REMEDIAL INVESTIGATION WORK PLAN

for the

PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET
BROOKLYN, NEW YORK 11215
BLOCK 1003, LOT 11

NYSDEC BROWNFIELD CLEANUP PROGRAM SITE NO. C224266

SCA PROJECT ID NO. 099267
SCA CONTRACT NO. C000014345
SCA SERVICE ID NO. 67807

TRC PROJECT NO. 287821

APRIL 5, 2018

Submitted to:
New York State Department of Environmental Conservation
Region 2, Long Island City, New York
47-40 21st Street
Long Island City, NY 11101
Attn: Ms. Wendi Zheng

Prepared by:

TRC Engineers, Inc.
1430 Broadway, 10th Floor
New York, NY 10018
Phone: (212) 221-7822
Fax: (212) 221-7840
Attn: Ms. Jennifer Miranda

Prepared for:

NYCSCA
30-30 Thomson Avenue
Long Island City, NY 11101-3045
Phone: (718) 472-8502
Fax: (718) 472-8500
Attn: Ms. Lee Guterman

CERTIFICATIONS

I, David S. Glass, P.E., P.G., certify that I am currently a registered professional engineer licensed by the State of New York and that this Remedial Investigation Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

I certify that all information and statements in this certification are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

DAVID SAMUEL GLASS
068884-1

4.5.2018

David S. Glass, P.E., P.G.
NYS Professional Engineer No. 068884-1

Date

It is a violation of Article 130 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by the New York State licensed engineer identified above in accordance with Section 7209(2), Article 130, New York State Education Law.

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ABBREVIATIONS AND ACRONYMS

$\mu g/m^3$	Micrograms per cubic meter
ACM	Asbestos-Containing Materials
ASP	Analytical Services Protocol
BCA	Brownfield Cleanup Agreement
BCP	Brownfield Cleanup Program
BGS	Below Ground Surface
CAMP	Community Air Monitoring Plan
CCR	Construction Completion Report
Cis-1-2-DCE	cis,1-2-Dichloroethene
CP-51	Commissioner Policy 51
CVOC	Chlorinated Volatile Organic Compounds
DER	Department of Environmental Remediation
DER-10	DER Technical Guidance for Site Investigation and Remediation
DO	Dissolved Oxygen
DQO	Data Quality Objectives
DUSR	Data Usability Summary Report
ELAP	Environmental Laboratory Approval Program
ESA	Environmental Site Assessment
ESI	Environmental Site Investigation
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IRM	Interim Remedial Measure
LBP	Lead-Based Paint
LNAPL	Light Non-Aqueous Phase Liquid
NTU	Nephelometric Turbidity Unit
NYCDCP	New York City Department of City Planning
NYCRR	New York Codes, Rules, and Regulations
NYCSCA	New York City School Construction Authority
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation Reduction Potential
PBS	Petroleum Bulk Storage
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PID	Photoionization Detector
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan

ABBREVIATIONS AND ACRONYMS (CONTINUED)

QA/QC	Quality Assurance/Quality Control
REC	Recognized Environmental Condition
RI	Remedial Investigation
SCO	Soil Cleanup Objective
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TIC	Tentatively Identified Compound
TKN	Total Kjeldahl Nitrogen
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The purpose of this Remedial Investigation Work Plan (RI Work Plan) is to present to the New York State Department of Environmental Conservation (NYSDEC), for review and approval, the proposed plan for further investigation at 168 8th Street, Brooklyn, New York 11215 (referred to as the “Site”). The New York City School Construction Authority (NYCSCA), a New York State Public Benefit Corporation, purchased the Site in May 2017 for construction of a Pre-Kindergarten Facility and is seeking acceptance of the Site into the Brownfield Cleanup Program (BCP) as a Volunteer. The proposed BCP Site name is “168 8th Street” and the BCP Site Number is C224266.

The overall objectives of the project are to prepare the Site for construction of a Pre-Kindergarten Facility, a Restricted-Residential Use, and to remediate the environmental conditions at the Site to the satisfaction of New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH).

This RI Work Plan will be implemented in accordance with the protocols in NYSDEC Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10).

Following completion of the RI, NYCSCA will submit an RI Report documenting the findings and conclusions of the investigation. The RI Report will also present the results of previous investigations.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Location and Setting

The Site is located at 168 8th Street, Brooklyn, New York 11215 and encompasses approximately 13,500 square feet or approximately 0.31 acre. The legal description of the Site is Block 1003, Lot 11. The Site location is shown on *Figure 1*.

The Site is bordered to the north by 8th Street followed by a two-story commercial building and three-story residential buildings; to the east by three- and four-story residential buildings; to the west by a one-story institutional building ("American Legion Hall") with a parking lot followed by a one-story commercial building with a parking lot ("Enterprise Rent-A-Car") and four-story residential buildings with one first-floor commercial tenant; and, to the south by 9th Street followed by a one-story commercial building ("Top Notch Auto Repair") and three-story residential buildings. The regional topography slopes downward to the northwest toward the Gowanus Canal. The northern portion of the Site is approximately one to two feet lower in elevation in comparison to the southern portion of the lot and a concrete ramp located on the east-central portion of the lot connects these two areas for vehicle access. A Site Plan showing the surrounding properties is presented as *Figure 2*.

According to the New York City Department of City Planning (NYCDCP) Zoning Map 16C, the Site is zoned for residential use (R6A for the southern portion of the Site and R6B for the northern portion of the Site). Residential districts permit community facilities such as schools. Properties in the area of the Site are zoned for residential, commercial, and manufacturing use.

2.2 Current Site Use

The Site has been vacant since approximately 1992, is currently unoccupied, and consists of a concrete and gravel covered lot. There are currently no above-ground structures on the Site.

2.3 Historic Site Use

Historic records indicate that the Site was first developed as farmland. A residential building, which was demolished in the late 1800s, was present on the southern portion of the Site. From the late 1800s to the early 1900s, the Site was occupied by an ink manufacturer (1888 to 1906), a storage facility (1906 to 1926) with a gauge manufacturer (circa 1917), a chemical laboratory (in 1926), and a machine works facility (1928 to 1934). In the mid- to late-1900s the Site was occupied by a garage and a gasoline station (from approximately 1926 to at least 1951), a plumbing supply/metal products manufacturer (1945 to 1965), and a textile factory (1976 to 1992). A fire occurred on the Site in the early 1990s and the lot has been vacant since approximately 1992.

2.4 Future Use of the Site and Site Development Schedule

The proposed future use of the Site is a Pre-Kindergarten Facility. The proposed redevelopment includes a three-story building with a basement on the southern portion of the Site and a playground encompassing approximately 2,800 square-feet on the northern portion of the Site. The depth of the building basement has not yet been confirmed and will be established during the design phase. Additionally, the conceptual design for the school facility is subject to change during the design process.

The NYCSCA purchased the Site in May 2017. Following the completion of the RI, the NYCSCA will issue a design package for construction of the proposed Pre-Kindergarten Facility, which will include required remedial actions. NYCSCA’s objective is to complete the remedy and obtain the Certificate of Completion by the summer of 2021.

2.5 Site Geology and Hydrogeology

The geology of Kings County consists of unconsolidated glacial deposits overlying crystalline bedrock. The subsurface geology for the Site property likely includes the following formations: Pleistocene upper glacial deposits, Gardiners Clay, Jameco Gravel, Cretaceous Raritan Formation consisting of sands and clays, and crystalline bedrock. Bedrock was not encountered in the soil borings or trench excavations advanced at the Site as the depth to crystalline bedrock for the area is estimated to be 200 feet below ground surface (bgs). Fill material consisting of brown sand, silts with fine gravel, coal, and brick fragments was encountered at the Site to a maximum depth of approximately 10 feet bgs. Deeper, native material consisting of sand, silt and clay was encountered to 20 feet bgs.

The Site is located approximately 0.4 mile east and 0.3 mile south of the Gowanus Canal, an extension of Gowanus Bay. Based on topography in the area, and review of the USGS Hydraulic Conditions Maps for Long Island, NY, 2013 (USGS *Groundwater Conditions on Long Island, New York in 2013),* it is expected that the predominant direction of groundwater flow is northwesterly; however, groundwater flow direction will be confirmed during implementation of the RI. Estimated groundwater levels and/or flow directions may vary due to seasonal fluctuations in precipitation, local usage demands, geology, and underground structures. Based on information gathered during the Phase II Environmental Site Investigation (ESI), the depth to groundwater at the Site ranges from approximately 13 to 19 feet bgs.

3.0 PREVIOUS INVESTIGATIONS

Presented in this section are summaries of the prior reports associated with the Site, which include a Phase I Environmental Site Assessment (ESA) Report prepared by TRC in 2011, a Phase II ESI Report prepared by TRC in 2013, a Letter Report prepared by TRC in July 2017 which describes the inspection services performed during the completion of a Phase IB Archeological Investigation, an Interim Remedial Measure (IRM) Work Plan prepared by TRC in September 2017, and an IRM Construction Completion Report (CCR) prepared by TRC in January 2018.

3.1 Phase I Environmental Site Assessment (ESA), May 2011

A Phase I ESA for Block 1003, Lot 11 (the Site) and the adjacent lot (Block 1003, Lot 59) was completed by TRC in 2011 on behalf of the NYCSCA. The Phase I ESA identified the following on-Site recognized environmental conditions (RECs) for Block 1003, Lot 11: the potential presence of buried structures from former on-site structures and fill material from unknown sources; and the historic use of the Site as an ink manufacturer, a storage facility with a gauge manufacturer, a machine works facility, a plumbing supply/metal products manufacturer, a garage with a gasoline station, a chemical laboratory, and a textile factory[1]. Off-site RECs identified included the historic and current use of nearby properties for manufacturing, factories, a printing facility, automobile repair facilities, garages with gasoline tanks, a fuel oil company, an undertaker, dry cleaning/laundry facilities, a tire shop, and a filling station. Additionally, nearby sites with the potential to impact the Site are listed in environmental regulatory agency databases for generation of hazardous waste and petroleum bulk storage. The Phase I ESA additionally identified environmental concerns including potential asbestos-containing material (ACM), lead-based paint (LBP), and polychlorinated biphenyl (PCB)-containing materials in buried structures and debris associated with former structures on the Site.

Based on the results of the Phase I ESA, TRC recommended performing a Phase II ESI to determine whether the identified RECs affected the suitability of the Site for the construction of a Pre-Kindergarten Facility. Environmental sampling was subsequently completed by TRC and is described below.

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[1] Note that certain information regarding the Site history was determined after completion of the Phase I ESA and has been incorporated into the description of on-Site RECs.

3.2 Phase II Environmental Site Investigation (ESI), March 2013

A Phase II ESI Report for Block 1003, Lot 11 was prepared by TRC in March 2013 on behalf of the NYCSCA to assess the RECs identified in the Phase I ESA. The following field activities were completed as part of the Phase II ESI:

- Geophysical surveys to verify that the proposed boring locations were clear of subsurface utilities and structures, and to identify potential buried structures in accessible areas of the Site;
- Advancement of twelve (12) soil borings; continuous soil sampling to a maximum depth of 20 feet bgs; and, laboratory analysis of discrete soil and groundwater samples.
- Installation of seven (7) soil vapor probes, and collection and laboratory analysis of a soil vapor sample from each vapor probe; and,
- Collection and analysis of one (1) ambient air sample.

Since the Site was rumored to be a potential burial ground for Revolutionary War soldiers, an archeologist from AKRF Engineering, PC (AKRF) was on-Site to screen the soils recovered from the soil borings. A Phase IB Archeological Investigation was subsequently completed in June 2017 (refer to Section 3.3).

The results of the geophysical surveys did not reveal evidence of utilities or buried structures in the vicinity of the soil borings. Although there were no underground storage tanks identified during the geophysical surveys due to a reinforced concrete slab covering the Site, subsequent trenches were advanced during implementation of the archeological investigation and three underground storage tanks (USTs) were identified (refer to Section 3.3). Fill material was identified to a depth of approximately 10 feet bgs and native material was observed below the fill material to 20 feet bgs. Groundwater was encountered at the Site at depths ranging from approximately 13 to 19 feet bgs.

Visual and olfactory indications of contamination were observed in one soil boring (TRC-SB6) at a discrete interval from 19 to 20 feet bgs, which is below the depth at which groundwater was encountered (i.e., a saturated soil sample). The VOCs naphthalene and 1,2,4-trimethylbenzene were detected in the soil sample selected for laboratory analysis from this interval (TRC-SB6 (19-20)) at concentrations slightly above the 6 New York Codes, Rules, and Regulations (NYCRR) Part 375 Unrestricted Use Soil Cleanup Objectives (SCOs) and Protection of Groundwater SCOs. The VOCs detected in the soil sample at concentrations slightly exceeding regulatory criteria were attributed to a discrete area of potential petroleum contamination identified in this soil interval.

Naphthalene and 1,2,4-trimethylbenzene were not detected in the groundwater sample collected at this location (TRC-GW6). Evidence of contamination was not identified in any other recovered soil samples. Mercury and nickel were detected in one soil sample (TRC-SB1 (1-4) at concentrations above the Restricted-Residential Use SCOs and chromium was detected in one soil sample (TRC-SB9 (1-4)) at a concentration above the Restricted-Residential Use SCO. The detected metal concentrations in soil were attributed to the characteristics of fill material encountered at the Site. A summary of the results of the analyses of the soil samples which exceed Unrestricted Use SCOs and Restricted-Residential Use SCOs is shown on *Figure 3.*

Two (2) VOCs were detected at concentrations exceeding the New York State Class GA Groundwater Standards (Class GA Values). Trichloroethene (TCE) was detected above the Class GA Value of 5 micrograms per liter (µg/L) in TRC-MW12 (at 99 µg/L), TRC-MW13 (at 34 µg/L) and TRC-GW1 (at 9.3 µg/L), and cis-1,2-dichloroethene (cis-1,2-DCE) was detected above the Class GA Value of 5 µg/L in TRC-MW12 (at 11 µg/L) and TRC-MW13 (at 18 µg/L). TRC-MW13 and TRC-GW1 were collected in the northern part of the Site. TRC-MW12 was collected below the 8th Street sidewalk immediately north of the Site. The VOCs detected in groundwater were attributed to former on-site activities or to a historic release from a former dry cleaner northwest of the Site at the southeast corner of 8th Street and 3rd Avenue. Naturally occurring metals (magnesium, manganese, and sodium) were also detected in filtered groundwater samples at concentrations exceeding the groundwater quality standards. The elevated concentrations of metals in filtered groundwater samples were attributed to the characteristics of Site soils. Additionally, if dewatering is required during construction, treatment of dewatering effluent will likely be required prior to discharge to the sewer system due to elevated concentrations of total suspended solids and TCE. *Figure 4* shows the groundwater sampling results greater than Class GA Values.

The seven soil vapor samples collected at the Site were analyzed for VOCs. The laboratory results identified the presence of several petroleum and chlorinated-solvent related VOCs at elevated concentrations (compared to typical background concentrations) in soil vapor, most notably at soil vapor sample locations TRC-SG1, TRC-SG2, and TRC-SG9 collected in the northern portion of the Site. Specifically, TCE was detected at a maximum concentration of 16,000 micrograms per cubic meter (µg/m^3) in TRC-SG1, cis-1,2-DCE was detected at a maximum concentration of 110 µg/m^3 in TRC-SG9, and tetrachloroethene (PCE) was detected at a maximum concentration of 940 µg/m^3 in TRC-SG1. Additionally, petroleum-related compounds including toluene, ethylbenzene, and xylenes were detected in soil vapor sample TRC-SG1 each at a concentration over 1,000 µg/m^3. Based on the concentrations of chlorinated volatile organic compounds (CVOCs) detected, mitigation would be the recommended action based on comparison of the soil vapor results to the NYSDOH Vapor Intrusion Matrices, if the results are considered representative of sub-slab vapor concentrations which would exist after construction of a building. VOCs were not detected in the ambient air sample at concentrations exceeding the NYSDOH Air Guideline Values (AGVs) or published background levels. *Figure 5* shows a comparison of the soil vapor sampling results to the NYSDOH Vapor Intrusion Matrices.

Based on the nature and extent of contaminants in soil vapor and groundwater, a formal agreement between the NYCSCA and the NYSDEC (i.e., Brownfield Cleanup Agreement) was recommended, if the NYCSCA decided to acquire the Site. Additionally, TRC recommended characterizing soil excavated during development of the Site to identify appropriate material disposal requirements and ensure management of excavated soil in accordance with applicable federal, state, and local laws and regulations. TRC also recommended that any exposed soil be covered with a minimum 2-foot thick layer of environmentally clean fill and if dewatering would be necessary during school construction activities, it would be likely that treatment of dewatering effluent would be required prior to discharge to the municipal sewer. Furthermore, integration of a soil vapor barrier and sub-slab depressurization system into the building design was recommended. Finally, TRC recommended identifying and properly managing suspect ACM, LBP, or PCBs in buried structures during Site redevelopment in accordance with all applicable regulations and NYCSCA policies and procedures. Note that during the pre-purchase due diligence period, environmental data generated by the NYCSCA was transmitted to the previous property owner.

3.3 Letter Report for Inspection Services during Phase IB Archeological Investigation, July 2017

In July 2017, TRC prepared a letter report titled "Inspection Services during Phase IB Archeological Investigation" for NYCSCA. The letter report summarizes the results of periodic inspection services completed by TRC in June 2017 on behalf of NYCSCA's Industrial and Environmental Hygiene Division during the implementation of a Phase IB Archeological Investigation implemented at the Site by AKRF. An environmental contractor, Brookside Environmental, Inc. (Brookside), was retained as a subcontractor by AKRF for excavation services. An excavator was utilized to complete eight (8) trenches to a maximum depth of 10 feet bgs. TRC was on-Site to screen soils for evidence of contamination. The approximate locations of the eight (8) trenches excavated during the Phase IB Archeological Investigation are shown on *Figure 6*.

AKRF identified items of potential archeological significance (i.e., cistern and hand-dug well) in Trench 5 and recommended the completion of a Phase 2 Archeological Evaluation.

A Phase 2 Archaeological Evaluation was completed by AKRF in September 2017 to further investigate the items of potential archeological significance. A Community Air Monitoring Plan (CAMP) was implemented during the Phase 2 Archaeological Evaluation. An additional item of potential archaeological significance (i.e., a privy) was identified. Based on the findings of the Phase 2 Archaeological Evaluation, with the exception of the privy, additional cultural resources were not identified and further archeological investigation is not required.

The subsurface excavations confirmed the presence of at least three USTs at the Site; one concrete encased UST on the southeastern portion of the Site and two steel USTs on the southern portion of the Site. The three USTs are each approximately 550-gallons in capacity, formerly contained gasoline, and are inactive. Additional investigation is required to confirm the dimensions and contents of each tank, and to determine if the tanks have leaked; and it is anticipated that the tanks will be further investigated, closed, and removed as part of the remedial actions for the Site. The three USTs were registered under PBS Facility ID No. 2-612781 following NYCSCA acquisition of the Site.

The inspections performed by TRC during the archaeological investigations revealed elevated photoionization detector (PID) readings and visual and olfactory indications of potential contamination in soil excavated from 7.5 to 8 feet bgs in the vicinity of a drainage feature and subsurface piping identified in Trench 2, located in the northern part of the Site. In addition, elevated PID readings were observed in soil excavated from Trench 2 from approximately 3.5 to 4 feet bgs; however, visual and olfactory indications of potential contamination were not identified at this depth interval. No other visual or olfactory indications of potential contamination or elevated PID readings were observed in the excavated soil from the remaining trenches. Three samples of soil excavated from Trench 2 were submitted for laboratory analysis for United States Environmental Protection Agency (USEPA) Target Compound List (TCL)/NYSDEC Commissioner Policy 51 Tables 2 and 3 (CP-51) VOCs. The locations of the three samples of soil excavated from Trench 2 are shown on *Figure 3.* TCE was detected in one soil sample (TRC-TR-2 [3.5-4]) at a concentration above the Unrestricted Use SCO and the Protection of Groundwater SCO (refer to *Figure 3)*. The concentration of TCE detected in the soil excavated from Trench 2 is attributable to former Site uses and is suspected to be associated with the former drainage system identified in Trench 2. Additional investigation of the drainage system and associated piping in Trench 2 and piping in Trenches 1 and 3 identified during the archeological investigation was recommend by TRC.

3.4 Interim Remedial Measure Work Plan, September 2017

In September 2017, TRC prepared an IRM Work Plan to further investigate and remove subsurface material initially encountered during the archeological investigation and suspected to be the likely source of CVOCs in soil, groundwater, and soil vapor in the northern portion of the Site. Specifically, the IRM Work Plan scope included investigation and removal of the observed drainage feature located on the northeastern portion of the Site (in Trench 2), subsurface piping and drainage features northwest of Trench 2, subsurface piping southwest of Trench 2, and impacted soil encountered. Note that the IRM Work Plan scope included investigation and excavation in areas beyond the limits of Trench 2, including previously unexcavated areas. The IRM Work Plan was submitted to NYSDEC on September 26, 2017. An email was received from NYSDEC on October 16, 2017 indicating that NYSDEC had no objection to the IRM Work Plan. However, NYSDEC indicated that the IRM would be completed outside of the BCP.

