and/or medical treatment have been completed. All necessary reports must be completed and submitted to the Project Manager within 24 hours after the incident.

If treatment beyond first aid is required, the injured should be transported to the nearest medical facility off-site. If the injured is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedics should be summoned. If there is any doubt as to the injured worker's condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

The closest 24-hour medical facility is White Plains Hospital, as described below. A map of the driving directions is included on the next page and in Appendix D.

Directions to White Plains Hospital, 41 East Post Rd, White Plains, NY 10601 (Map in Appendix D)





850 Dobbs Ferry Rd

White Plains, NY 10607

Get on Sprain Brook Pkwy N

2 min (0.9 mi)

Take I-287 E to Bloomingdale Rd in White Plains. Take exit 8W from I-287 E

5 min (4.8 mi)

Take Maple Ave to your destination

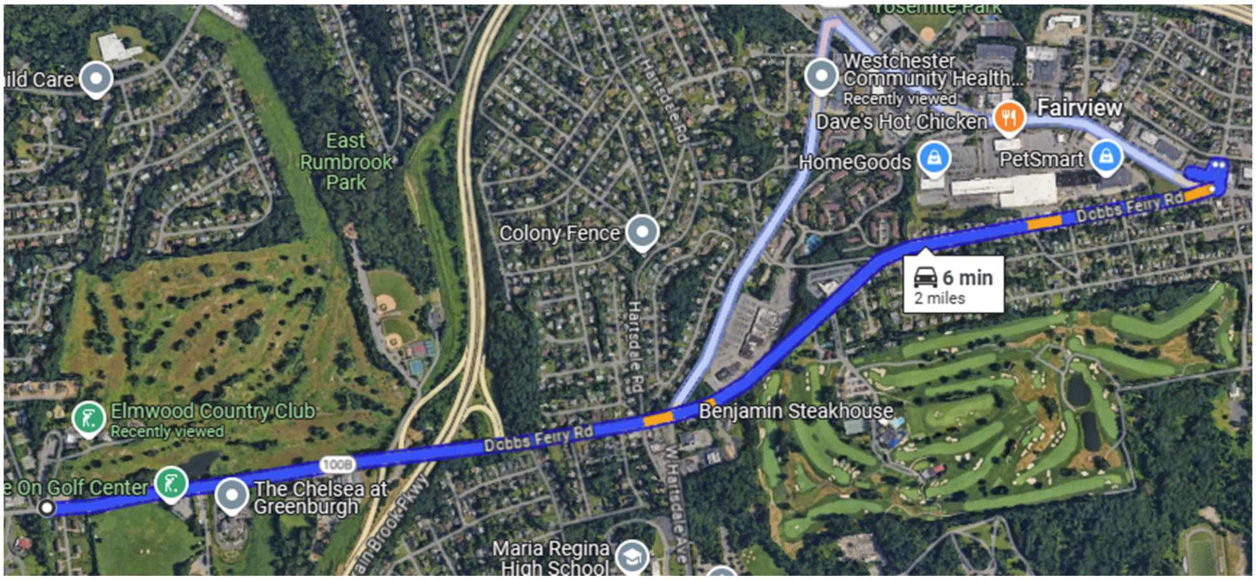
4 min (0.8 mi)