3.5 Interim Remedial Measure Construction Completion Report, January 2018

In January 2018, TRC prepared an IRM Construction Completion Report (CCR), which described the results of the IRM completed in accordance with the September 26, 2017 IRM Work Plan. IRM field activities were completed between October 30, 2017 and November 6, 2017. The IRM consisted of soil excavation in the northern portion of the Site (over an approximately 48 feet wide by 44 feet long area to a maximum depth of 19 feet bgs) and removal of subsurface structures (including cast-iron and lead piping, brick walls, and drains); collection of eight (8) post-excavation soil samples and three (3) documentation soil samples[2] for analysis for VOCs; off-Site transportation of approximately 354 tons of impacted soil and crushed scrap metal (subsurface piping) for disposal; and backfilling of the excavation with excavated soil which was free of impacts and clean fill material (sand) which met the Restricted-Residential Use requirements for imported fill material found in Appendix 5 of DER-10. A demarcation layer (i.e., plastic orange fencing) was placed between Site soil and imported material and the ground surface was restored with two feet of virgin bluestone.

The most impacted interval of soil (exhibiting odors, and a maximum PID reading of 608.5 ppm) was encountered in the southeastern portion of the excavation from approximately 6 to 7 feet bgs, approximately 3 feet below the nearest subsurface piping. The soil inside the piping and in the immediate vicinity of the nearest subsurface piping did not exhibit evidence of contamination, and an exact point of a release could not be determined. Free product was not observed in the excavation. Soil at the deepest part of the excavation was saturated; however, groundwater did

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[2] The documentation soil samples were samples of soil that were later removed.

not accumulate in the excavation. There were no VOCs detected at concentrations above the Restricted-Residential Use SCOs in the post-excavation and documentation soil samples. The approximate area of the IRM excavation is shown on *Figure 6.*

Based on the results of the IRM, subsurface material that was likely the primary source of CVOCs in soil, groundwater, and soil vapor in the northern portion of the Site was substantially removed and disposed of off-Site.

4.0 REMEDIAL INVESTIGATION OBJECTIVES AND METHODS

This section of the Work Plan presents the objectives and methods for the proposed additional investigation for the Site, and follows the guidance for an investigative work plan in NYSDEC DER-10, Technical Guidance for Site Investigation and Remediation. The Work Plan has been prepared in consideration of the Site history and findings of previous investigations (refer to Sections 2.0 and 3.0).

4.1 Objectives

The principal objectives of the RI are to complete the characterization of soil, groundwater, and soil vapor at the Site and confirm groundwater flow direction. The data obtained during the implementation of the RI will be utilized for remedial action decisions.

The three USTs identified during the archeological investigation will be further investigated as part of the RI and removed as part of the remedial action. The USTs are located in the footprint of the proposed school building and removal activities will be performed during the excavation for construction of the new school building. To investigate and delineate the extent of petroleum impacts, if any, associated with the USTs, TRC will characterize soil in the vicinity of the USTs as described below.

4.2 Scope of Investigation

The scope of the planned field investigation activities has been organized into the following tasks:

- Task 1 – Utility Clearance
- Task 2 – Soil Sampling
- Task 3 – Monitoring Well Installation and Development and Groundwater Sampling
- Task 4 – Soil Vapor Sampling
- Task 5 – Sample Location Survey
- Task 6 – Management of Investigation Derived Waste

Additionally, quality control and quality assurance procedures are summarized in the following task:

- Task 7 – Quality Assurance/Quality Control (QA/QC) Data Evaluation

The site-specific sampling techniques and analytical methods to be used in implementing the RI are presented in the Quality Assurance Project Plan (QAPP) in *Appendix A*. The investigation activities will be performed in accordance with the CAMP and the Odor Monitoring and Mitigation Plan in *Appendix B* and the site-specific Health and Safety Plan (HASP) in *Appendix C*.

4.3 Task 1 – Utility Clearance

Required New York One Call notifications will be made at least three days prior to intrusive work, and the locations of underground utility lines in public roads and rights-of-way will be marked out. Note that a geophysical survey of the Site was completed during prior investigations (i.e., Phase II ESI). Since the exact dimensions of the USTs have not been determined, the UST series soil borings will be hand cleared to at least six (6) feet bgs.

4.4 Task 2 - Soil Sampling

TRC will advance 14 soil borings (TRC-SB-101 through TRC-SB-106 and TRC-UST-1 through TRC-UST-8). Please refer to *Figure 6* for the proposed boring locations. The soil sampling program will include the following:

- A truck or track-mounted hollow-stem auger drill rig will be used to advance 4- or 5-foot long 2-inch diameter macrocore samplers lined with acetate sleeves to collect soil samples. Soil samples will be collected continuously to a depth of approximately ten (10) feet below the groundwater surface. Since groundwater is expected to be encountered at depths ranging between 13 and 19 feet bgs, it is expected that the soil borings will be advanced to approximately 23 to 29 feet bgs. Soil borings TRC-SB-101 through TRC-SB-106 and TRC-UST-7 will each be converted to permanent monitoring wells as discussed further below.
- Soil samples collected from each boring will be screened with a PID and inspected for indications of contamination (e.g., staining, odors, etc.). Geologic descriptions of the soil and field screening results will be recorded in field logs.
- Soil samples from TRC-SB-101 through TRC-SB-106 will be selected for laboratory analysis based on the following rationale:
    - If no apparent impacted soils are identified, soil samples from the interval directly above the groundwater table will be selected for laboratory analysis.
    - If impacted soils are identified, one soil sample will be selected from the most impacted zone (based on field screening), one soil sample will be selected from the first underlying apparent clean interval, and a third soil sample will be selected from the interval directly above the groundwater table. If no apparent underlying clean interval

is observed, the second soil sample submitted for analysis will be the sample collected from the deepest interval of the boring (i.e., below the water table).

- Soil samples collected from TRC-UST-1 through TRC-UST-8 will be selected for laboratory analysis based on the following rationale:
    - If no apparent impacted soils are identified, one (1) sample collected from approximately 1 to 3 feet below the invert of each UST (approximately 11 to 13 feet bgs from borings TRC-UST-1 through TRC-UST-4 and approximately 9 to 11 feet bgs from borings TRC-UST-5 through TRC-UST-8) will be selected for analysis.
    - If impacted soils are identified, one soil sample will be selected from the most impacted zone (based on field screening) and one (1) soil sample from the first underlying apparent clean interval encountered will be selected. If no apparent underlying clean interval is observed, the second soil sample selected will be from the two-foot interval directly above the groundwater table.
- Soil samples from TRC-SB-101 through TRC-SB-106 and TRC-UST-1 through TRC-UST-8 will be analyzed for Target Compound List (TCL) and NYSDEC CP-51-listed VOCs plus the 10 highest concentration tentatively identified compounds (TICs)[3] will be reported, TCL and CP-51-listed semivolatile organic compounds (SVOCs) plus the 20 highest concentration TICs will be reported[4], TAL metals and cyanide, TCL pesticides, TCL herbicides, and PCBs. Additionally, shallow soil samples (from 1 to 4 feet bgs) from borings TRC-SB-101, TRC-SB-102, TRC-SB-104 and TRC-SB-105, on the northern portion of the Site, will be analyzed for TAL metals.
- Duplicate and equipment blank samples will be collected at a frequency of 1 per 20 soil samples and analyzed for TCL and NYSDEC CP-51-listed VOCs plus the 10 highest concentration TICs will be reported, TCL and CP-51-listed SVOCs plus the 20 highest concentration TICs will be reported, TAL metals and cyanide, TCL pesticides, TCL herbicides, and PCBs.
- Soil samples will be containerized in laboratory prepared jars, labeled, sealed, and placed in a chilled cooler for shipment to a NYSDOH Environmental Laboratory Approval

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[3] Results of analyses for VOCs will include all TCL VOCs and CP-51-listed VOCs. Included on the TCL and CP-51 list are the 6 NYCRR Part 375-listed VOCs.

[4] Results of analyses for SVOCs will include all TCL SVOCs and CP-51-listed SVOCs. Included on the TCL and CP-51 list are the 6 NYCRR Part 375-listed SVOCs.

Program (ELAP)-certified laboratory for analysis. NYSDEC Analytical Services Protocol (ASP) Category B deliverable packages will be provided.

4.5 Task 3 – Monitoring Well Installation and Development and Groundwater Sampling

The work under this task includes the installation, development and sampling of seven (7) permanent monitoring wells to assess groundwater conditions at the Site (refer to *Figure 6* for proposed monitoring well locations).

Groundwater monitoring well installation and sampling will include the following:

- Soil borings TRC-SB-101 through TRC-SB-106 will be converted to permanent monitoring wells TRC-MW-101 through TRC-MW-106 as described further below. Additionally, soil boring TRC-UST-7 will be converted to a permanent monitoring well, TRC-MW-107.
- Monitoring wells will be installed to approximately 10 feet below the observed water table. Each monitoring well will be constructed using 4-inch diameter polyvinyl chloride (PVC) monitoring well riser and screen. Each well will be screened from approximately 5 feet above the observed water table to 10 feet below the observed water table.
- Clean silica sand, Morie No. 1, or similar, will be placed in the annular space around each groundwater monitoring well to a minimum of one foot above the top of the well screen, two feet being optimal. A two-foot bentonite seal will be placed above the sand pack. The monitoring wells will be completed with a flush-mounted outer protective casing.
- Well construction diagrams will be prepared for each well.
- Following installation, the groundwater monitoring wells will be developed using backwashing or mechanical surging methods until five well volumes are removed and the water is reasonably free of turbidity and field parameter readings (temperature, conductivity, oxidation reduction potential (ORP), pH, and dissolved oxygen [DO]) sufficiently stabilize. During well development, TRC will actively monitor and track the volume of water purged and the field parameter readings. Field measurements will be recorded in a field logbook. Fifty nephelometric turbidity units (NTUs) or less will be the turbidity goal, but not an absolute value. The groundwater monitoring wells will be allowed to equilibrate for one week prior to sampling.

- On the day of groundwater sampling and prior to initiation of sampling activities, a synoptic round of water level measurements will be collected and each well will be gauged for non-aqueous phase liquid. Additionally, a headspace reading will be collected, using a PID, from each monitoring well location.
- Although not anticipated, if light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) is encountered, groundwater from that well will not be analyzed.
- Prior to sampling, groundwater will be purged until a minimum of three well volumes have been removed and field parameters have stabilized in accordance with USEPA Low-Stress (Low-Flow) sampling procedures. A turbidity level of 50 NTUs or less is the well purging goal. Other field parameters including temperature, conductivity, ORP, pH, and DO will also be monitored and, prior to sampling, field parameters should generally be within ±10% for three consecutive readings, three to five minutes apart. Ideally, pumping rates will be maintained between 100 and 500 milliliters per minute (ml/min) so that no drawdown of the groundwater level occurs (i.e., pumping rate is less than recharge rate). During purging, TRC will actively monitor and track the volume of water purged and the field parameter readings. Field measurements will be recorded in a field logbook. Once groundwater conditions have stabilized and groundwater levels have recovered, the samples will be collected.
- Groundwater samples collected from TRC-MW-101 through TRC-MW-107 will be analyzed for TCL and CP-51-listed VOCs plus TICs, TCL and CP-51-listed SVOCs plus TICs, TAL metals (field filtered and unfiltered), total cyanide, PCBs, TCL pesticides, TCL herbicides, and natural attenuation parameters including alkalinity, sulfate, total organic carbon and total kjeldahl nitrogen (TKN). Additionally, the groundwater samples collected from TRC-MW-101 through MW-105 will be analyzed for 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS)[5].
- One duplicate and one equipment blank sample (from a well on the northern portion of the Site (e.g., TRC-MW-101 through TRC-MW-105)) will be collected for analysis for TCL and CP-51-listed VOCs plus TICs, TCL and CP-51-listed SVOCs plus TICs, TAL metals (field filtered and unfiltered), total cyanide, PCBs, TCL pesticides, TCL herbicides, natural attenuation parameters (including alkalinity, sulfate, total organic carbon and total kjeldahl

---

[5] Refer to the QAPP (Appendix A) for the PFAS to be reported.

nitrogen (TKN)), 1,4-dioxane and PFAS. Additionally, one (1) trip blank sample will be analyzed for TCL and CP-51-listed VOCs plus TICs.

- Groundwater samples will be containerized in laboratory supplied jars, labeled, sealed, and placed in a chilled cooler for shipment to the laboratory. Groundwater samples will be analyzed by an ELAP-certified laboratory approved by the NYSDOH and NYSDEC ASP Category B deliverable packages will be provided.

4.6 Task 4 - Soil Vapor Sampling

This task includes the collection of soil vapor samples to determine the concentrations of VOCs in soil vapor. Eight (8) soil vapor samples (TRC-SV-101 through TRC-SV-105 and TRC-SV-108 through TRC-SV-110) will be collected at the locations shown on Figure 6.

Soil vapor sampling will be conducted in accordance with the NYSDOH “Guidance for Evaluating Soil Vapor Intrusion in the State of New York” and ASTM International (ASTM) Standard E 2600-10.

The soil vapor samples will be collected using a direct-drive rig (i.e., Geoprobe) or hollow-stem auger rig that utilizes drive rods to advance the stainless steel probe to the desired sample depth. Soil vapor samples will be generally collected at a depth of approximately five (5) feet bgs. The adequacy of each seal will be tested in accordance with the NYSDOH-approved method for vapor sampling using a 5-gallon bucket or cardboard box placed over the soil vapor sampling point and sealed from the ambient air using bentonite. Helium tracer gas will then pumped into the bucket. The above grade end of the tubing, which is the sample collection point, will then be attached to a helium gas detector. The adequacy of the seal will be verified by direct helium readings of less than 10 percent.

The temporary soil vapor probes will be purged using a PID to evacuate one to three volumes of soil vapor. The concentrations of ionizable vapors measured with the PID will be recorded. After purging, each probe will be connected via Teflon tubing to a laboratory-supplied individually certified clean 6-liter SUMMA canister and a 1-hour flow controller.

After sample collection, the soil vapor samples will be shipped overnight to an ELAP-certified laboratory for analysis of VOCs by USEPA Method TO-15. Method TO-15 will provide detection limits of 0.20 $\mu g/m^3$ for carbon tetrachloride, cis-1,2-DCE, 1,1-dichloroethene, TCE, and vinyl chloride allowing for comparison with the lowest action levels for these compounds in the NYSDOH “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York”. The detection limit for all other compounds will be 1 $\mu g/m^3$. The soil vapor samples will be analyzed for the 26 VOCs listed in the QAPP (refer to *Appendix A).* NYSDEC ASP Category B deliverable packages will be provided.

Following sampling, soil vapor probes will be removed and the ground surface will be restored (i.e., patched with concrete).

4.7 Task 5 – Sample Location Survey

The coordinates and elevations of the top of the casing of each permanent monitoring well and the adjacent ground surface will be surveyed to determine water table elevations and groundwater gradient. The survey will be performed by a land surveyor licensed to practice in the State of New York. Additionally, ground surface elevations in the vicinity of the 2012 and 2013 sampling locations will be surveyed to aid in preparation of geologic cross-sections.

4.8 Task 6 – Management of Investigation Derived Waste

Investigation derived waste (IDW) is anticipated to include the following: decontamination fluids and well purge and development water, and soil cuttings. IDW will be containerized in New York State Department of Transportation-approved 55-gallon drums for off-site disposal. Used personal protective equipment (PPE) and disposable sampling equipment will be bagged as regular refuse and disposed as solid waste, unless grossly contaminated.

4.9 Task 7 – Quality Assurance /Quality Control (QA/QC)

A QA/QC program for the RI will be instituted to verify that the project analytical data objectives were met. The QA/QC program will be implemented consistent with the QAPP, which specifies the data quality objectives (DQOs) for each analytical parameter for the entire investigation. During the program, the collection of QC samples will be monitored to verify that the field QC samples are collected at the proper frequency. Finally, the QA/QC program will include data validation for analytical data generated during this RI, as specified in the QAPP (refer to *Appendix A).*

The results of the data validation will be summarized in Data Usability Summary Reports (DUSRs). Note that, with the exception of the three soil samples collected in June 2017 from Trench 2 during the archeological investigation, data validation will not be performed on historic analytical data samples collected prior to implementation of the RI.

5.0 PROJECT PERSONNEL

Key project personnel and contact information are identified in the table below. Resumes of key TRC project personnel are in *Appendix D*.

Key Personnel and Contact Information

Name	Role	Phone Number
Lee Guterman, NYCSCA	NYCSCA, IEH Division	(718)-472-8502
Bob Kanaparthi, NYCSCA	NYCSCA, IEH Division	(718) 472-8620
Michael Sherwood, NYCSCA	NYCSCA, IEH Division	(718) 752-5211 cellular: (914) 400-5205
David Glass, TRC	TRC Vice President	(212) 221-7822, ext. 112
Jennifer Miranda, TRC	TRC Principal Scientist/Office Practice Leader	(212) 221-7822, ext. 102 cellular: (646) 285-8990
Lindsay O'Hara, TRC	TRC Project Manager	(203) 278-5305 cellular: (914) 420-9649
Wes Lindemuth, TRC	TRC Office Safety Coordinator	(212) 221-7822, ext. 103 cellular: (347) 738-1452
Daniel Schmidt, TRC	TRC Project Engineer	(212) 221-7822, ext. 115 cellular: (347) 213-0470
Sanjay Sharma, TRC	TRC Project Geologist	(212) 221-7822 cellular: (631) 645-1314
Elizabeth Denly, TRC	TRC Quality Assurance Officer	(978) 970-5600
William Poupis, Cascade Drilling	Drilling Services	(516) 616-6026
Jannel Franklin, TestAmerica	Laboratory Services	(732) 593-2551
Karolina Borowski, Perfect Point	Land Surveying Services	(718) 474-7700

6.0 REPORTING

A comprehensive Remedial Investigation Report (RI Report) will be prepared after receipt of surveying and laboratory data. The RI Report will conform to the guidelines set forth in NYSDEC DER-10 Sections 3.14 (Remedial Investigation Report) to the extent consistent with the scope of the investigation described above and to the extent necessary and applicable. The RI Report will include the following:

- Summaries of historic data and the results of prior investigations;
- A description of the scope of the Remedial Investigation;
- Descriptions of investigation methods;
- Scaled Site plan showing sampling locations;
- Field sample screening data and documentation (logs, chain-of-custody forms, etc.);
- Results of analyses of samples, including laboratory data packages, and a discussion of the findings;
- Data Usability Summary Reports;
- Map summarizing the results of the sampling, showing locations of and highlighting exceedances of relevant regulatory standards, criteria, and guidance;
- Groundwater surface elevation contour map showing apparent gradients and inferred predominant local groundwater flow directions;
- Geologic cross sections;
- A Fish and Wildlife Analysis;
- Qualitative Human Health Exposure Assessment and Conceptual Site Model; and,
- An analysis and discussion with a supporting drawing showing the estimated overall extent of contamination, if appropriate.

7.0 SCHEDULE

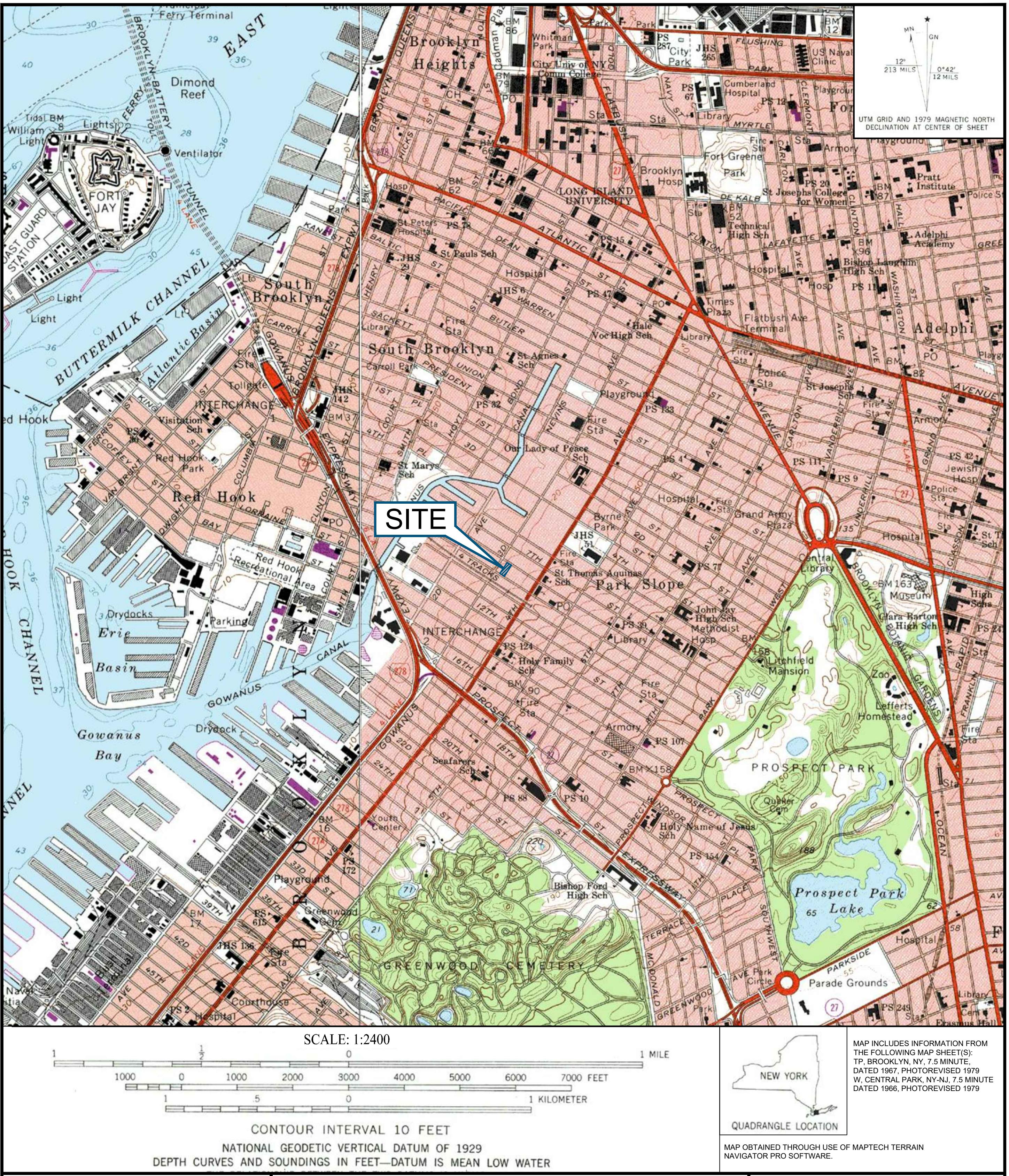
It is anticipated that the RI Work Plan will be implemented following the execution of the Brownfield Cleanup Agreement (BCA) and NYSDEC approval of the RI Work Plan. Presented below are estimated completion dates for key milestones associated with implementation of the Remedial Investigation.

KEY MILESTONE	ESTIMATED TIME TO COMPLETION IN CALENDAR DAYS FROM EXECUTION OF THE BCA
Execution of the BCA and NYSDEC Approval of RI Work Plan	0
Begin Remedial Investigation Field Activities	14
Complete Remedial Investigation (including laboratory analyses)	45
Submit Remedial Investigation Report to NYSDEC	90

8.0 REFERENCES

1. 6 NYCRR 375: New York State Department of Environmental Conservation Rules and Regulations, Remedial Program Requirements.
2. 6 NYCRR 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations.
3. ASTM E 2600-10 "Standard Guide for Vapor Encroachment Screening on Property Involved in Real Estate Transactions."
4. New York State Department of Environmental Conservation (NYSDEC) Division of Environmental Remediation (DER)-10, Technical Guidance for Site Investigation and Remediation, May 2010.
5. New York State Department of Health, "Guidance for Evaluating Soil Vapor Intrusion in the State of New York", October 2006, as amended.
6. TRC Engineers, Inc., *Phase I Environmental Site Assessment of Proposed Public School, 168 8th Street and 203 9th Street, Block 1003, Lots 11 and 59; Brooklyn, New York 11215,* May 27, 2011.
7. TRC Engineers, Inc., *Phase II Environmental Site Investigation Report of Proposed Public School, 168 8th Street, Block 1003, Lot 11, Brooklyn, New York 11215,* March 14, 2013.
8. TRC Engineers, Inc., *Letter Report - Inspection Services during Phase IB Archaeological Investigation, 168 8th Street, Block 1003, Lot 11, Brooklyn, New York 11215,* July 31, 2017.
9. TRC Engineers, Inc., *Interim Remedial Measure Work Plan, 168 8th Street, Block 1003, Lot 11; Brooklyn, New York 11215,* September 25, 2017.
10. TRC Engineers, Inc., *Interim Remedial Measure Construction Completion Report, 168 8th Street, Block 1003, Lot 11; Brooklyn, New York 11215,* January 12, 2018.

FIGURES



MAP INCLUDES INFORMATION FROM THE FOLLOWING MAP SHEET(S):
TP, BROOKLYN, NY, 7.5 MINUTE, DATED 1967, PHOTOREVISED 1979
W, CENTRAL PARK, NY-NJ, 7.5 MINUTE DATED 1966, PHOTOREVISED 1979

MAP OBTAINED THROUGH USE OF MAPTECH TERRAIN NAVIGATOR PRO SOFTWARE.

TRC

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New York, NY 10018
Phone: 212.221.7822

PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

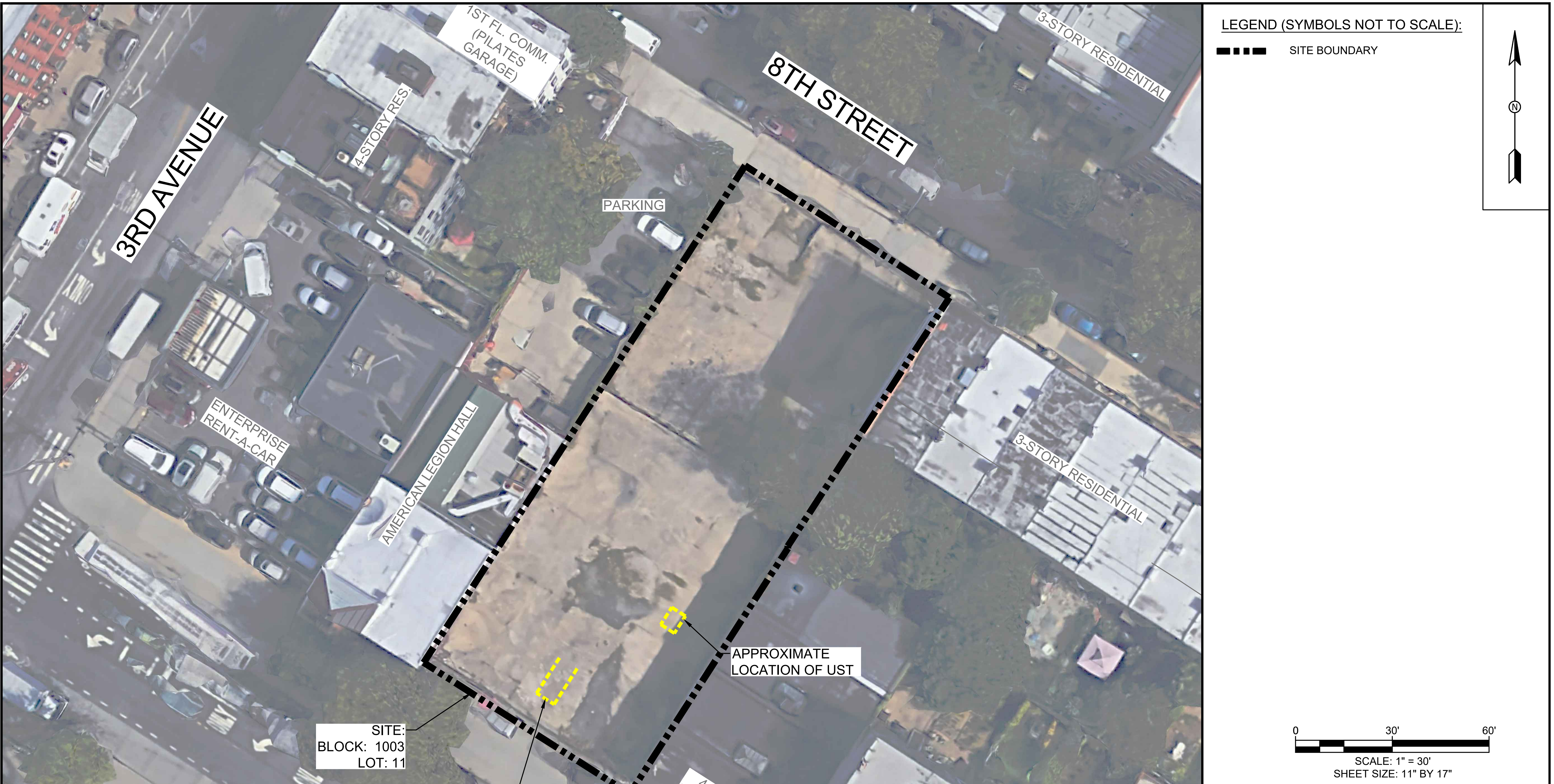
TITLE:

SITE LOCATION MAP

DRAWN BY:	H. DELGADO
CHECKED BY:	L. O'HARA
APPROVED BY:	J. MIRANDA
DATE:	APRIL 2018
PROJ. NO.:	287821.0000.0000
FILE:	Figure 1 - Site Location Map.dwg

FIGURE 1

8.5x11 --- ATTACHED XREF'S: --- ATTACHED IMAGES: 197-203 9th street_01; 197-203 9th street_02;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 1 - Site Location Map.dwg --- PLOT DATE: April 02, 2018 - 12:26PM --- LAYOUT: 8.5x11P



NOTES:

1. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.

PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

TITLE:

SITE PLAN

DRAWN BY:	H. DELGADO	PROJ NO.:	287821.0000.0000
CHECKED BY:	L. O'HARA	**FIGURE 2**	
APPROVED BY:	J. MIRANDA		
DATE:	APRIL 2018		

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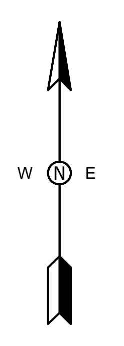
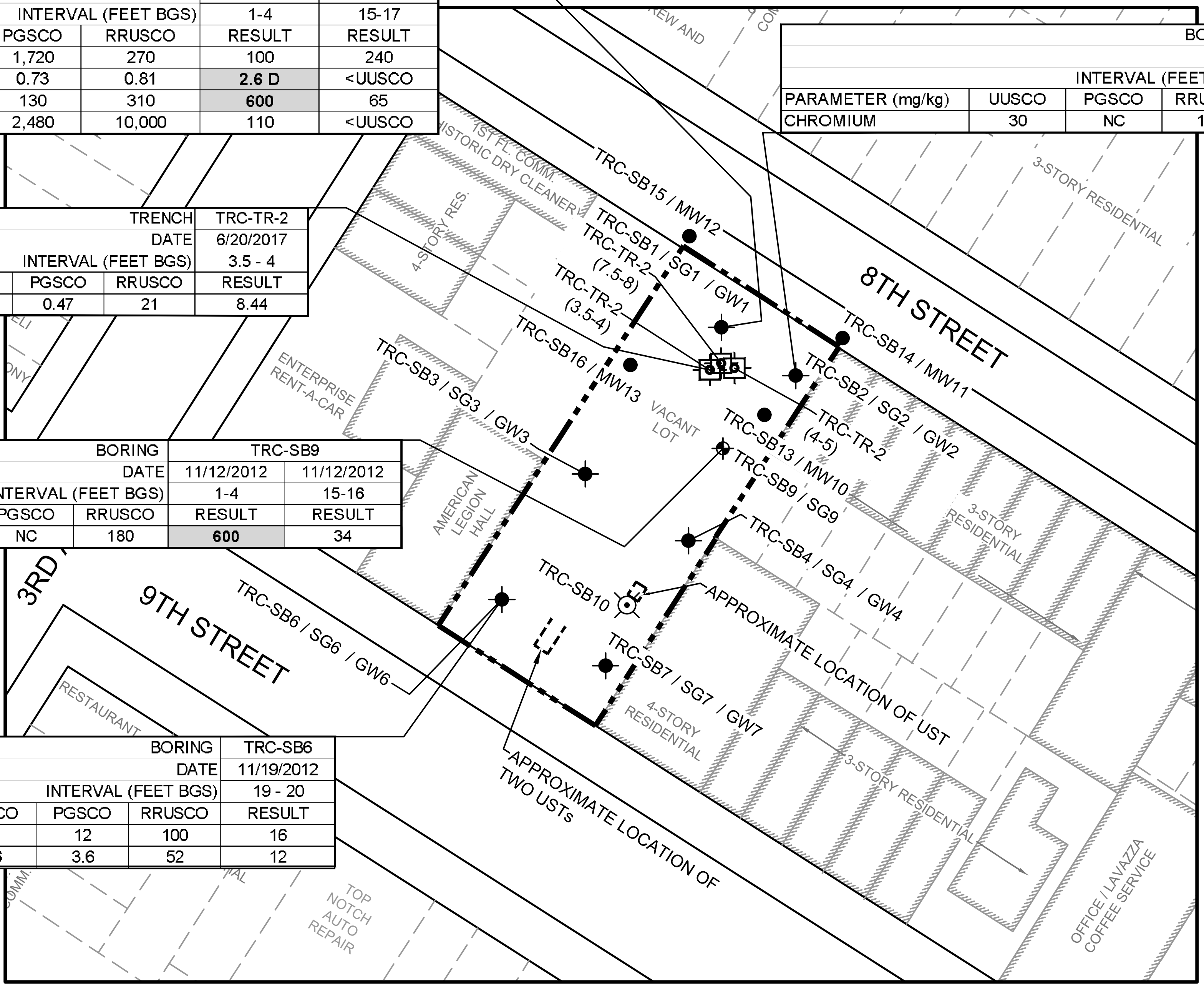
FILE NO.: Figure 2 - Site Plan.dwg

11x17 --- ATTACHED XREF'S: Brooklyn --- ATTACHED IMAGES: 051593; 168 8TH STREET - GEPRO-600FT color; 168 8TH STREET - GEPRO-600FT color; 197-203 9th Street map_image; Arch Assessment Testing Location; Fig2 - AKRF Site Plan with Trench locations;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 2 - Site Plan.dwg --- PLOT DATE: April 02, 2018 - 12:27PM --- LAYOUT: 11X17L

LEGEND (SYMBOL NOT TO SCALE):

▬ ▪ ▬	SITE BOUNDARY
▨	BUILDING FOOTPRINT
- - - - -	LOT BOUNDARY
⊗ TRC-SBX	SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
⊕ TRC-SBX / SGX	SOIL SAMPLING AND SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
⊕ TRC-SBX / SGX / GWX	SOIL SAMPLING, SOIL VAPOR SAMPLING, AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
● TRC-SBX / MWX	SOIL SAMPLING AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN JANUARY 2013)
⊡ TRC-TR-2 (X-X)	SOIL SAMPLE LOCATION AND IDENTIFICATION NUMBER FROM TRENCH EXCAVATION DURING ARCHEOLOGICAL ASSESSMENT (JUNE 2017) (DEPTH IN FEET)





			BORING	TRC-SB1	
			DATE	11/12/2012	11/12/2012
			INTERVAL (FEET BGS)	1-4	15-17
PARAMETER (mg/kg)	UUSCO	PGSCO	RRUSCO	RESULT	RESULT
COPPER	50	1,720	270	100	240
MERCURY	0.18	0.73	0.81	**2.6 D**	<UUSCO
NICKEL	30	130	310	**600**	65
ZINC	109	2,480	10,000	110	<UUSCO

			BORING	TRC-SB2
			DATE	11/12/2012
			INTERVAL (FEET BGS)	1-4
PARAMETER (mg/kg)	UUSCO	PGSCO	RRUSCO	RESULT
CHROMIUM	30	NC	180	120

			TRENCH	TRC-TR-2
			DATE	6/20/2017
			INTERVAL (FEET BGS)	3.5 - 4
PARAMETER (mg/kg)	UUSCO	PGSCO	RRUSCO	RESULT
TRICHLOROETHENE (TCE)	0.47	0.47	21	8.44

			BORING	TRC-SB9	
			DATE	11/12/2012	11/12/2012
			INTERVAL (FEET BGS)	1-4	15-16
PARAMETER (mg/kg)	UUSCO	PGSCO	RRUSCO	RESULT	RESULT
CHROMIUM	30	NC	180	**600**	34

			BORING	TRC-SB6
			DATE	11/19/2012
			INTERVAL (FEET BGS)	19 - 20
PARAMETER (mg/kg)	UUSCO	PGSCO	RRUSCO	RESULT
NAPHTHALENE	12	12	100	16
1,2,4-TRIMETHYLBENZENE	3.6	3.6	52	12

0 60' 120'

SCALE: 1" = 60'
SHEET SIZE: 11" BY 17"

NOTES:

1. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
2. BLACK BOLD TEXT WITH GRAY SHADE EXCEEDS RESTRICTED-RESIDENTIAL USE SCO.
3. SOIL SAMPLE SB-6 (19-20') WAS COLLECTED BELOW THE WATER TABLE.
4. THERE IS NO SCO FOR TOTAL CHROMIUM. THE SCO FOR TRIVALENT CHROMIUM IS USED.
5. BGS - BELOW GROUND SURFACE
6. D - DILUTED
7. UST - UNDERGROUND STORAGE TANK
8. mg/kg - MILLIGRAMS PER KILOGRAMS
9. NC - NO CRITERIA
10. PGSCO - 6 NYCRR PART 375 PROTECTION OF GROUNDWATER SOIL CLEANUP OBJECTIVE
11. RRUSCO - 6 NYCRR PART 375 RESTRICTED-RESIDENTIAL USE SOIL CLEANUP OBJECTIVE
12. UUSCO - 6 NYCRR PART 375 UNRESTRICTED USE SOIL CLEANUP OBJECTIVE

PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

TITLE:
EXCEEDANCES OF SOIL CLEANUP OBJECTIVES

DRAWN BY:	H. DELGADO	PROJ NO.:	287821.0000.0000
CHECKED BY:	L. O'HARA	**FIGURE 3**	
APPROVED BY:	J. MIRANDA		
DATE:	APRIL 2018		

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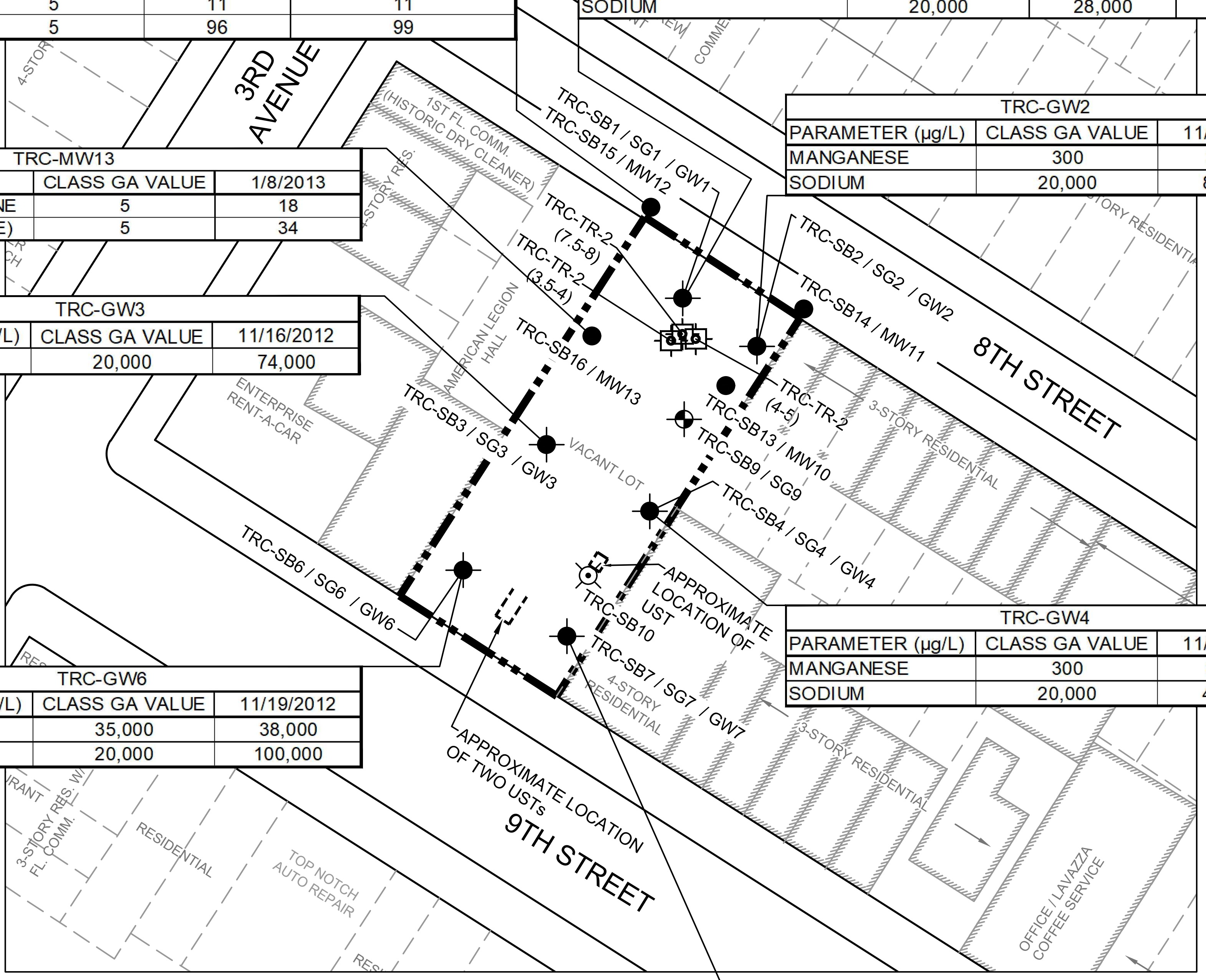
FILE NO.: Figure 3 - Exceed. of SCOs.dwg