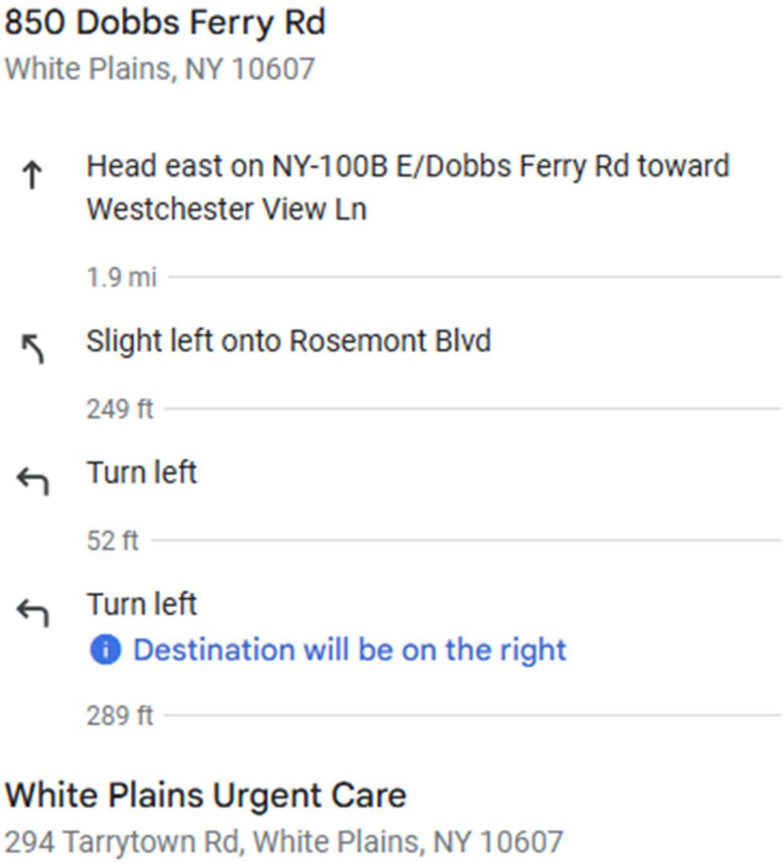
White Plains Hospital

41 E Post Rd, White Plains, NY 10601

The closest urgent care facility is White Plains Urgent Care, as described below. A map of the driving directions is included on the next page and in Appendix D.

Directions to White Plains Urgent Care, 294 Tarrytown Rd, White Plains, NY 10607 (Map in Appendix D)





850 Dobbs Ferry Rd
White Plains, NY 10607

↑ Head east on NY-100B E/Dobbs Ferry Rd toward Westchester View Ln

1.9 mi

↖ Slight left onto Rosemont Blvd

249 ft

↰ Turn left

52 ft

↰ Turn left
ⓘ Destination will be on the right

289 ft

White Plains Urgent Care
294 Tarrytown Rd, White Plains, NY 10607

Figures

Appendix A

Contact Names and Phone Numbers

Emergency Contacts

Emergency Services (Police/Fire Department/Ambulance): 911

White Plains Hospital emergency room: (914) 681-0600

WorkCare 24-hour Telehealth Service: (888) 449-7787

National Response Center: (800) 424-8802

Poison Control Center: (800) 876-4766 or (800) 222-1222

CHEMTREC: (800) 424-9300

Terraphase

Conshohocken Office:

Office Number: (215) 297-3502

Princeton Office:

Office Number: (609) 236-8171

Corporate Health and Safety Officer: Daren Roth

Office Number: (925) 444-0555 x38

Cell Number: (925) 719-5496

Project Manager: Nicholas Krasnecky

Cell Number: (201) 552-0224

Project Leader/SSHO: Alex Strohl

Cell Number: (570) 447-0558

Appendix B

HASP Review and Acceptance Form

HASP Review and Acceptance Form

All field personnel working on the site must be familiar with the HASP. By signing below, you confirm you have read, understand, and agree to abide by the HASP. Any questions regarding health and safety on this site may be directed to either the Project Leader/SSHO or Project Manager.

Name	Company	Date

Appendix C

Safety Meeting Sign-In Sheets

Safety Meeting Sign-In Sheet

Conducted By:

Date:

Topics Discussed:

Concerns/Problems/Hazards:

Meeting Attendees

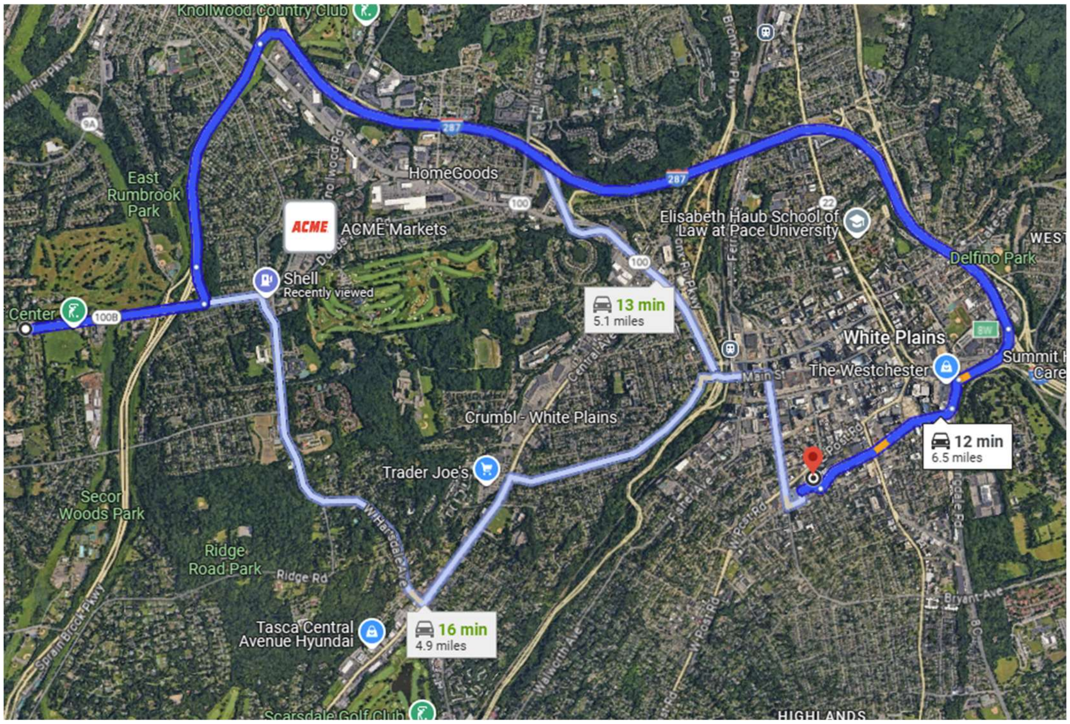
Name	Company

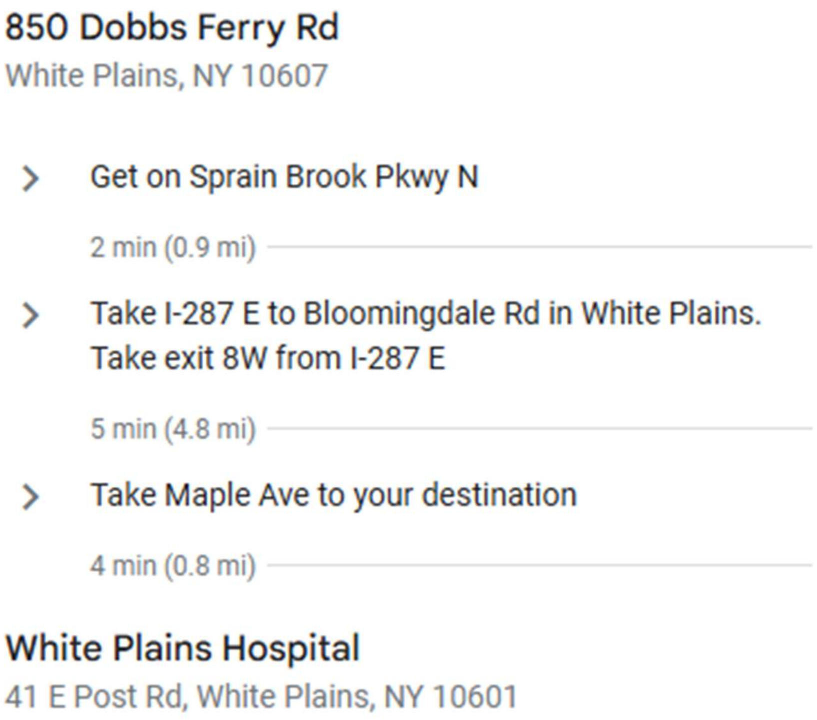
Appendix D

Driving Directions to Nearest Urgent Care or Hospital

The closest 24-hour medical facility is White Plains Hospital, as described below. A map of the driving directions is included on the next page and in Appendix D.