11x17 --- ATTACHED XREFS: Brooklyn --- ATTACHED IMAGES: 051593; 168 8TH STREET - GEPRO-600FT color; 197-203 9th Street map_image; Arch Assessment Testing Location;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 3 - Exceed. of SCOs.dwg --- PLOT DATE: April 02, 2018 - 12:28PM --- LAYOUT: 11X17L



TRC-MW12			
PARAMETER (µg/L)	CLASS GA VALUE	1/9/2013	1/9/2013 (TRC-DUP1)
CIS-1,2-DICHLOROETHENE	5	11	11
TRICHLOROETHENE (TCE)	5	96	99

TRC-GW1			
PARAMETER (µg/L)	CLASS GA VALUE	11/12/2012	11/12/2012 (TRC-DUP-1)
TRICHLOROETHENE (TCE)	5	9.3	9.2
SODIUM	20,000	28,000	NOT ANALYZED

TRC-MW13		
PARAMETER (µg/L)	CLASS GA VALUE	1/8/2013
CIS-1,2-DICHLOROETHENE	5	18
TRICHLOROETHENE (TCE)	5	34

TRC-GW2		
PARAMETER (µg/L)	CLASS GA VALUE	11/12/2012
MANGANESE	300	370 D
SODIUM	20,000	89,000

TRC-GW3		
PARAMETER (µg/L)	CLASS GA VALUE	11/16/2012
SODIUM	20,000	74,000

TRC-GW4		
PARAMETER (µg/L)	CLASS GA VALUE	11/16/2012
MANGANESE	300	840 D
SODIUM	20,000	49,000

TRC-GW6		
PARAMETER (µg/L)	CLASS GA VALUE	11/19/2012
MAGNESIUM	35,000	38,000
SODIUM	20,000	100,000

TRC-GW7		
PARAMETER (µg/L)	CLASS GA VALUE	11/19/2012
SODIUM	20,000	50,000

LEGEND (SYMBOLS NOT TO SCALE):

Symbol	Description
▬ · ▬	SITE BOUNDARY
▨	BUILDING FOOTPRINT
- - - -	LOT BOUNDARY
⊗ TRC-SBX	SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
⊕ TRC-SBX / SGX	SOIL SAMPLING AND SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
⊕ TRC-SBX / SGX / GWX	SOIL SAMPLING, SOIL VAPOR SAMPLING, AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
● TRC-SBX / MWX	SOIL SAMPLING AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN JANUARY 2013)
⊡ TRC-TR-2 (X-X)	SOIL SAMPLE LOCATION AND IDENTIFICATION NUMBER FROM TRENCH EXCAVATION DURING ARCHEOLOGICAL ASSESSMENT (JUNE 2017) (DEPTH IN FEET)

W N E

0 60' 120'

SCALE: 1" = 60'
SHEET SIZE: 11" BY 17"

NOTES:

1. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
2. EXCEEDANCES OF CLASS GA VALUES FOR UNFILTERED METALS ARE NOT SHOWN.
3. CLASS GA VALUE - NEW YORK STATE CLASS GA GROUNDWATER STANDARD OR GUIDANCE VALUE PUBLISHED IN THE NYSDEC TOGS 1.1.1, AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES.
4. µg/L - MICROGRAMS PER LITER
5. D - DILUTED
6. UST - UNDERGROUND STORAGE TANK
7. VOC - VOLATILE ORGANIC COMPOUND

PROJECT: NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

TITLE:
EXCEEDANCES OF CLASS GA VALUES IN GROUNDWATER

DRAWN BY:	H. DELGADO	PROJ NO.:	287821.0000.0000
CHECKED BY:	L. O'HARA	FIGURE 4	
APPROVED BY:	J. MIRANDA		
DATE:	APRIL 2018		

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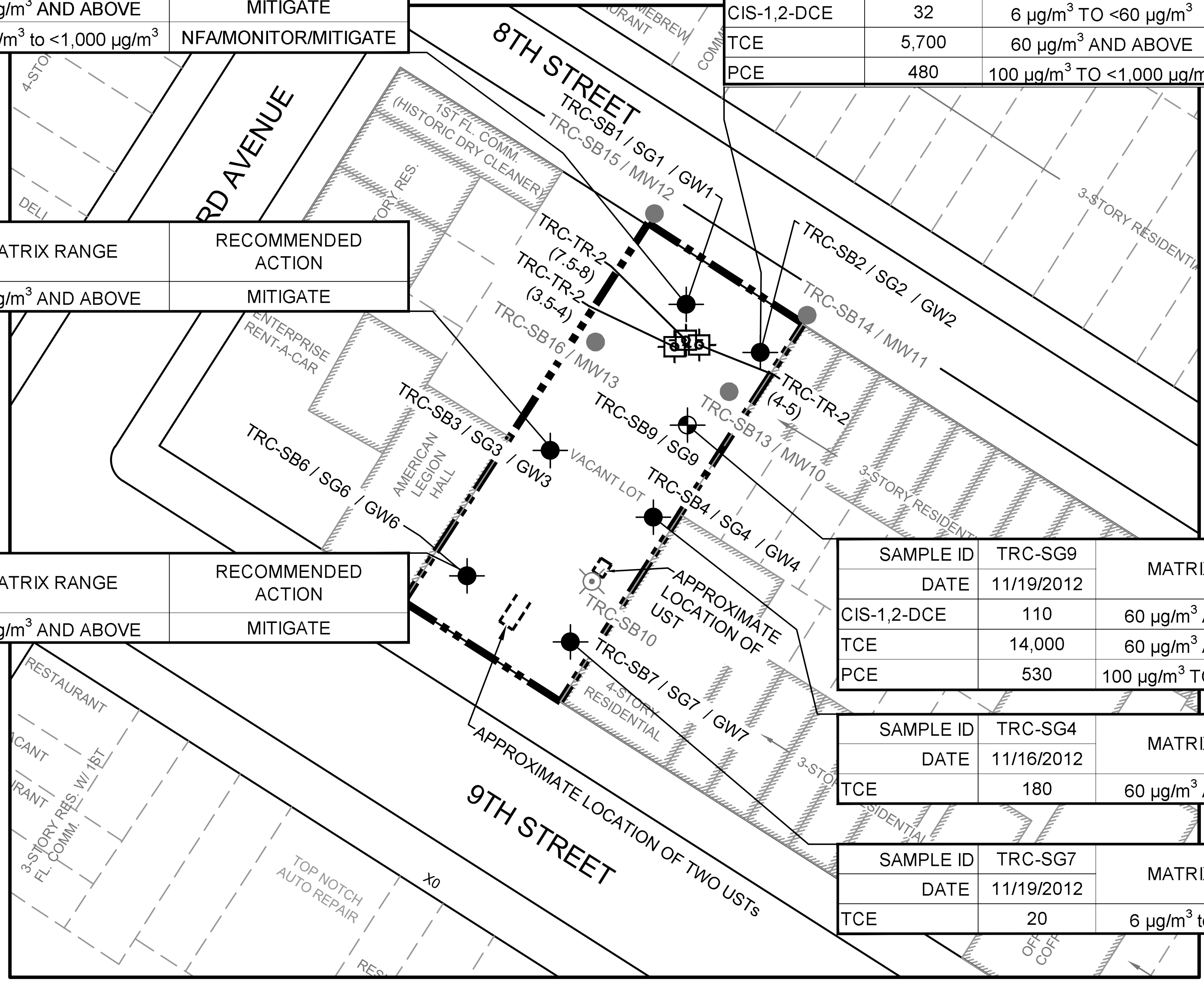
Phone: 212.221.7822

FILE NO.: Figure 4 - Exceed. of Class GA Values in GW.dwg

11x17 --- ATTACHED XREF'S: 8.5x11 Border --- ATTACHED IMAGES: 051593; 197-203 9th Street map_image;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 4 - Exceed. of Class GA Values in GW.dwg --- PLOT DATE: April 02, 2018 - 12:30PM --- LAYOUT: 11x17L



SAMPLE ID	TRC-SG1	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/12/2012		
1,1-DCE	10	6 µg/m^3 TO <60 µg/m^3	NFA/MONITOR/MITIGATE
CIS-1,2-DCE	78	60 µg/m^3 AND ABOVE	MITIGATE
TCE	16,000	60 µg/m^3 AND ABOVE	MITIGATE
PCE	940	100 µg/m^3 to <1,000 µg/m^3	NFA/MONITOR/MITIGATE

SAMPLE ID	TRC-SG2	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/12/2012		
CIS-1,2-DCE	32	6 µg/m^3 TO <60 µg/m^3	NFA/MONITOR/MITIGATE
TCE	5,700	60 µg/m^3 AND ABOVE	MITIGATE
PCE	480	100 µg/m^3 TO <1,000 µg/m^3	NFA/MONITOR/MITIGATE

SAMPLE ID	TRC-SG3	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/16/2012		
TCE	4,000	60 µg/m^3 AND ABOVE	MITIGATE

SAMPLE ID	TRC-SG6	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/19/2012		
TCE	150	60 µg/m^3 AND ABOVE	MITIGATE

SAMPLE ID	TRC-SG9	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/19/2012		
CIS-1,2-DCE	110	60 µg/m^3 AND ABOVE	MITIGATE
TCE	14,000	60 µg/m^3 AND ABOVE	MITIGATE
PCE	530	100 µg/m^3 TO <1,000 µg/m^3	NFA/MONITOR/MITIGATE

SAMPLE ID	TRC-SG4	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/16/2012		
TCE	180	60 µg/m^3 AND ABOVE	MITIGATE

SAMPLE ID	TRC-SG7	MATRIX RANGE	RECOMMENDED ACTION
DATE	11/19/2012		
TCE	20	6 µg/m^3 to <60 µg/m^3	NFA/MONITOR/MITIGATE

LEGEND (SYMBOLS NOT TO SCALE):

▬ ▪ ▪ ▬	SITE BOUNDARY
▨	BUILDING FOOTPRINT
- - - - - -	LOT BOUNDARY
⊗ TRC-SBX	SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
⊕ TRC-SBX / SGX	SOIL SAMPLING AND SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
● TRC-SBX / SGX / GWX	SOIL SAMPLING, SOIL VAPOR SAMPLING, AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN NOVEMBER 2012)
● TRC-SBX / MWX	SOIL SAMPLING AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (INSTALLED IN JANUARY 2013)
⊡ TRC-TR-2 (X-X)	SOIL SAMPLE LOCATION AND IDENTIFICATION NUMBER FROM TRENCH EXCAVATION DURING ARCHEOLOGICAL ASSESSMENT (JUNE 2017) (DEPTH IN FEET)

W N E

0 60' 120'

SCALE: 1" = 60'
SHEET SIZE: 11" BY 17"

NOTES:

1. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
2. DATA SHOWN IN µg/m^3 - MICROGRAMS PER CUBIC METER
3. MATRIX RANGE IS APPLICABLE SUB-SLAB VAPOR CONCENTRATION RANGE IN THE NEW YORK STATE DEPARTMENT OF HEALTH (NYSDOH) VAPOR INTRUSION MATRICES.
4. RECOMMEND ACTIONS BASED ON NYSDOH VAPOR INTRUSION MATRICES.
5. INDOOR AIR DATA NOT AVAILABLE. INDOOR AIR DATA WOULD BE REQUIRED TO DETERMINE FINAL RECOMMENDED ACTIONS.
6. RECOMMENDED ACTIONS IDENTIFIED FOR SOIL VAPOR SAMPLES BASED ON SOIL VAPOR RESULTS BEING REPRESENTATIVE OF SUB-SLAB CONDITIONS IF A BUILDING WAS CONSTRUCTED AT THE SAMPLING LOCATION.
7. ONLY RESUTS THAT COULD POTENTIALLY REQUIRE RECOMMENDED ACTION ARE SHOWN.
8. 1,1-DCE - 1,1-DICHLOROETHENE
9. CIS-1,2-DCE - CIS-1,2-DICHLOROETHENE
10. TCE - TRICHLOROETHENE
11. PCE - TETRACHLOROETHENE
12. UST - UNDERGROUND STORAGE TANK
13. NFA - NO FURTHER ACTION
14. NYSDOH - NEW YORK STATE DEPARTMENT OF HEALTH

PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

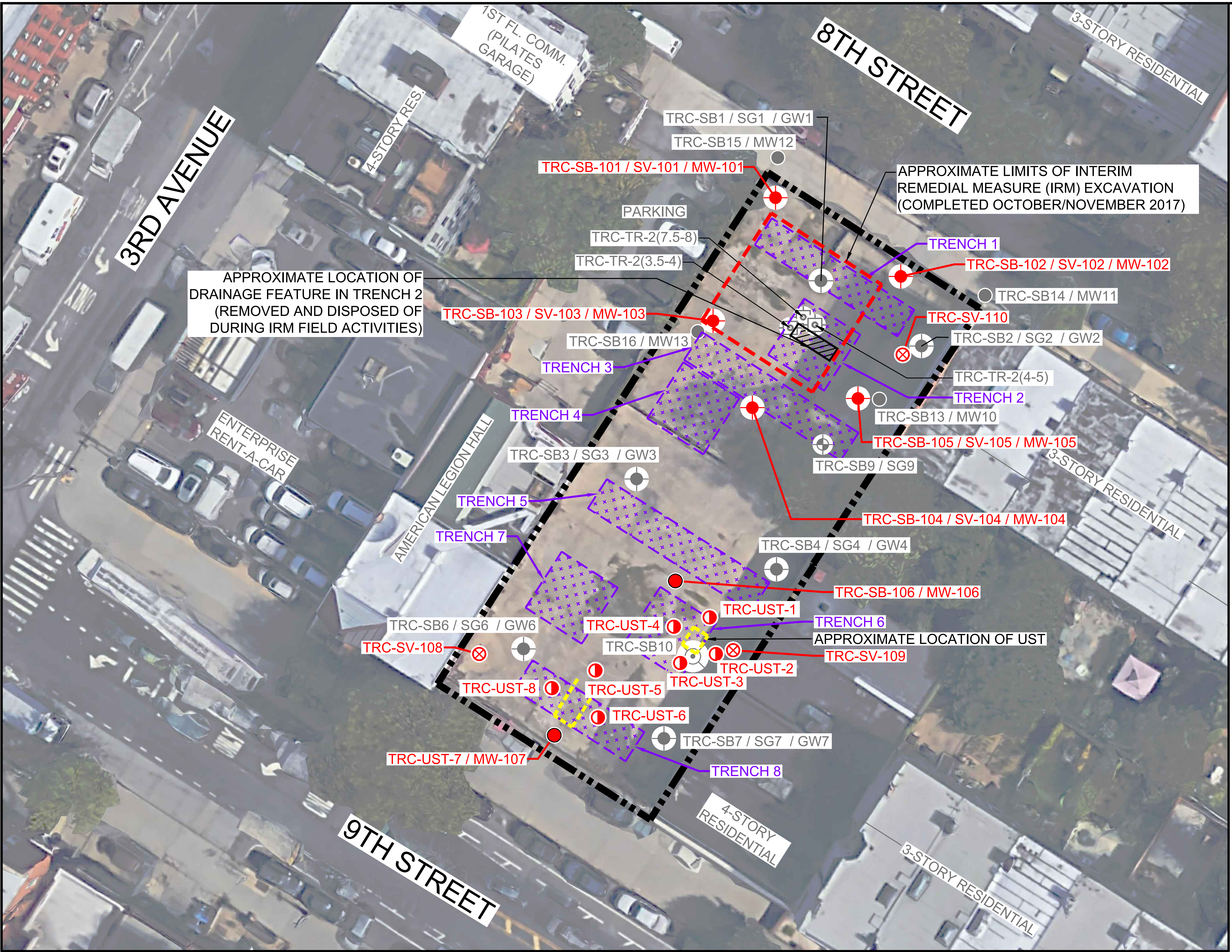
TITLE:
COMPARISON OF SOIL VAPOR SAMPLING RESULTS TO NYSDOH VAPOR INTRUSION MATRICES

DRAWN BY:	H. DELGADO	PROJ NO.:	287821.0000.0000
CHECKED BY:	L. O'HARA	**FIGURE 5**	
APPROVED BY:	J. MIRANDA		
DATE:	APRIL 2018		

TRC
1430 Broadway
10th Floor
New York, NY 10018
Phone: 212.221.7822

FILE NO.: Figure 5 - Comp. of SV Samp. Res. to NYDOH Vapor Intrusion Matrices.dwg

11x17 --- ATTACHED XREF'S: --- ATTACHED IMAGES: 168 8TH STREET - GEPRO-600FT color;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 6 - Proposed Sample Location Plan.dwg --- PLOT DATE: April 02, 2018 - 12:33PM --- LAYOUT: 11X17L



LEGEND (SYMBOLS NOT TO SCALE):

▬ ▪ ▪ ▪	SITE BOUNDARY
TRC-TR-2 (X-X)	TRENCH SAMPLE LOCATION AND IDENTIFICATION NUMBER (DEPTH IN FEET)
▨	TRENCH AREA LOCATION AND IDENTIFICATION (JUNE 2017 ARCHEOLOGICAL INVESTIGATION)
TRC-SBX	SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED IN 2012)
TRC-SBX / SGX	SOIL SAMPLING AND SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED 2012)
TRC-SBX / SGX / GWX	SOIL SAMPLING, SOIL VAPOR SAMPLING, AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED IN 2012)
● TRC-SBX / MWX	SOIL SAMPLING AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED IN 2013)
TRC-SB-X / SV-X / MW-X	PROPOSED SOIL AND SOIL VAPOR SAMPLING AND PERMANENT MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
● TRC-SB-X / MW-X OR TRC-UST-X / MW-X	PROPOSED SOIL SAMPLING AND PERMANENT MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
⊗ TRC-SV-X	PROPOSED SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER
◐ TRC-UST-X	PROPOSED SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER

N

0 30' 60'

SCALE: 1" = 30'
SHEET SIZE: 11" BY 17"

NOTES:

1. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
2. THE NORTHERN LIMITS OF THE TANKS IN TRENCH 8 WERE NOT IDENTIFIED SINCE TRENCH 8 WAS NOT EXCAVATED TO THE TANK LIMITS.

PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

TITLE:

PROPOSED SAMPLE LOCATION PLAN

DRAWN BY:	H. DELGADO	PROJ NO.:	287821.0000.0000
CHECKED BY:	L. O'HARA	**FIGURE 6**	
APPROVED BY:	J. MIRANDA		
DATE:	APRIL 2018		

TRC
1430 Broadway
10th Floor
New York, NY 10018
Phone: 212.221.7822

FILE NO.: Figure 6 - Proposed Sample Location Plan.dwg

APPENDIX A

Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the field activities described in the scope of work. The QAPP also describes specific protocols for field sampling, sample handling and storage, and laboratory analysis. The data generated from the analysis of samples will be used to characterize soil, groundwater, and soil vapor at the Site; confirm groundwater flow direction at the Site; and, develop remedial action decisions.

Project Organization and Responsibility

A qualified person will coordinate and manage the sampling and analysis program, data reduction, QA/QC, data validation, analysis, and reporting. TRC will direct the sampling activities and coordinate laboratory and remedial investigation activities. The TRC Project Quality Assurance (QA) Officer will be Elizabeth Denly and will report directly to the Project Manager, Lindsay O'Hara.

A qualified person will ensure that the QAPP is implemented and will oversee data validation. A qualified person will provide oversight and technical support for the sampling and analytical procedures followed in this project. This individual has the broad authority to approve or disapprove project plans, specific analyses, and final reports. The Project QA Officer is independent from the data generation activities. In general, the QA officer will be responsible for reviewing and advising on all QA/QC aspects of this program.

Laboratories used will be New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified laboratories. The laboratories will communicate directly with the Project Manager regarding the analytical results and reporting and will be responsible for providing all labels, sample containers, trip blanks, temperature blanks, shipping coolers, and laboratory documentation.

QA Objectives for Data Management

New York State Analytical Services Protocol (ASP) Category B laboratory packages will be provided by the laboratory.

All analytical measurements will be made so that the results are representative of the media sampled and the conditions measured. Data will be reported in consistent dry weight units for solid samples (i.e., µg/kg and/or mg/kg). Tables 1A-1C present the proposed samples, sampling and analytical parameters, analytical methods, sample preservation requirements, containers, and QA/QC samples.

Quantitation Limits (QLs) are laboratory-specific and reflect those values achievable by the laboratory performing the analyses.

Data Quality Levels (DQLs) are those reporting limits required to meet the objectives of the program (i.e., program action levels, cleanup standards, etc.).

Data Quality Objectives (DQOs) define the quality of data and documentation required to support decisions made in the various phases of the data collection activities. The DQOs are dependent on the end uses of the data to be collected and are also expressed in terms of objectives for precision, accuracy, representativeness, completeness, and comparability.

The analytical methods to be used at this site provide the highest level of data quality and can be used for purposes of risk assessment, evaluation of remedial alternatives and verification that cleanup standards have been met. However, in order to ensure that the analytical methodologies are capable of achieving the DQOs, measurement performance criteria have been set for the analytical measurements in terms of accuracy and precision.

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting which will provide results that are scientifically valid, and the levels of which are sufficient to meet DQOs.

For quantitation limits for parameters associated with soil samples, the laboratory will be required to attempt to meet or surpass the parameter-specific limits listed in 6 NYCRR Part 375 Unrestricted Use Criteria and Commissioner Policy 51 Tables 2 and 3 (CP-51).

For quantitation limits for parameters associated with groundwater samples, the laboratory will be required to attempt to meet or surpass the parameter-specific limits for groundwater from the NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values.

For quantitation limits for parameters associated with soil vapor, the laboratory will be required to use Method TO-15, which will provide detection limits of 0.20 micrograms per cubic meter for vinyl chloride, trichloroethene (TCE), cis-1,2-dichloroethene, 1,1-dichlorethene, and carbon tetrachloride, allowing for comparison with the lowest action levels for these compounds in the NYSDOH “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York”, dated October 2006. All other compounds will have a detection limit of 1 microgram per cubic meter.

The QA objectives are defined as follows:

- ***Accuracy*** is the closeness of agreement between an observed value and an accepted reference value. The difference between the observed value and the reference value includes components of both systematic error (bias) and random error.

  Accuracy in the field is assessed through the adherence to all field instrument calibration procedures, sample handling, preservation, and holding time requirements, and through the collection of equipment blanks prior to the collection of samples for each type of equipment being.

  The laboratory will assess the overall accuracy of their instruments and analytical methods (independent of sample or matrix effects) through the measurement of “standards,” materials of accepted reference value. Accuracy will vary from analysis to analysis because of individual sample and matrix effects. In an individual analysis, accuracy will be measured in terms of blank results, the percent recovery (%R) of surrogate compounds in organic analyses and/or laboratory control samples (LCSs). This gives an indication of expected recovery for analytes tending to behave chemically like the spiked or surrogate compounds. Tables 2A, 2B, 2B-1 and 2C summarize the laboratory accuracy requirements.

- ***Precision*** is the agreement among a set of replicate measurements without consideration of the “true” or accurate value: i.e., variability between measurements of the same material for the same analyte. Precision is measured in a variety of ways including statistically, such as calculating variance or standard deviation.

Precision in the field is assessed through the collection and measurement of field duplicates (one extra sample in addition to the original field sample). Field duplicates will be collected at a frequency of one per twenty investigative samples per matrix per analytical parameter. Precision will be measured through the calculation of relative percent differences (RPDs). The resulting information will be used to assess sampling and analytical variability. These criteria apply only if the sample and/or duplicate results are >5x the quantitation limit; if both results are < 5x the quantitation limit, the criterion will be doubled.

Precision in the laboratory is assessed through the calculation of RPD for duplicate samples. For organic soil and groundwater analyses, laboratory precision will be assessed through the analysis of field duplicates.

- ***Completeness*** is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. "Normal conditions" are defined as the conditions expected if the sampling plan was implemented as planned.

  Field completeness is a measure of the amount of (1) valid measurements obtained from all the measurements taken in the project and (2) valid samples collected. The field completeness objective is greater than 90 percent.

  Laboratory completeness is a measure of the amount of valid measurements obtained from all valid samples submitted to the laboratory. The laboratory completeness objective is greater than 95 percent.

- ***Representativeness*** is a qualitative parameter that expresses the degree to which data accurately and precisely represents either a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. To ensure representativeness, the sampling locations have been selected to provide coverage over a wide area and to highlight potential trends in the data. In addition, field duplicate samples will provide an additional measure of representativeness at a given location.

  Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the IRM Work Plan (Work Plan) are followed and that proper sampling, sample handling, and sample preservation techniques are used.

  Representativeness in the laboratory is ensured by using the proper analytical procedures, appropriate methods, and meeting sample holding times.

- ***Comparability*** expresses the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Work Plan are followed and that proper sampling techniques are used. Maximization of comparability with previous data sets is expected because the sampling design and field protocols are consistent with those previously used.

  Comparability is dependent on the use of recognized United Stated Environmental Protection Agency (USEPA) or equivalent analytical methods and the reporting of data in standardized units. Laboratory procedures are consistent with those used for previous sampling efforts.

Table 1A
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Soil Samples

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[3]	Sample Container
Soil	TCL and CP-51 VOCs	Grab	14-34	Duplicate: 1/20	8260C	Sealed in EnCore® bag; Cool to 4° C	48 hours to extract: 2 EnCore® samplers extruded in 5 mL DI water and freeze vials to <-7°C; 1 EnCore® sampler extruded in 5 mL methanol and Cool to 40 C; 14 days to analysis	3 x 5 gram EnCore® samplers
Soil	TCL and CP-51 SVOCs	Grab	14-34	Duplicate: 1/20	8270D	Cool to 4° C	14 days to extract	8 oz glass jar
Soil	TAL Metals	Grab	18-38	Duplicate: 1/20	6010C	Cool to 4° C	Other metals: 180 days to analysis	8 oz glass jar
Soil	Mercury	Grab	14-34	Duplicate: 1/20	7471B	Cool to 4° C	Mercury: 28 days to analysis	8 oz glass jar
Soil	Total Cyanide	Grab	14-34	Duplicate: 1/20	SW 846 9012B	Cool to 4° C	14 days to extract	8 oz glass jar
Soil	TCL Pesticides	Grab	14-34	Duplicate: 1/20	8081B	Cool to 4° C	14 days to extract	8 oz glass jar
Soil	TCL Herbicides	Grab	14-34	Duplicate: 1/20	8151A	Cool to 4° C	14 days to extract	8 oz glass jar
Soil	PCBs	Grab	14-34	Duplicate: 1/20	8082A	Cool to 4° C	14 days to extract	8 oz glass jar

[1] A six-inch sampling interval is the targeted sample size; however, sample volume recovery, analytical method requirements, and field conditions can affect the actual sample interval size. For these reasons, the actual sampling interval may change in order to obtain adequate volume.

[2] Actual number of samples may vary depending on field conditions, sample material availability, and field observations.

[3] From date and time of sample collection

Table 1B
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Groundwater Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[2]	Sample Container
Groundwater	TCL and CP-51 VOCs	Grab	7	Trip Blank[3]: as necessary (one per day, per cooler containing VOC groundwater samples) Duplicate: 1/20 Equipment Blank: 1/20	8260C	pH<2 with HCl; cool to 4ºC; no headspace	14 days to analysis	3 40-mL glass vials
Groundwater	TCL and CP-51 SVOCs	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	8270D	Cool, 4ºC	14 days to analysis	2 250-ml amber glass jar
Groundwater	TAL Metals (unfiltered)	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	6010C	pH < 2 w/ HNO_3; Cool, 4ºC	Other Metals: 180 days to analysis	500 mL polyethylene bottle
Groundwater	TAL Metals (field filtered)	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	6010C	pH < 2 w/ HNO_3; Cool, 4ºC	Other Metals: 180 days to analysis	500 mL polyethylene bottle
Groundwater	Mercury (unfiltered)	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	7470A	pH < 2 w/ HNO_3; Cool, 4ºC	Mercury: 28 days to analysis	250 mL polyethylene bottle
Groundwater	Mercury (field filtered)	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	7470A	pH < 2 w/ HNO_3; Cool, 4ºC	Mercury: 28 days to analysis	250 mL polyethylene bottle
Groundwater	Total Cyanide	Grab	7	Duplicate: 1/20	SW 846-9012B	pH < 2 w/ NaOH; Cool, 4ºC	14 days to extract	250 mL polyethylene bottle
Groundwater	TCL Pesticides	Grab	7	Duplicate: 1/20	8081B	Cool to 4º C	14 days to extract	2 250-ml amber glass jar

Table 1B
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Groundwater Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[2]	Sample Container
Groundwater	TCL Herbicides	Grab	7	Duplicate: 1/20	8151A	Cool to 4° C	14 days to extract	2 250-ml amber glass jar
Groundwater	PCBs	Grab	7	Duplicate: 1/20	8082A	Cool to 4° C	14 days to extract	2 250-ml amber glass jar
Groundwater	1,4-Dioxane[4]	Grab	5	Duplicate: 1/20 Equipment Blank: 1/20	8270D SIM	Cool to 4°C	14 days to analysis	2 250-ml amber glass jar
Groundwater	PFAS[5,6]	Grab	5	Duplicate: 1/20 Equipment Blank: 1/20	537 Modified	Cool to 4 ± 2 °C	14 days to prepare, 28 days from preparation to analysis	2 x 250 mL HDPE[7] Bottles
Groundwater	Sulfate	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	300.0	Cool to 4°C	28 days to analysis	250 mL polyethylene bottle
Groundwater	Total Organic Carbon	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	SM 5310B	pH<2 with HCl; cool to 4°C	28 days to analysis	One 60-mL glass vial
Groundwater	Alkalinity	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	SM 2320B	Cool to 4°C	14 days to analysis	250 mL polyethylene bottle
Groundwater	Total Kjeldahl Nitrogen	Grab	7	Duplicate: 1/20 Equipment Blank: 1/20	351.2	pH<2 with H_2SO_4; cool to 4°C	28 days to analysis	250 mL polyethylene bottle

[1] Actual number of samples may vary depending on field conditions, sample material availability, and field observations.

[2] From date and time of sample collection

[3] Trip blank bottleware – 3 40-mL HCl-preserved glass vials

[4] The method detection limit for 1,4-dioxane is 0.0160 ug/L

[5] Select list of 21 PFAS for analysis includes Perfluoroheptanoic acid (PFHpA), Perfluorooctanoic acid (PFOA), Perfluorononanoic acid (PFNA), Perfluorobutanesulfonic acid (PFBS), Perfluorohexanesulfonic acid (PFHxS), Perfluorooctanesulfonic acid (PFOS), perfluoroheptanesulfonic acid (PFHpS), perfluorodecanesulfonic acid (PFDS), Perfluorobutanoic acid (PFBA), Perfluoropentanoic acid (PFPeA), Perfluorohexanoic acid (PFHxA), Perfluorodecanoic acid (PFDA), Perfluoroundecanoic acid (PFUA/PFUdA), Perfluorododecanoic acid

Table 1B
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Groundwater Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[2]	Sample Container

(PFDoA), Perfluorotridecanoic acid (PFTriA/PFTrDa), Perfluorotetradecanoic acid (PFTA/PFTeDA), 6:2 Fluorotelomer sulfonate (6:2 FTS), 8:2 Fluorotelomer sulfonate (8:2 FTS), Perfluroroctanesulfonamide (FOSA), N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA), N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA).

[6] The reporting limit for PFAS compounds is 2 ng/L with the exception of N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA), N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA), 1H,1H,2H,2H-perfluorooctane sulfonate (6:2 FTS), and 1H,1H,2H,2H-perfluorodecane sulfonate (8:2 FTS). The reporting limit for these four PFAS is 20 ng/L.

[7] HDPE – High density polyethylene

Table 1C
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Soil Vapor Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[1]	Sample Container
Soil Vapor	VOCs[2]	Grab	8	None	TO-15	None	30 days to analysis	One 6-L Summa Canister

[1] From date and time of sample collection

[2] Select list of 26 VOCs for analysis includes benzene, carbon tetrachloride, chlorobenzene, chloroethane, chloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, methyl tert-butyl ether, methylene chloride, naphthalene, tetrachloroethene (PCE), toluene, 1,1,1-trichloroethane, trichloroethene (TCE), 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, vinyl chloride, m,p-xylenes, and o-xylene.

Table 2A
Laboratory Data Quality Objectives: Precision and Accuracy: Soil Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TCL and CP-51 VOCs	8260C	Soil	Surrogates % Rec. 1,2-Dichloroethane-d4 78-135 4-Bromofluorobenzene 67-126 Toluene-d8 73-121 Dibromfluoromethane 61-149	Surrogates: All samples, standards, QC samples	Field Duplicates RPD ≤50	Field Duplicates: One per 20 soil samples
TCL and CP-51 SVOCs	8270D	Soil	Surrogates % Rec. 2-Fluorophenol 38-95 Phenol-d5 32-91 2,4,6-Tribromophenol 10-103 Nitrobenzene-d5 37-94 2-Fluorobiphenyl 38-95 Terphenyl-d14 24-109	Surrogates: All samples, standards, QC samples	Field Duplicates RPD ≤50	Field Duplicates: One per 20 soil samples
TAL Metals	6010C	Soil	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
Mercury	7471B	Soil	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
Total Cyanide	SW 846-9012B	Soil	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples

Table 2A
Laboratory Data Quality Objectives: Precision and Accuracy: Soil Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
				Laboratory Control Samples: One per 20 samples per laboratory analytical batch		
TCL Pesticides	8081B	Soil	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
TCL Herbicides	8151A	Soil	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
PCBs	8082A	Soil	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits		Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TCL and CP-51 VOCs[1]	8260C	Groundwater	Surrogates 1,2-Dichloroethane-d4 4-Bromofluorobenzene Toluene-d8	% Rec. 74-132 77-124 80-120	Surrogates: All samples, standards, QC samples	Field Duplicates RPD ≤30	Field Duplicates: One per 20 groundwater samples
TCL and CP-51 SVOCs[2]	8270D	Groundwater	Surrogates 2-Fluorophenol Phenol-d5 2,4,6-Tribromophenol Nitrobenzene-d5 2-Fluorobiphenyl Terphenyl-d14	% Rec 25-58 14-39 26-139 51-108 45-107 40-148	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤30	Method Blank/LCS/MS/MSD: 1 per preparation batch of 20 or fewer field samples.
TAL Metals (unfiltered)	6010C	Groundwater	Matrix Spikes 75-125% recovery		Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
TAL Metals (filtered)	6010C	Groundwater	Matrix Spikes 75-125% recovery		Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
Mercury (unfiltered)	7470A	Groundwater	Matrix Spikes: 80-120% recovery		Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples

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[1] Results of analyses for VOCs will include all TCL VOCs and CP-51-listed VOCs. Included on the TCL and CP- 51 list are the 6 NYCRR Part 375-listed VOCs.
[2] Results of analyses for SVOCs will include all TCL SVOCs and CP-51-listed SVOCs. Included on the TCL and CP-51 list are the 6 NYCRR Part 375-listed SVOCs.

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
Mercury (unfiltered)	7470A	Groundwater	Matrix Spikes: 80-120% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
Total Cyanide	SW 846-9012B	Groundwater	Matrix Spikes: 90-110% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
TCL Pesticides	8081B	Groundwater	Matrix Spikes: 80-120% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
TCL Herbicides	8151A	Groundwater	Matrix Spikes: 80-120% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
PCBs	8082A	Groundwater	Matrix Spikes: 80-120% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
1,4-Dioxane	8270D SIM	Groundwater	Matrix Spikes 70-130% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	**Method**	**Matrix**	**Accuracy Control Limits**	**Accuracy Frequency Requirements**	**Precision (RPD) Control Limits**	**Precision Frequency Requirements**
PFAS	537 Modified	Groundwater	Extracted Internal Standard (IDA): 25-150 Refer to Table 2B-I below for LCS & MS/MSD.	Extracted Internal Standard (IDA): Every field and QC sample. LCS/MS/MSD: one per extraction batch of no more than 20 samples. LCSD if not enough sample for MS/MSD.	LCS/LCSD or MS/MSD: RPD ≤30	LCS/LCSD or MS/MSD for each batch of no more than 20 field samples.
Sulfate	300.0	Groundwater	Matrix Spikes 90-110% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤30	Field Duplicates: One per 20 groundwater samples
Total Organic Carbon	SM 5310B	Groundwater	Matrix Spikes 85-115% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤30	Field Duplicates: One per 20 groundwater samples
Alkalinity	SM 2320	Groundwater	Laboratory Control Sample 90-110% recovery	Laboratory Control Sample One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤30	Field Duplicates: One per 20 groundwater samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
Total Kjeldahl Nitrogen	351.2	Groundwater	Matrix Spikes 90-110% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤ 10	Field Duplicates: One per 10 groundwater samples

Table 2B-I
LCS & MS/MSD Accuracy Control Limits for PFAS

Analyte	LCS/MS/MSD % R	Analyte	LCS/MS/MSD % R
Perfluorobutanoic acid (PFBA)	78 - 138	Perfluorononanoic acid (PFNA)	77 - 137
Perfluoropentanoic acid (PFPeA)	66 - 136	Perfluorodecanoic acid (PFDA)	74 - 134
Perfluorohexanoic acid (PFHxA)	76 - 136	Perfluoroundecanoic acid (PFUnA)	68 - 128
Perfluoroheptanoic acid (PFHpA)	78 - 138	Perfluorododecanoic acid (PFDoA)	72 - 132
Perfluorooctanoic acid (PFOA)	70 - 130	Perfluorotridecanoic acid (PFTriA)	56 - 163
Perfluorotetradecanoic acid (PFTeA)	63 - 123	Perfluorodecanesulfonic acid (PFDS)	75 - 135
Perfluorobutanesulfonic acid (PFBS)	79 - 139	Perfluorooctane sulfonamide (FOSA)	82 - 142
Perfluorohexanesulfonic acid (PFHxS)	77 - 137	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	79 - 139
Perfluoroheptanesulfonic acid (PFHpS)	83 - 143	N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	77 - 137
Perfluorooctanesulfonic acid (PFOS)	74 - 134	1H,1H,2H,2H-perfluorooctane sulfonate (6:2 FTS)	82 - 142
		1H,1H,2H,2H-perfluorodecane sulfonate (8:2 FTS)	80 -140

Table 2C

Laboratory Data Quality Objectives: Precision and Accuracy: Soil Vapor Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
VOCs[1]	TO-15	Soil Vapor	LCS limits vary by analyte (see analytical SOP BR-AT-004)	Each batch or every 20 samples, whichever is less.	N/A	N/A

N/A – Not applicable

[1] Select list of 26 VOCs for analysis includes benzene, carbon tetrachloride, chlorobenzene, chloroethane, chloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, methyl tert-butyl ether, methylene chloride, naphthalene, tetrachloroethene (PCE), toluene, 1,1,1-trichloroethane, trichloroethene (TCE), 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, vinyl chloride, m,p-xylenes, and o-xylene.

[2] Refer to SOP BR-AT-004, provided in Attachment A.

Project Goals

The principal objectives of the Remedial Investigation (RI) are to complete the characterization of soil, groundwater, and soil vapor at the Site and confirm groundwater flow direction. The data obtained during the implementation of the RI will be utilized to develop remedial action decisions.

Project Scope

In order to assess soil, groundwater, and soil vapor at the Site, the scope of work includes the advancement of soil borings; installation of temporary soil vapor probes and permanent groundwater monitoring wells; and the collection and laboratory analysis of soil vapor, soil, and groundwater samples.

Select soil and groundwater samples will be analyzed for TCL and NYSDEC CP-51-listed VOCs plus the 10 highest concentration tentatively identified compounds (TICs); TCL and NYSDEC CP-51-listed SVOCs plus the 20 highest concentration TICs; TAL metals and cyanide, TCL pesticides, TCL herbicides, and PCBs. Select groundwater samples will also be analyzed for 1,4-dioxane, per- and polyfluoroalkyl substances (PFAS), and natural attenuation parameters including alkalinity, sulfate, total organic carbon, and total kjedahl nitrogen (TKN).