Directions to White Plains Hospital, 41 East Post Rd, White Plains, NY 10601 (Map in Appendix D)





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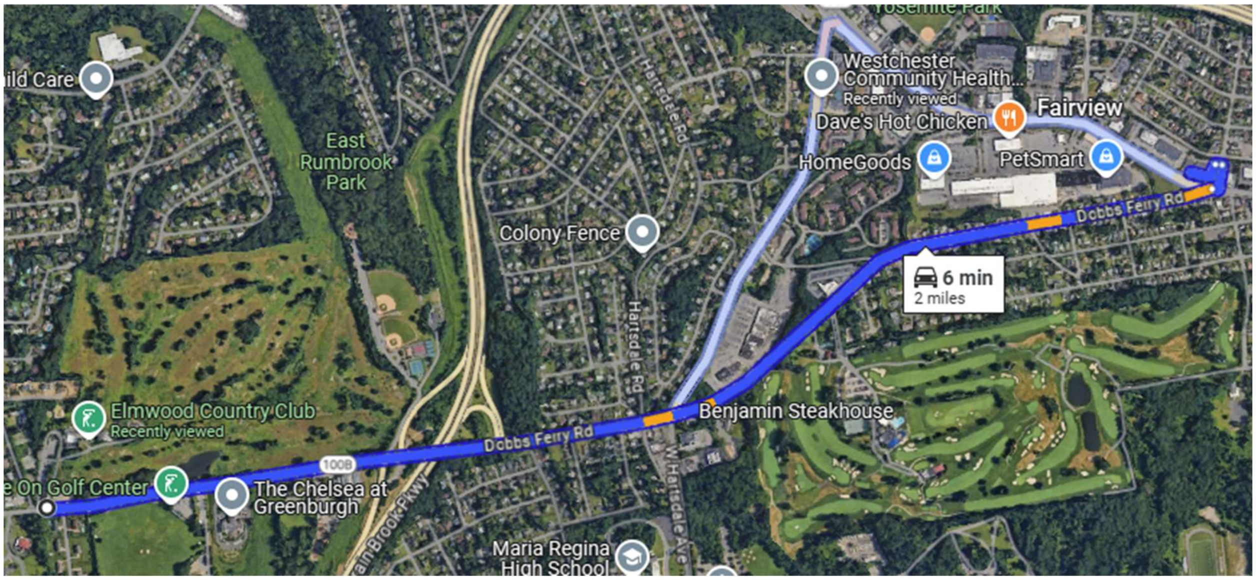

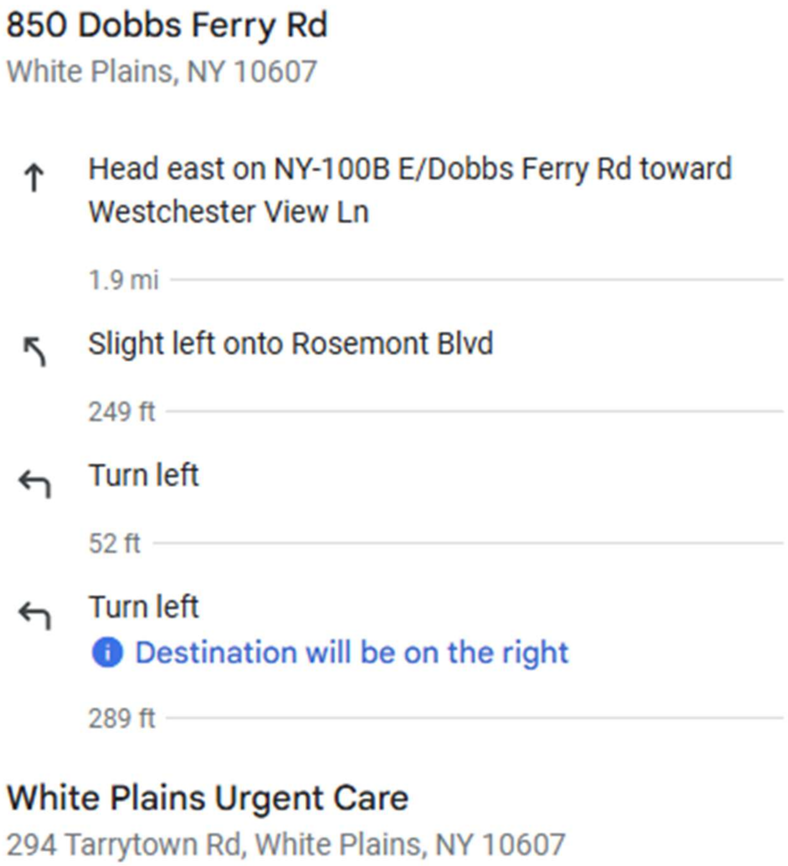

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289 ft

White Plains Urgent Care
294 Tarrytown Rd, White Plains, NY 10607

Appendix D

Community Air Monitoring Plan

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. "Periodic" monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

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