Sampling Plan

Environmental sampling will include soil, groundwater, and soil vapor. Soil samples will be collected using disposable sampling equipment. Groundwater samples will be collected from permanent monitoring wells using peristaltic pumps and new dedicated high density polyethylene (HDPE) tubing. Soil vapor samples will be collected from temporary soil vapor probes using dedicated sampling equipment.

Soil Sampling

Soil samples will be collected in 2-inch diameter acetate sleeve-lined macrocore samplers continuously from the ground surface to approximately 10 feet below ground surface (bgs). With the exception of soil collected for VOC analysis, the samples will be collected with a disposable scoop and placed in the sample bottles. EnCore® samplers will be used to collect soil samples for VOC analysis. Samplers will wear phthalate-free gloves such as nitrile (no latex will be used). Only clean instruments will be allowed to touch the sample.

Groundwater Sampling

Groundwater samples will be collected from four-inch diameter permanent wells installed on the Site. Groundwater from each well will be purged via a peristaltic pump equipped with HDPE tubing until parameters have stabilized in accordance with USEPA Low-Stress (Low-Flow) sampling procedures. A turbidity level of 50 Nephelometric Turbidity Units (NTUs) or less is the well purging goal, but not an absolute value before sampling. Other field parameters including temperature, conductivity, pH, and dissolved oxygen (DO) will also be monitored. As practical, all field measurements will be taken from the flow-through cell and will be recorded during and after purging, and before sampling. Field parameters should generally be within ±10 percent for three consecutive readings prior to sampling.

A minimum of three well volumes will be purged prior to sample collection. Ideally, pumping rates will be maintained between 100 and 500 milliliters per minute (ml/min) so that no drawdown of the groundwater level occurs (i.e., pumping rate is less than recharge rate). During purging, the sampler will actively monitor and track the volume of water purged and the field parameter readings. Data will be recorded in the field logbook. For example, the sampler will record the running total volume purged from each well and note the readings for the corresponding field parameters.

Once groundwater conditions have stabilized and groundwater levels have recovered, samples will be collected. Sampling will be performed with the pump intake at the same location used for purging. Pumping rates for withdrawing the samples will be similar to those followed for well purging.

The samples will be collected in sample bottles (pre-preserved, if appropriate), placed in chilled coolers and removed from light immediately after collection. All bottles will be filled to avoid cascading and aeration of the samples, the goal being to minimize any precipitation of colloidal matter.

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. When sampling for PFAS in groundwater, specific modifications, in accordance with TRC's Standard Operating (SOP) for Groundwater Sampling dated November 2016, will be implemented. TRC's SOP for Groundwater Sampling is provided as Attachment A.

Soil Vapor Sampling

Soil vapor sampling will be conducted in accordance with the NYSDOH "Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006)" and ASTM Standard E 2600-10.

The soil vapor samples will be collected using a direct-drive rig (i.e., Geoprobe) that utilizes drive rods to advance the stainless steel probe to approximately 5 feet bgs, the desired sample depth. In accordance with the NYSDOH vapor intrusion guidance, tracer gas (i.e., helium) will be used at each soil vapor sampling location to ensure that an adequate surface seal has been created.

The temporary vapor probe will then be purged using a photoionization detector (PID) to evacuate one to three volumes of soil vapor. Maximum VOC concentrations will be recorded by the field technician. Each probe will be connected via Teflon tubing to a laboratory-supplied individually certified clean SUMMA canister with a 1-hour flow controller.

QC Sample Collection

QC samples will include trip blanks for groundwater and field duplicates and equipment blanks for soil and groundwater samples. Refer to Tables 1A-1C for a summary of QC sample preservation and container requirements.

Trip blanks will consist of distilled water (supplied by the laboratory) and will be used to assess the potential for volatile organic compound contamination of groundwater samples due to contaminant migration during sample shipment and storage. Trip blanks will be transported to the Site unopened, stored with the investigative samples, and kept closed until analyzed by the laboratory. Trip blanks will be submitted to the laboratory at a frequency of one per cooler that contains groundwater samples for analysis for VOCs.

Field duplicates are an additional aliquot of the same sample submitted for the same parameters as the original sample. Field duplicates will be used to assess the sampling and analytical reproducibility. Field duplicates will be collected by alternately filling sample bottles from the source being sampled. Field duplicates will be submitted at a frequency of one per 20 samples for all matrices and all parameters. Refer to Tables 1A-1C for a summary of QC sample preservation and container requirements.

Equipment blanks will consist of distilled water and will be used to check for potential contamination of the equipment, which may cause sample contamination. Equipment blanks will be collected by routing the distilled water through the sampling equipment prior to sample collection. Equipment blanks will be submitted to the laboratory at a frequency of one per 20 samples. Equipment blanks will not be collected with soil vapor samples submitted for laboratory analysis. Refer to Tables 1A-1C for a summary of QC sample preservation and container requirements.

Sample Preservation and Containerization

The analytical laboratory will supply the containers for analytical samples. These containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in the latest USEPA's Specifications and Guidance for Contaminant-Free Sample Containers. Certificates of analysis are provided with each bottle lot and maintained on file to document conformance to USEPA specifications. Soil and groundwater samples will be placed in chilled coolers immediately after collection.

Equipment Decontamination

Re-usable sampling equipment shall be cleaned between each use in the following manner:

- Wash and scrub with Alconox and water mixture
- Tap water rinse
- Wash and scrub with biodegradable degreaser ("ZEP") if there is oily residue on equipment surface.
- Tap water rinse
- Distilled/deionized water rinse
- Air dry

As noted above, special care should be taken when sampling for PFAS. TRC will implement TRC's SOP ECR-010 Equipment Decontamination for PFAS-specific decontamination protocols. TRC's Equipment Decontamination SOP is provided in Attachment A.

Field Custody Procedures

Sample chain-of-custody and packaging procedures are summarized below. These procedures are intended to ensure that the samples will arrive at the laboratory with the chain-of-custody intact.

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or dispatched properly. Field procedures have been designed such that as few people as possible will handle the samples.

- All bottles will be identified by the use of sample labels with sample numbers, sampling locations, date/time of sample collection, and type of analysis.

- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the pen would not function in wet weather.

- Samples will be accompanied by a properly completed chain-of-custody form. The sample numbers and locations will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage location. A Chain of Custody Form is provided in Attachment B.

- All shipments will be accompanied by the chain-of-custody record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler and placed in the project files.

- Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front right and back left of the cooler and covered with clear plastic tape after being signed by field personnel. The cooler will be strapped shut with strapping tape in at least two locations.

- If the samples are sent by common carrier, the air bill will be used. Air bills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.

- Samples remain in the custody of the sampler until transfer of custody is completed. This consists of delivery of samples to the laboratory sample custodian, and signature of the laboratory sample custodian on chain-of-custody document as receiving the samples and signature of sampler as relinquishing samples.

Data Management and Reporting

ASP Category B Laboratory Packages will undergo data validation. A NYSDEC Data Usability Summary Report (DUSR) will be prepared for each laboratory package. Note that waste characterization samples, if collected for laboratory analysis, will not undergo data validation.

ATTACHMENT A

Standard Operating Procedures – TRC and TestAmerica

Title: **Groundwater Sampling**	Procedure Number: **ECR 009**
	Revision Number: **2**
	Effective Date: **November 2016**

Authorization Signatures	
Cinnamon Smith	Elizabeth Denly
Technical Reviewer Cinnamon Smith	Date 11/14/16
ECR Practice Quality Coordinator Elizabeth Denly	Date 11/14/16

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Attachment D	SOP Modifications for PFAS

1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) was prepared to provide TRC personnel with general guidance in performing groundwater sampling activities. This SOP details equipment and sampling procedures for low-flow sampling, multi-volume purge sampling and passive diffusion bag sampling from monitoring wells. Various regulatory agencies and project-specific work plans may have specific requirements (e.g., equipment/instrument, flow rate, etc.) that may be applicable and take precedence, depending on the program.

The objective of groundwater sampling is to obtain a representative sample of water from a saturated zone or groundwater-bearing unit (i.e., aquifer) with minimal disturbance of groundwater chemistry. This requires that the sample being collected is representative of groundwater within the formation surrounding the well bore as opposed to stagnant water within the well casing or within the filter pack immediately surrounding the well casing.

1.2 Summary of Method

There are three general approaches to groundwater purging/sampling that can be used to obtain a representative groundwater sample for analysis: 1) the low-flow or micropurge method where the mixing of the stagnant water is minimized using low-flow pumping rates during the collection of the groundwater sample; 2) the multiple well volume removal approach in which the stagnant water is removed from the well and the filter pack prior to sample collection; and 3) the passive sampler procedure where water quality equilibration with the surroundings is achieved through deployment of the passive sampler for a sufficient amount of time prior to sampling.

For low-flow and multiple well volume removal, there are various types of equipment available to perform groundwater sampling. The most common of these are the submersible pump, peristaltic pump, and bailer. However, the equipment selected and the purge method used, if any, will depend on project goals, data quality objectives (DQOs), hydrogeologic conditions, and regulatory requirements. Care should be taken when choosing the sampling procedures and device(s), as some procedures have the potential to affect the representativeness of the sample more than others. For repeated monitoring events, the sampling methodology and operating equipment employed should be consistent to minimize potential variability due to sampling procedures. The type of sampling method utilized is dependent upon site-specific conditions and it is not within the scope of this document to recommend a specific methodology. For specialized sampling programs involving per- and polyfluorinated alkyl substances (PFAS), refer to Attachment D for further details. Information on applicability of sampling methods can be found on Interstate Technology & Regulatory Council (ITRC) and United States Environmental Protection Agency (EPA) websites.

1.3 Equipment

The following equipment is commonly used to collect groundwater samples from a monitoring well. Site-specific conditions may warrant the use of additional equipment or deletion of items from this list.

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific Health and Safety Plan (HASP)
- Electronic water level indicator capable of measuring to 0.01 foot accuracy
- Oil/water interface probe
- Extra batteries for water level/interface probe
- Submersible pump with low-flow capabilities (less than 1 liter/min) constructed of inert materials (e.g., stainless steel and Teflon®), such as a bladder pump (with sufficient quantity of bladders, o-rings, grab plates, etc.)
- Peristaltic pump
- Source of power for use with submersible or peristaltic pump (e.g., 12-volt battery, compressor, generator, compressed gas tanks, etc.)
- Flow controller for use with submersible pump (varies depending on type of pump used)
- Bottom-filling bailer constructed of inert materials (i.e., polyethylene, polyvinyl chloride [PVC], stainless steel or Teflon®)
- Bailer cord or wire (recommended Teflon®-coated, stainless steel cable; bailer wire; or contaminant-free rope with a Teflon®-coated stainless steel leader to connect bailer and rope)
- Tubing (Teflon®, Teflon®–lined polyethylene, or high density polyethylene [HDPE], type dependent upon project objectives)
- Silicone tubing (only used for peristaltic pump head and/or flow-through cell connections)
- Water quality meter(s) capable of measuring parameters, such as pH, temperature, specific conductivity, oxidation-reduction potential (ORP), and dissolved oxygen (DO)
- Flow-through cell
- T-connector
- Turbidity meter
- Passive sampling device (and any device-specific accessories)
    - Passive diffusion bags (PDBs)
    - Tether (stainless steel cable or marine-grade polyethylene rope), well cap, and weights, unless already installed
    - Funnel (Fill kit)
    - PVC cable ties
    - Tool to cut cable ties
    - PVC discharge tubes
    - Tether reel

- Well lock keys
- Bolt cutters

- Appropriate tools for equipment and to open well box (e.g., socket wrench, pry bar, etc.)
- Containers with lids for purge water (i.e., 5-gallon buckets, drums, etc.)
- Stopwatch or timer
- Graduated measuring container appropriately sized to measure flow rate
- Sample bottle labels
- Laboratory-grade water (can request from lab – for equipment blanks)
- Chain-of-custody (COC) forms
- Sample cooler(s)
- Photoionization detector (PID) or flame ionization detector (FID) for well head monitoring
- Sample containers (may be supplied by the laboratory depending upon the regulatory program): The proper containers should be determined in conjunction with the analytical laboratory in the planning stages of the project. If not included in sample containers provided by laboratory, sample preservatives will need to be kept with sample containers, and added to sample containers prior to sample collection.
- Field book and/or Groundwater Field Data Record (multiple copies)
- Filtration equipment
- In-line filter (0.45 micron [µm]) or as otherwise required by the project-specific work plan.
- Bubble wrap/Bubble wrap bags
- Lint-free, non-abrasive, disposable towels (e.g., Kimwipes®)
- Indelible marking pens
- Plastic bags (e.g., Ziploc®)
- Ice
- Teflon® tape
- Plastic sheeting or large trash bags which can be cut open
- Umbrella, tent, or equivalent for shading equipment (particularly the flow-through cell) from sunlight or blocking rain
- Equipment decontamination supplies
- Container for bailing water out of water-logged road boxes or well vaults
- Map of well locations and well construction data
- Copy of field notes from previous sampling event for reference
- Project-specific work plan

1.4 Definitions

Bailer	A cylindrical device suspended from a rope or cable, which is used to remove water, non-aqueous phase liquid (NAPL), sediment or other materials from a well or open borehole. Usually equipped with some type of check valve at the base to allow water, NAPL, and/or sediment to enter the bailer and be retained as it is lifted to the surface. A bailer may be made in varying diameters; however a bailer that fits in a two-inch well is the most common. In some instances a < 1-inch diameter bailer (a.k.a. pencil bailer) is used for small diameter wells.
Borehole	A hole drilled into the soil or bedrock using a drill rig or similar equipment.
Dense Non-aqueous Phase Liquid (DNAPL)	Separate-phase product that is denser than water and, therefore, sinks to the bottom of the water column.
Depth To Water (DTW)	The distance to the groundwater surface from an established measuring point.
Drawdown	The response to purging/pumping a well resulting in the lowering of groundwater within the water column in the well or in a water-bearing zone.
FID	An instrument that uses a flame to break down volatile organic compounds (VOCs) into ions that can be measured.
Flow-Through Cell	The container used to immerse the multi-parameter probes in well purge water during pre-sampling well purging. The flow-through cell is usually made of transparent acrylic and is connected to the end of the discharge tubing creating an in-line, sealed container in which purge water circulates around the measurement probes. The discharge from the pump prior to the flow-through cell may be fitted with a check valve or T-connector for collection of water for turbidity measurement.
Flush Mount	The type of well completion where the riser terminates at or below grade. Flush-mounted wells are typically completed with a "curb box" which is an "at-grade" enclosure designed to protect the well riser.
Light Non-aqueous Phase Liquid (LNAPL)	Separate-phase product that is less dense than water and therefore floats on the surface of the water.

Monitoring Well	A well made from a PVC pipe, or other appropriate material, with slotted screen installed across or within a saturated zone. A monitoring well is typically constructed with a PVC or stainless steel pipe in unconsolidated deposits and with steel casing in bedrock.
PID	An instrument that uses an ultraviolet light source to break down VOCs into ions that can be measured.
Piezometer	A well made from PVC or metal with a slotted screen installed across or within a saturated zone. Piezometers are primarily installed to monitor changes in the potentiometric surface elevation.
Potentiometric Surface	A surface representing the hydraulic head of groundwater.
Protective Casing	The pipe installed around the well riser that sticks up from the ground (above-grade completions) or is flush with the ground (at-grade completions, e.g., curb box) in order to protect the well integrity. Protective casings are typically constructed of steel or aluminum and usually closeable with a locking cover/hasp to maintain well integrity between sampling events.
Recharge Rate	The rate at which groundwater returns to the water column in the well.
Separate-Phase Product	A liquid that does not easily dissolve in water. Separate-phase product can be more dense (i.e., DNAPL) or less dense (i.e., LNAPL) than water and, therefore, can be found at different depths in the water column.
Static Water Level	Level at which water resides in a well when the water level is at equilibrium with atmospheric pressure.
Well Cover	The cap or lid constructed at the end of the protective casing (above-grade completions) or flush-mounted curb box (ground surface completions) to secure access to the well. Well covers for stick-up wells are often equipped with a hasp to accommodate a padlock. Well covers for flush-mounted road boxes or vaults are opened and closed using a threaded bolt.
Well Filter Pack	A material composed of clean silica sand or sand and gravel of selected grain size and gradation that is placed in the annulus between the screened interval and the borehole wall in a well for the purpose of retaining and stabilizing the formation material.
Well Plug/Expansion Plug	The plug fashioned into a cap placed into the top of the well riser (e.g., J-Plug). Well plugs are usually designed with an expandable gasket that is activated by turning a locking wing nut or removable key latch, closing a snap cap or engaging a magnetic clutch cap to seal the well riser.

Well Riser	Sections of blank (non-slotted) pipe that extend from the well screen to or above the ground surface.
Well Screen	Pipe (typically PVC or stainless steel) used to retain the formation or filter pack materials outside of the well. The pipe has openings/slots of a uniform width, orientation, and spacing. The openings/slots can vary based on formation and filter pack material specifications.

1.5 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific HASP. TRC personnel will use the appropriate level of PPE as defined in the HASP.

The well head should be pre-screened using a PID/FID to avoid inhalation of contaminants venting from the well. If monitoring results indicate sustained elevated concentrations of organic contaminants, the level of PPE may need to be increased in accordance with the HASP or work could be conducted upwind of the well.

When present, special care should be taken to avoid contact with LNAPL or DNAPL. The use of an air monitoring program, as well as the proper PPE designated by the site-specific HASP, can identify and/or mitigate potential health hazards.

Implementing this SOP may require the use of reagents and/or compressed gases for the calibration and operation of field equipment. These substances may be hazardous and TRC personnel must appropriately handle, store, and dispose of them at all times. Skin contact with liquid from preserved sample bottles must be avoided as they may contain strong acids or bases. When filling bottles pre-preserved with acid (e.g., hydrochloric acid, nitric acid, sulfuric acid), vapors may be released and should not be inhaled. Do not allow bottles with acid to be exposed to elevated atmospheric temperatures or sunlight as this will facilitate fumes from the acids.

1.6 Cautions and Potential Problems

The following sections highlight issues that may be encountered and should be discussed with the Project Manager prior to mobilization into the field. Special care should be taken when sampling for PFAS. Please refer to Attachment D for details.

1.6.1 Pre-Sampling Issues

(a) Selection of equipment for groundwater sampling should consider multiple factors, including: DTW, well specifications (e.g., depth and length of well screen intervals), desired flow rate, possible weather conditions, type and concentration of contaminant(s), and remoteness/accessibility to the site. The benefits and limits of each type of groundwater sampling equipment should be fully reviewed during project planning or prior to mobilization if the project-specific work plan does not identify the required equipment. For example, peristaltic pumps are incapable of withdrawing water in wells in which the depth to water is greater than approximately 20-25 feet below ground surface (bgs).

(b) If the screen or open borehole is greater than 10 feet in length, consult the project-specific work plans for the target sampling interval. Generally, pumps are either placed in the middle of the saturated zone if the water level is below the top of the screen or in the middle of the screen interval if the water level is above the top of the screen.

(c) The need for redevelopment of the monitoring wells should be evaluated periodically in accordance with the project-specific requirements. This is assessed by comparing the measured total depth of the well with the constructed depth. If the measured depth is less than the constructed depth, this may indicate siltation of the well and/or the presence of an obstruction in the well. If it is determined that redevelopment is necessary, it should be performed in accordance with RMD SOP 006, *Well Development*. The time necessary for a well to restabilize after redevelopment will be determined on a project-specific basis and may depend on regulatory requirements.

(d) During the total well depth measurement, there is the potential for sediment, if present at the bottom of the well, to be disturbed, thereby increasing the turbidity of the groundwater. Therefore, the total well depth measurement should be collected the day prior to collecting groundwater samples, if possible.

(e) Use caution if using compressed gas cylinders (e.g., nitrogen, carbon dioxide) for purging/sampling of groundwater. Check for leaks around regulator connections by spraying soapy water on the connections. If a leak is discovered, the connection to the regulator should be disassembled, wrapped with Teflon® tape, and reconnected to the cylinder. If the leak continues, the regulator should be replaced. It should be noted that Department of Transportation (DOT) regulations apply to the transportation and handling of compressed gas cylinders (see 49 Code of Federal Regulations [CFR] 171). Never transport cylinders with the regulator attached. Replace the cylinder valve cover on the compressed gas cylinder before transport.

(f) All field personnel must be made aware of the water level measurement reference point being used for each well at a site (i.e., must be clearly marked) in order to ensure collection of comparable data between events.

(g) Bolt cutters may be necessary to remove rusted locks. Dipping rusted locks in a soapy solution may help with opening difficult locks. Oils and other products containing VOCs (e.g., WD-40) should not be used on locks as these compounds may cause contamination of water samples collected at the well. Replace cut locks and note in the field book.

(h) Prior to accessing the well, physical conditions around the well head should be assessed for situations that might result in cross-contamination or the introduction of foreign material/debris into the well. For example, flush-mounted wells may have water or road sand/salt/debris inside the curb box. Rodents and insects (e.g., bees, wasps) have been known to construct nests within the protective casing of a well. If bees, wasps, or other insects are encountered, insecticides should be used with caution as the chemicals may cause contamination of water samples collected at the well. If water or foreign material is introduced into the well, the Project Manager should be immediately notified.

1.6.2 General Purging and Sampling Issues

(a) Prior to installation of a submersible pump into a well, ensure that the tubing is properly sealed to the pump to avoid losing the pump down the well and to prevent escape of air or water from the pump, which could result in poor pump performance and the aeration of the well water. Do not do this by tugging on tubing. Never lower pumps into the well using only tubing; instead a security line attached to the pump is required to prevent potentially losing the pump down the well.

(b) A submersible pump should not be lowered to the bottom of the well to avoid stirring up any sediment at the bottom of the well and prevent getting the pump stuck (fine sediment accumulation in the bottom of the well can create a strong suction with a flat bottom pump such as a bladder pump, which may require jetting to retrieve the pump).

(c) Start with the lowest pumping rate possible and increase until a sustainable rate is reached. Avoid high pumping rates (> 1 liter/min), as this could lead to damage of the well filter pack, if present. Where practical and/or possible, refer to previous sampling events to establish consistent flow rates.

(d) Some regulatory agencies may have concern about the use of peristaltic pumps when sampling for VOCs due to the potential for loss of VOCs during sampling and alteration of other water quality parameters such as pH and alkalinity. Samplers should review the requirements in the project-specific work plan and/or regulatory guidelines prior to performing the work. Explicit approval to use a peristaltic pump for the collection of VOCs may be required by the governing regulatory agency. An option may be to use the “soda straw” method to collect the VOC sample which does not allow the water to go through the pump head:

    (1) After purging the well with the peristaltic pump, collect all fractions <u>except VOCs</u> from the outlet side of the pump (i.e., VOCs will be collected last instead of first).
    (2) Turn the pump off.
    (3) Change into clean gloves.
    (4) Disconnect the tubing coming out of the well from the inlet side of the pump and <u>immediately</u> put a finger over the end of this tubing to prevent water from draining out of the tubing.
    (5) Retrieve tubing from the well, coiling it in one hand as it is being retrieved (maintain finger over end of tubing).
    (6) Open VOC vials. Briefly remove finger from end of tubing to allow water to flow into vial. Replace finger on end of tubing to stop flow. Do this for remaining VOC vials.

(e) In the event that a well cannot be purged and sampled with a pump, the alternative to pumping may be the use of a bottom-filling bailer. The applicable regulatory agency requirements and the Project Manager should be consulted if in doubt about the appropriateness of using a bailer at a site or during a particular sampling event.

(f) During purging and sampling, the tubing should remain filled with water to minimize possible changes in water chemistry due to contact with the atmosphere. All flow-through cells should be shaded from direct sunlight to minimize the potential for off-gassing and temperature fluctuations.

(g) Ensure monitoring instruments (i.e., multi-parameter water quality instrument, turbidity meter, water level measuring device) are maintained in good condition and properly calibrated to ensure accurate readings. Be sure to have appropriate-sized extra batteries on hand.

(h) Adverse weather conditions may present challenges that need to be dealt with on a case-by-case basis. For example, air temperatures below 32°F may cause ice formation in the tubing, flow-through cell, and on the sampling equipment, or heavy rain could cause standing water issues with flush-mounted wells. Heavy rain can also impact electronic sampling equipment; preventative measures should be taken to keep electronic equipment dry.

(i) Observe and avoid any uncontrolled ambient/surrounding air conditions that could affect analytical results (e.g., truck/vehicle exhaust nearby, industrial building vents). Always ensure that vehicles are turned off during sampling to avoid introducing vehicle exhaust into the sample. If uncontrolled ambient/surrounding air conditions cannot be avoided, contact the Project Manager for further instruction; collection of a field blank sample may be warranted in this situation.

(j) Procedures should be established to minimize potential cross-contamination. For example:

- Wrap monitoring and sampling equipment with protective material (e.g., aluminum foil, polyethylene sheeting, Ziploc® bags) after decontamination and between sampling locations to minimize the potential for cross-contamination between well purging events at different locations.
- Use dedicated or disposable sampling equipment or new tubing at each sampling point when appropriate to minimize the need for decontamination.
- Protect sampling equipment and/or the open well head from blowing soil and dust by covering with plastic sheeting as needed.
- If a bailer and rope are used to purge and/or sample the well, then there is the possibility of contamination from the rope used to lower the bailer. New or dedicated rope should be used when appropriate. Alternatively, a decontaminated, Teflon®-coated stainless steel leader can be attached between the rope and the bailer. The leader acts as an extension to the rope and allows for the top of the bailer to enter the water column without immediately placing the rope into the water. It is important to keep the rope clean and not allow contact with the ground surface during bailing.

(k) Disposal of the groundwater collected during purging must be performed in accordance with all applicable regulations and the project-specific work plan.

(l) Clear tape should not be used to cover labels on containers used for certain analyses (e.g., 40-mL vials for VOC analysis) due to potential interference with analytical equipment.

(m) In cases where it is difficult to obtain sufficient sample volume for multiple analytical fractions as well as required quality control (QC) analyses (*e.g.*, field duplicates, matrix spike/matrix spike duplicate [MS/MSD] analyses), discuss this situation with the Project Manager and laboratory prior to sample collection. Laboratories can often "make do" with less volume, especially for inorganic parameters, or increase the reporting limit proportional to the sample volume obtained.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project- and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project-specific work plan. These requirements may include:

- OSHA 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers
- 8-hour annual HAZWOPER refresher training.

2.0 PROCEDURES

Procedures for collecting groundwater samples from monitoring wells are described below. The project-specific work plan should also be consulted for specific details regarding sampling.

Sampling should always begin at the monitoring well with the least contaminated groundwater and systematically proceed to the well with the most contaminated groundwater, if possible.

2.1 Pre-sampling Activities

(a) It should be determined if there is the requirement to determine static water level measurements on <u>all</u> wells at the site prior to sampling, regardless if the well is being sampled.

(b) Prior to field activities, review historical groundwater sampling logs (if available) to maintain consistency for the current sampling event (e.g., equipment type, pump intake depth setting, flow rate, etc.)

(c) Organize monitoring, purging, and sampling equipment taking care not to allow cross-contamination. This can be accomplished by laying new polyethylene sheeting near the well or using new buckets, etc.

(d) Calibrate (or perform a calibration check on) all field monitoring equipment on the same day before collecting groundwater samples. Refer to TRC SOPs and manufacturer's equipment calibration instructions. A calibration check may also be required during or at the end of each sampling day. Consult the project-specific work plan.

(e) Unlock the well cover on the well.

(f) Record the sample location, time, and date in the field book and/or on the Groundwater Field Data Record.

(g) On the Groundwater Field Data Record, note the physical condition of the well, including damage, deterioration, and signs of tampering, if any. Collect photographic documentation of serious damage to present to the Project Manager.

(h) Open the well cap and expansion plug, and stay upwind of and not directly over the well. Note any unusual odors, sounds, or difficulties in opening the well and, if required, measure the organic vapor reading at the rim of the well with a suitable organic vapor screening device (e.g., PID or FID), and record the reading in the field book and/or on the Groundwater Field Data Record. If pressure or vacuum is noted or suspected in the well, allow sufficient time for the water level elevation in the well to equilibrate.

(i) Gently lower a clean, decontaminated water level measuring device into the well to determine the static water level. If appropriate for site conditions, check for the presence of LNAPL or DNAPL using an oil/water interface probe (refer to ECR SOP 004, *Water Level and Product Measurements*). If LNAPL or DNAPL is detected, contact the Project Manager before proceeding with purging and sampling activities. Record the information on depth to groundwater to the nearest 0.01 feet, depth to LNAPL or DNAPL, and/or thickness of NAPL in the field book and/or the Groundwater Field Data Record. Refer to ECR SOP 004, *Water Level and Product Measurements*, for proper procedures in performing these measurements.

(j) If required in the project-specific work plan, measure the depth to the bottom of the well to assist in calculating the well volume of the well. If possible, avoid making total well depth measurements on the same day as sampling due to the tendency to disturb sediment during this measurement. If NAPL is suspected, use a decontaminated oil/water interface probe. If the measured depth is less than the constructed depth, this may indicate that the well needs to be redeveloped (see RMD SOP 006, *Well Development*). Consult the project-specific work plan or Project Manager for further instructions.

2.2 *Groundwater Purging Activities*

Purging is conducted to ensure that representative groundwater is obtained from the water-bearing unit for analysis. The multiple-volume or low-flow purging approach may be used to remove water from the well and monitor the water in order to determine when a well has been adequately purged (i.e., stabilized); at a minimum, the pH, specific conductance and temperature of the groundwater removed during purging should be monitored and recorded in the field notes. Other parameters may be required in some regulatory jurisdictions (e.g., turbidity). Additionally, the purge volume should be monitored and recorded. In some instances, such as when monitoring at solid waste disposal facilities, simply removing an adequate volume of water (e.g., three well volumes) may be suitable for adequate purging, and sampling can commence. Check with the project-specific work plan and appropriate regulatory guidance to determine any specific purging requirements.

If the well has been previously sampled consistent with this SOP, then the prior purging strategy (e.g., method, pump intake depth and the flow rates) should be followed during subsequent sampling events to maintain consistency and minimize potential variability due to the sampling procedure.

2.2.1 Multiple-Volume Purging Approach

The multiple-volume purging approach is typically performed using bailers or submersible or peristaltic pumps. In the multiple-volume purging approach, there are two measurements used to determine adequate purge volume removal prior to sample collection: 1) purge volume and 2) field parameter stabilization. The field parameters should be recorded at regular volumetric intervals. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough (e.g., every 3 to 5 minutes) to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes may be sufficient.

Purge Volume

Prior to purging a well, the amount of water inside the well riser and well screen (i.e., water column) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. The specific methodology for obtaining these measurements is included in SOP 004 *Water Level and Product Measurements*.

Once this information is known, the well volume can be calculated using Equation 1:

Well Volume (V) = $\pi r^2 h$ (cf) **Equation 1**

where:
π = pi (3.14)
r = radius of well in feet (ft)
h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3.

The volume in gallons/linear foot (gal/ft) and liters/linear foot (L/ft) for common-size wells are as follows:

Well Inside Diameter (inches)	Volume (gal/ft)	Volume (L/ft)
1	0.0408	0.1529
2	0.1631	0.6174
3	0.3670	1.3892
4	0.6524	2.4696
6	1.4680	5.5570

If the volumes for the common-size wells above are utilized, Equation 1 is modified as follows:

Well volume = (h)(f) **Equation 2**

where:
h = height of water column (feet)
f = the volume in gal/ft or L/ft

For volumetric purging, an adequate purge is typically achieved when 3 to 5 well volumes have been removed. The field notes should reflect the single-well volume calculations or determinations according to one of the above methods and a reference to the appropriate multiplication of that volume, (i.e., a minimum of 3 well volumes) clearly identified as a purge volume goal.

For volumetric purging, it is suggested that field readings are collected every ½ well/well screen volume after an initial 1 to ½ well volumes are purged. The volume removed between readings can be adjusted as well-specific information is developed.

If removing a specified volume of water (e.g., 3 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume. In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection. If, after 3 well volumes have been removed, the field parameters have not stabilized (see discussion in Section 2.2.3), additional well volumes (up to a total of 5 well volumes), should be removed. If the parameters have not stabilized within five well volumes, it is at the discretion of the Project Manager whether or not to collect a sample or to continue purging. If, after 5 well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible with respect to turbidity. The conditions of sampling should be noted in the field book.

2.2.2 Low-flow Purging Approach

The low-flow purging approach is typically performed using peristaltic pumps or submersible pumps. Low-flow purging (also referred to as low-stress purging, low-volume purging, or Micropurging®) is a method of well purging/sampling that minimizes the volume of water withdrawn from a well in obtaining a representative sample. The term low-flow refers to the low velocity with which water enters the pump intake during purging and sampling. The objective is to draw representative saturated zone water through the well screen to the pump intake while avoiding disturbance of the stagnant water above the well screen through minimizing drawdown of the water column in the well. To achieve this, the flow rate should be adjusted to less than 1 L/min (usually, this will be a rate less than 500 ml/min and may be as low as 100 ml/min). Once drawdown stabilizes, the sampled water is isolated from the stagnant water in the well casing, thus eliminating the need for its removal. This sampling method is based on the principle that water within the screened zone passes through continuously and does not mix with water above the screen. Water entering the pump can be considered representative of water in the formation after drawdown and indicator parameters have stabilized.

When performing low-flow purging and sampling, it is recommended that the pump intake be set in the center of the well screen interval (or center of the water column within the well screen if the water level is below the top of the well screen) to help prevent disturbance of any sediment at the bottom of the well. If known, the pump can be placed adjacent to the areas with the highest hydraulic conductivity or highest level of contaminants. Dedicated pumps can be utilized to minimize disturbance of the water column. Subsequent sampling events should duplicate as closely as possible the pump intake depth and the stabilized flow rate from the previous events.

To begin purging, the pump should be started at the lowest pressure/power flow rate setting (e.g., 100 mL/min) and then slowly increased until water begins discharging. Monitor the water level and slowly adjust the pump speed until there is little or no drawdown or drawdown has stabilized. The pump pressure/power may need to be increased for discharge to occur.

The stabilization of drawdown should be documented. Measure and record the flow rate and water level every 3 to 5 minutes during purging. The flow rate should be reduced if drawdown is greater than 0.3 feet over three consecutive 3 to 5 minute interval readings. Note any flow rate adjustments on the Groundwater Field Data Record. Once an appropriate purge rate has been achieved, record this information, continue purging until water quality indicator parameters have stabilized (see Section 2.2.3), and then sample the well.

Attempts should be made to avoid pumping a well dry. If drawdown cannot be maintained at less than 0.3 feet and the falling water level is approaching the top of the screened interval (or the top of the pump for sampling that began with the water level below the top of the screen), perform the following steps:

1. Reduce the flow rate, or turn the pump off and allow for recovery. (The pump must have a check valve to prevent backflow if it is shut off).
2. Begin pumping again at a lower flow rate.
3. If water draws down to the top of the screened interval again (or the top of the pump for sampling that began with the water level below the top of the screen), turn the pump off and allow for recovery.
4. If two tubing volumes (including volume of water in the pump and flow-through cell) have been removed during purging, sampling can proceed the next time the pump is turned on without waiting for indicator field parameters to stabilize. The project-specific work plan or Project Manager should be consulted for guidance.
5. If this procedure is used, this should be recorded in the field book and/or on the Groundwater Field Data Record.

2.2.3 Field Parameter Stabilization During Purging

Stabilization criteria may depend on project objectives or regulatory-specific requirements. Refer to Appendix A for some of the regulatory-specific requirements for field parameter stabilization. Generally, an adequate purge with respect to the ground water chemistry is achieved when, stability for at least three consecutive measurements is as follows:

- pH ± 0.1 standard unit (SU)
- specific conductance within 3%
- turbidity within 10% for values greater than 5 nephelometric turbidity units (NTUs). If three turbidity readings are less than 5 NTUs, the values are considered as stabilized

Other parameters, such as DO, may also be used as a stabilization parameter. Typical stabilization goals for DO are within 0.2 mg/L or 10% saturation, whichever is greater. DO measurements should be conducted using either a flow-through cell or an over-topping cell to minimize or reduce potential oxygenation of the sample.

Because groundwater temperature is generally not very sensitive in distinguishing between stagnant casing water and formation water and is subject to rapid changes during purging, its usefulness is subject to question for the purpose of determining parameter stability. Even if temperature is not used to determine stability during well purging, it is still advisable to record the sample temperature, along with the other groundwater chemistry parameters, during well purging, as it may be needed to interpret other parameter results.

ORP is not always used as a stabilization parameter since it may also be subject to rapid changes during the purging process; however, it may be measured and recorded during well purging.

2.2.4 Special Considerations During Purging

Wells Purged Dry/Purge Adequacy
For wells with slow groundwater recovery, attempts should be made to avoid purging the well dry. This may be accomplished by slowing the purge rate. As water enters a well that has been purged dry, the water may cascade down the sand pack and/or the well screen, potentially stripping VOCs that may be present and/or potentially mobilizing soil fines into the re-accumulating water column.

However, even with slower purge rates, in some situations, a well may be pumped or bailed dry (evacuated) during the purging process. In these situations, evacuation generally constitutes an adequate purge and the well may be sampled following sufficient recovery (enough volume to allow filling of all sample containers). **It is not necessary that the well be evacuated three times before it is sampled.** Purging parameters should be measured and recorded during sample collection to serve as the measurements of record for the sampling event.

It is particularly important that wells be sampled as soon as possible after purging to maintain sample representativeness. If adequate volume is available upon completion of purging, the well should be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. If possible, sampling of wells that have a slow recovery should be scheduled so that they can be purged and sampled in the same day after adequate volume has recovered. Wells of this type should, unless it is unavoidable, not be purged at the end of one day and sampled the following day.

Temporary Monitoring Wells
Procedures used to purge temporary groundwater monitoring wells may differ from permanent wells, because temporary wells are installed with different DQOs for immediate sample acquisition. Wells of this type may include standard well screens and risers placed in boreholes created by hand augering, power augering, or by drilling. Alternatively, they may consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15/16 sampler, or a Hydropunch® sampler.

Purging to address stagnant water may not necessarily apply to temporary wells, because stagnant water is not typically present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column may become, and the more appropriate it may be to apply, to the extent possible, standard permanent monitoring well purging criteria.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing saturated conditions, resulting primarily in increased turbidity. Therefore, the goal of purging, if conducted, may be to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low-stress purging techniques using variable-speed peristaltic pumps.

2.2.5 Equipment Considerations for Purging

Monitoring well purging is accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The pump of choice is usually a function of the purging approach (e.g., multiple-volume vs. low-flow), well diameter, the DTW, the total depth of the well, the amount of water that is to be removed during purging, the specific analytical testing program for the well, and the equipment previously used during purging and sampling of the well. A peristaltic pump is appropriate for purging whenever the head difference between the sampling location and the water level is less than the limit of suction (approximately 25’ to 30’) and the volume to be removed is reasonably small. For wells where the water level is below the limit of suction, and/or where there is a large volume of water to be purged, the variable-speed electric submersible pump or adjustable-rate bladder pumps would be appropriate. Bailers may also be used for purging in appropriate situations (e.g., shallow wells with small purge volumes); bailers are not suitable for low-flow purging.

The following subsections describe well evacuation devices that are most commonly used. Other devices are available but are not discussed in this SOP due to their limited use. Site-specific operating procedures should be developed in the case that an uncommon purge device is used.

2.2.5.1 Purging with a Suction Pump

There are many different types of suction pumps. They commonly include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low-volume pump that incorporates a roller to squeeze flexible tubing, thereby creating suction. This tubing can be dedicated to a well for re-use or discarded. It is recommended that 1/4 inch or 3/8 inch (inner diameter) tubing be used to help ensure that the sample tubing remains filled with water and to prevent water from being aerated as it flows through the tubing. Purging procedures are as follows.

(a) Determine the volume of water to be purged as described in Section 2.2.1 or follow the low-flow approach described in Section 2.2.2 (applicable to peristaltic pumps only).
(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of pumps, tubing or other purging/sampling equipment with foreign materials.
(c) Assemble the pump, tubing and power source, if necessary, in accordance with manufacturer’s specifications.
(d) Ensure that the pump tubing is set at the pre-determined pump intake depth.
(e) Connect the discharge line from the pump to the flow-through cell for parameter measurements. Use a T-connection or valve prior to the flow-through cell to allow for collection of water for turbidity measurements. Direct the discharge line from the flow-through cell to a 5-gallon bucket (or equivalent) to contain the purge water for proper disposal. Verify the end of the tubing is not submerged in the purge bucket. Manage purge water as specified in the project-specific work plan.

(f) Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, adjust the rate accordingly or, if consistent with the purging and sampling objectives, lower the tubing further into the well and continue pumping.

(g) Using the water quality meter, take an initial reading of the required indicator parameters. All measurements, except turbidity, must be obtained using a transparent flow-through cell unless an unforeseen situation makes this impractical or inadvisable. Initially, turbidity may be elevated. Once turbidity has decreased to a measurable range, begin monitoring indicator parameters at approximately every 3-5 minutes, or as appropriate. Please note that flow-through cell size should be taken into account in conjunction with the flow rate to determine the length of time between water quality parameter readings. At least one flow-through cell volume should be turned over between readings. For example, if the flow through cell size is 500 mL and the flow rate is 100 mL/min, then it would be appropriate to measure water quality parameters every 5 minutes.

(h) Record the readings on the Groundwater Field Data Record. The monitoring probes must be submerged in water at all times. Record the indicator parameters, along with the water level, as described in Step (g) above. If removing a specified volume of water (e.g., 3-5 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume. In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection. Stabilization criteria are discussed in Section 2.2.3.

Particulate build-up in the flow-through cell may impact indicator parameters. If the cell must be cleaned during pumping operations, continue pumping and disconnect the cell for cleaning, then reconnect and continue monitoring. Record the start and stop times, and describe the cleaning steps in the field book.

If indicator parameter stabilization is required and parameters have not stabilized after 2-hours of purging (or other pre-determined length of time), one of three options may be taken after consultation with the Project Manager:

1) continue purging until stabilization is achieved;
2) discontinue purging, do not collect any samples, and record in the field book and/or on the Groundwater Field Data Record the stabilization conditions and steps taken to attempt to achieve stabilization; or,
3) discontinue purging, collect samples and document attempts to achieve stabilization.

NOTE: If parameters do not stabilize, or turbidity remains greater than 5 NTU within the project-determined time range (EPA recommends up to 2 hours), contact the Project Manager to develop a modified sampling approach.

(i) Record the volume of water purged on the Groundwater Field Data Record. Record the disposal method used for purge water in the field book.

(j) Once the required volume of water is removed (typically 3 to 5 well volumes) from the well and/or parameters are stabilized to the satisfaction of the project-specific work plan, proceed to Section 2.3, Post-purging Groundwater Sample Collection.

2.2.5.2 Purging with a Submersible Pump

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas. Electric pumps can be powered by a 12-volt DC rechargeable battery, or a 110-

or 220-volt AC power supply. Those units powered by compressed gas (e.g., bladder pump) normally use a small electric controller that also needs a 12-volt DC battery or 110-volt AC power. They may also utilize compressed gas from bottles. Pumps differ according to the depth and diameter of the monitoring wells and the height of the potentiometric surface/water table (e.g., pressure head). It is recommended that 1/4-inch or 3/8-inch (inner diameter) tubing be used to help ensure that the sample tubing remains filled with water and to prevent water from being aerated as it flows through the tubing. Purging procedures are as follows.

(a) Determine the volume of water to be purged as described in Section 2.2.1 or follow the low-flow approach described in Section 2.2.2.

(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of pumps, tubing or other purging/sampling equipment with foreign materials.

(c) Assemble the pump, tubing and power source, if necessary, in accordance with manufacturer's specifications. If the pump itself is being lowered into the well, ensure a safety line is attached.

(d) Non-dedicated purge/sampling vs. dedicated purge/sampling systems.

<u>Dedicated systems:</u> Pump has already been installed. Refer to historical monitoring well information, and record the depth of the pump intake in the field book and/or on the Groundwater Field Data Record.

<u>Non-dedicated systems:</u> Determine the target depth of the pump intake. Note that this may be a historical intake depth; see well construction data or the project-specific work plan. If there is not an established intake depth, the center of the screened interval should be targeted. If the measured water level is lower than the top of the well screen, position the pump intake at the midpoint of the water column. The intake should be generally 1 to 2 feet above the bottom of the well to minimize potential mobilization of any settled sediment, the risk of the pumping suction being broken, or the entrainment of air in the pump tubing and resulting sample. Slowly lower the pump, safety line, and tubing into the well to the pre-determined pump intake depth. The tubing should be cut to the desired length to assist in installing the pump. Measure the depth of the pump intake while lowering the tubing/pump into location. Record the pump intake depth in the field book and/or on the Groundwater Field Data Record. For deeper wells and large diameter wells, two staff members may be necessary to accomplish this task.

(e) Connect the discharge line from the pump to the flow-through cell for parameter measurements. Use a T-connection or valve prior to the flow-through cell to allow for collection of water for turbidity measurements. Direct the discharge line from the flow-through cell to a 5-gallon bucket (or equivalent) to contain the purge water for proper disposal. Verify the end of the tubing is not submerged in the purge bucket. Manage purge water as specified in the project-specific work plan.

(f) Measure the flow rate of the pump with a graduated container and stop watch. The pump pressure may need to be increased for discharge to occur. Record the volume of water collected for a period of 1 minute and calculate the flow rate as follows.

$$Flowrate\,(mL\ /\ min) = \frac{volume\ collected\ (mL)}{1\,minute}$$

(g) Measure the water level and record the flow rate and the water level. This should be performed every 3 to 5 minutes during purging. For low-flow purging, the flow rate should be adjusted to result in a rate between 100 to 500 mL/min; however, if drawdown of the well is observed, a slower flow rate may be necessary. If using a bladder pump, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL volatile organic analysis (VOA) vial, if possible.

(h) Prior to recording the water quality indicator parameters, a minimum of one tubing volume should be purged. Note that this includes the volume of the flow-through cell.

(i) Proceed to steps (g) through (j) in Section 2.2.5.1.

2.2.5.3 Purging with a Bailer

(a) Determine the volume of water to be purged as described in Section 2.2.1.

(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of tubing or other purging/sampling equipment with foreign materials.

(c) Use a well-dedicated bailer (i.e., used exclusively for that well only), a decontaminated bailer or an unused, disposable bailer.

(d) Attach an appropriate length of (a) bailing line, (b) Teflon®-coated bailing wire or (c) rope with Teflon®-coated stainless steel leader to reach the bottom of the well. Secure a knot or series of knots to the top of the bailer. Be sure to have additional length of line to facilitate handling of the bailer at the surface (typically 10 ft).

(e) Lower the bailer gently into the well until it reaches the water column and fills with water from the bottom. Note: It is recommended that the bailer be lowered into the water to a depth that prevents the water from entering the top of the bailer. This is done to prevent excess turbulence caused by filling from the bottom and the top simultaneously. Controlling the line attached to the bailer as it is lowered into the well is also important to prevent degassing of the water as the bailer impacts the water. In shallow wells, controlling the line is not too difficult; however, for wells of greater depths it is common to utilize a hand-over-hand (windmill) approach using both hands to control longer lengths of line and prevent the loops in the line from tangling with one another. This procedure is simple to learn and saves a good deal of time by preventing tangles. Do not allow the bailing line or rope to become contaminated by surface soil.

(f) Once the bailer is full of water, gently withdraw the bailer from the well until it comes out of the top of the well. Be sure to control excess line in your hands to prevent the rope and bailer from touching the ground, and then grasp the bailer as it appears at the top of the well.

(g) Immediately pour the water into a vessel for water quality measurements, and record the measurements in the field book or on the Groundwater Field Data Record (at the project-required frequency). Otherwise, pour water into a 5-gallon bucket or other vessel to track the volume purged. As a general rule, standard 2-inch bailers are able to hold about 1 liter of water when full. This process will have to be repeated several times to complete adequate purging of the well (e.g., three to five well volumes).

(h) Record the volume of water purged on the Groundwater Field Data Record. Record the disposal method used for purge water in the field book.

(i) Once the required volume of water is removed (typically 3 to 5 well volumes) from the well and/or parameters are stabilized to the satisfaction of the project-specific work plan, proceed to Section 2.3, Post-purging Groundwater Sample Collection.

2.3 Post-purging Groundwater Sample Collection

(a) New, disposable gloves should be donned immediately prior to sample collection and should be changed at any point that their cleanliness becomes compromised during sample collection.

(b) If using a submersible or peristaltic pump, maintain the same flow rate as used during purging. Disconnect the pump tubing from the flow-through cell or sample from the T-connector, if used. Samples must be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. This is critically important to avoid cross-contamination between wells.

(c) If using bottom-filling bailers,

- Slowly lower the bailer into the well until it is submerged to the point where water does not enter the top (i.e., bottom-filling).
- Retrieve the bailer. The first bailer recovered after well purging must be used for sample collection.

2.3.1 Sample Collection Order

Fractions of the groundwater sample should be collected in the following order (i.e., decreasing volatility) unless otherwise specified in the project-specific work plan:

1. VOCs;
2. Semivolatile organic compounds (SVOCs);
3. Other organic parameters;
4. Unfiltered inorganic constituents (e.g., total metals);
5. Filtered inorganic constituents (e.g., dissolved metals); and
6. Other constituents.

During sample collection, allow the water to flow directly down the side of the sample container without allowing the tubing to touch the inside of the sample container or lid in order to minimize aeration and turbulence and maintain sample integrity. The tubing should remain filled with water.

2.3.2 VOC Sample Collection

<u>Collection of VOCs/Volatile Petroleum Hydrocarbons (VPH):</u> Samples for VOCs will be collected first unless they are being collected by the “straw” method described in Section 1.6.2 (d), and the sample vial must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken to not flush any preservative out of the vial when topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected. Note: Extra VOC vials should be obtained prior to the sampling event in case this situation occurs.

Note: When using a bladder pump, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 ml VOA vial, if possible.

When acid preservation is used for the collection of VOCs, the acid must be added to the vials before sample collection. However, in most cases 40-ml VOA vials come pre-preserved. If a pre-preserved vial effervesces upon the addition of sample, the acid preservative can be rinsed out of the vial with sample water and then used to collect the sample. The laboratory should be made aware that the affected sample will not be acid-preserved as this may affect the sample holding time. Note effervescence in the field book for future reference.

2.3.3 Non-VOC Sample Collection

Completely fill the remaining sample containers for all non-VOC analyses.

Preserve the non-VOC samples in accordance with method and project-specific requirements following sample collection if the sample containers are not pre-preserved. (**NOTE:** Pre-preserved vials may be supplied by the laboratory, depending on the program).

2.3.4 Field Filtering

Depending upon project requirements, field filtering may be performed for non-VOC analyses. An in-line filter should be fitted at the end of the discharge tubing and the sample should be collected after the filter. Pre-rinse the in-line filter by allowing a minimum of 0.5 to 1 liter of groundwater from the well to pass through the filter prior to sampling. Ensure the filter is free of air bubbles prior to collecting samples. Preserve the filtered water sample immediately or directly fill pre-preserved containers (if provided). Clearly note “filtered” or “dissolved” on sample label and COC document.

2.4 Groundwater Sample Collection Without Purging (Passive Sampling)

Passive sampling can be defined as the free flow of contaminants from the media being sampled to a receiving phase in a sampling device. Depending upon the sampler, the receiving phase can be a solvent (e.g., water), chemical reagent, or porous adsorbent (e.g., activated carbon). While there are many different types of passive samplers, most have a barrier between the medium being sampled and the receiving phase. The barrier determines the sampling rate that contaminants are collected at a given concentration and can be used to selectively permit or restrict various classes of chemicals from entering the receiving phase.

There are three generic forms of passive (no purge) samplers: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers. However, this SOP focuses on the more commonly used diffusion (equilibrium) samplers.

Passive samplers are deployed down a well to the desired depth within the screened interval or open borehole to obtain a discrete sample without using pumping or a purging technique. Most samplers are able to be stacked to obtain samples at multiple depths. Some samplers can also be used to measure contaminants in groundwater as it enters a surface water body.

Diffusion, or equilibrium, samplers are devices that rely on diffusion of the analytes to reach equilibrium between the sampler fluid and the well water. Samples are time-weighted toward conditions at the sampling point during the latter portion of the deployment period. The degree of weighting depends on analyte and device-specific diffusion rates. Typically, conditions during only the last few days of sampler deployment are represented. Depending upon the contaminant of concern, equilibration times range from a few days to several weeks. Diffusion samplers are less versatile than grab samplers as they are not generally effective for all chemical classes.

Both the diffusion and integrating samplers depend upon permeation or diffusion through barriers that hold the receiving phase. This diffusion process is chemical and barrier specific. Diffusion samplers are commonly known as PDBs or rigid porous polyethylene (RPP) samplers. PDBs may be used to sample for VOCs, and RPPs may be used to sample for various organic and inorganic constituents. PDBs must be allowed to remain in the well for a sufficient period of time to allow the deionized water in the sampler to come into equilibrium with the constituents in the ambient groundwater.

Some regulatory agencies allow groundwater samples to be collected without purging the well. This may be accomplished by suspending a passive sampler in the well for a period of time appropriate for the type of passive sampler being used. It is important to confirm that the chosen sampler is compatible with the contaminants of concern including all VOCs of interest at the site.

Diffusion passive samplers are used most commonly and the procedure for their use is as follows:

(a) Passive samplers are deployed at a predetermined depth across the well screen. Typically, the initial sampling event may deploy multiple passive samplers across 5-foot intervals of saturated well screen to observe any potential stratification. Long-term sampling depths typically target a zone of higher concentration, if present.

(b) New passive samplers are attached via PVC cable ties to a tether (a pre-made marine-grade polyethylene rope or stainless steel cable with a weight at the bottom) that is then suspended within the well. There should be sufficient well screen saturation within the well to completely cover the passive sampler. For VOCs, it is recommended that there should be several feet of groundwater above the top of the PDB.

(c) The passive sampler should be allowed to equilibrate with groundwater for an appropriate period of time (e.g., at least 2 weeks for PDB samplers). Longer equilibration times may be necessary in lower permeability formations. Once sufficient time for equilibration has passed, the PDB samplers can be retrieved when convenient.

(d) Raise the passive sampler to the surface using a tether reel. Examine the surface of the passive sampler for evidence of algae, iron, or other coatings, and for tears to the membrane. Note observations in the field book. If tears are present and water is leaking out, the sample is not considered viable. Contact the Project Manager.

(e) Detach the passive sampler from the tether.

(f) Remove excess beaded water from the passive sampler with a clean gloved hand, running top to bottom; this is to minimize the contact of beaded water with water in the passive sampler.

(g) Use a small diameter discharge tube (<0.15 inch diameter to reduce volatilization) and pierce near the bottom, allowing water to smoothly flow into the VOA vial. Tilting the passive sampler will control the flow rate. The VOA vials must be filled within the first several minutes of passive sampler retrieval. (Note that sample vials should be prepared and opened on a stable surface or holding device such as a foam pack. Decanting sample from passive samplers into containers requires techniques that may require some practice and patience.) Refer to Section 2.3.2 for special circumstances regarding the filling of VOA vials.

(h) A small amount of water may remain within the passive sampler after filling the VOA vials and can be used for field parameter measurements if required.

(i) Dispose of the passive sampler after use.

2.5 Post-sampling Activities

(a) Cease pumping and, if system is non-dedicated, disassemble and decontaminate the purging and sampling equipment. Verify the end of the tubing is not submerged in the purge bucket prior to turning off the pump.

(b) Dispose of the bailer (if disposable) and/or rope and/or other disposable equipment in accordance with the project-specific work plan, or store the bailer in a plastic bag for transport to the site decontamination area.

(c) Dispose of the empty passive sampler and/or rope and/or other disposable equipment in accordance with the project-specific work plan, or store the empty passive sampler in a plastic bag for transport to the site decontamination area

(d) Replace the well cap and well cover on the well and lock the outer casing (if present).

(e) Label each sample. If the labels are covered with clear tape, ensure this is not performed for VOA vials.

(f) Place all samples in a cooler with ice.

(g) Ensure samples are delivered to the laboratory well before the required holding time expires.

(h) Consult the project-specific work plan to determine if a calibration check is required at the end of the day for the water quality parameters.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager.

Each project must consider investigation-derived waste disposal methods and have a plan in place prior to performing the field work. Provisions must be in place as to what will be done with investigation-derived waste. If investigation-derived waste cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The collection of QC samples is dependent upon the DQOs. Project-specific work plans should be consulted to determine the required frequency of QC sample collection.

4.1 Field Duplicates

The following procedures should be used for collecting field duplicates of groundwater samples:

(a) For QC purposes, each duplicate sample will be typically submitted to the laboratory as a “blind” duplicate sample, in that a unique sample identification not tied to the primary sample identification will be assigned to the duplicate (e.g., DUP-01). Standard labeling procedures used for groundwater sampling will be employed. However, a sample collection time will not be included on the sample label or the COC form. The actual source of the duplicate sample will be recorded in the field book and/or on the Groundwater Field Data Record.

(b) Each duplicate sample will be collected simultaneously with the actual sample by alternately filling sample and duplicate bottles. Following the order of collection specified for each set of containers (VOCs, SVOCs, other organic parameters, unfiltered inorganic constituents, and filtered inorganic constituents), the duplicate sample containers will be alternately filled with groundwater for each parameter.

(c) All collection and preservation procedures outlined for groundwater sampling will be followed for each duplicate sample.

4.2 Equipment Blanks

Equipment blanks include reagent water that is run through the bailer (if not disposable), rope, leader line, decontaminated pump, a representative section of the pump’s tubing, or any other piece of sampling equipment that may have come in contact with the sample. The equipment blanks are collected and preserved in the same sample containers as field samples. If dedicated or disposable systems are used, equipment blanks are not required, although an initial blank could be performed to demonstrate that the dedicated equipment is clean prior to use. If only dedicated tubing is used, the equipment blank will include only the pump in subsequent sampling events. A passive sampler is considered a dedicated device and no equipment blank is required.

Ideally, the reagent water should come from the laboratory and be certified clean. If not certified and/or if not from the laboratory performing the analyses, a separate water blank that has not run through the sampling equipment should be sent to the laboratory for analysis.

4.3 Trip Blanks

Trip blanks will be used to check for potential contamination of VOCs via migration during storage and shipping. Trip blanks typically consist of two to three 40 mL VOA vials filled with analyte-free water and preserved with hydrochloric acid (HCl) to pH <2 SU. Trip blank containers are usually supplied pre-filled by the laboratory. Trip blanks are typically submitted to the laboratory at a frequency of one per cooler for coolers that contain samples for VOC and/or VPH analysis. Trip blanks are analyzed by the laboratory for VOCs and/or VPH, depending on field sample analyses.

4.4 MS/MSDs and MS/Duplicates

MSs are an additional analysis of a sample spiked by the laboratory with a subset or all of the target analytes and are used to demonstrate the accuracy of analytical methods for a given matrix. MSDs are an additional analysis of a sample spiked with a subset or all of the target analytes and are also used to demonstrate the accuracy of analytical methods for a given matrix. MS/MSDs also provide a measure of analytical precision for a given matrix. Duplicates are an additional analysis of a sample and are used to demonstrate the precision of analytical methods for a given matrix.

Triplicate volumes of a field sample must be collected in order for the laboratory to have enough volume to perform the MS/MSD analyses for organic parameters. Duplicate volumes of a field sample must be collected in order for the laboratory to have enough volume to perform MS/Duplicate analyses for inorganic parameters. The sample designated for MS/MSD or MS/Duplicate analyses should be noted in the Comments column of the COC document.

4.5 Temperature Blanks

Temperature blanks consist of a sample container filled with non-preserved water (potable or distilled) and typically are included in all coolers that contain samples that require temperature preservation. These may be added to the coolers by the field team if not provided by the laboratory. Temperature blanks must remain inside the coolers on ice during the sampling process.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Record the sample location, sample identification, and date and time of collection in the field book and/or the Groundwater Field Data Record. The Groundwater Field Data Record (Attachment B) should be used to record the following information:

- Volume of each sample
- Sample identification number
- Sample location (sketch of the sample point)
- Time and date sample was collected
- Personnel performing the task
- Volume of water removed
- Purging time
- Flow rate during purging and sampling
- Weather conditions during sampling
- Field parameters such as water level, pH, temperature, conductivity, turbidity, ORP, and DO
- Sample collection equipment and method used
- Decontamination procedures
- Analytical parameters
- Preservation method and amount of preservative

All sample numbers must be documented on the COC form that accompanies the samples during shipment. Any deviations from the records management procedures specified in the project-specific work plan must be approved by the Project Manager and documented in the field book.

6.0 REFERENCES

Interstate Technology Regulatory Council (ITRC). March 2006. *Technology Overview of Passive Sampler Technologies.*

USEPA. November 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance*. EPA/530-R-93-001. USEPA Office of Solid Waste.

USEPA. April 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA Ground Water Issue. EPA/540-S-95-504. USEPA Office of Solid Waste and Emergency Response.

USEPA. May 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. EPA/542-S-02-001. USEPA Office of Solid Waste and Emergency Response.

USEPA. September 2004. Field Sampling Guidance Document #1220: Groundwater Well Sampling. USEPA Region 9 Laboratory Richmond, California.

USEPA, January 19, 2010. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*. USEPA Region 1, Rev. 3.

USEPA. March 6, 2013. *Groundwater Sampling.* SESDPROC-301-R3. USEPA Region 4, Science and Ecosystem Support Division. Athens, Georgia.

USEPA. April 22, 2014. Passive (No Purge) Samples.
http://www.clu-in.org/characterization/technologies/default.focus/sec/Passive_%28no%20purge%29_Samplers/cat/Overview/

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	AUGUST 2014	NOT APPLICABLE
1	JULY 2016	ADDED ATTACHMENT D TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFCS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.
2	NOVEMBER 2016	ADDED ADDITIONAL INFORMATION REGARDING PFAS.

Attachment A:

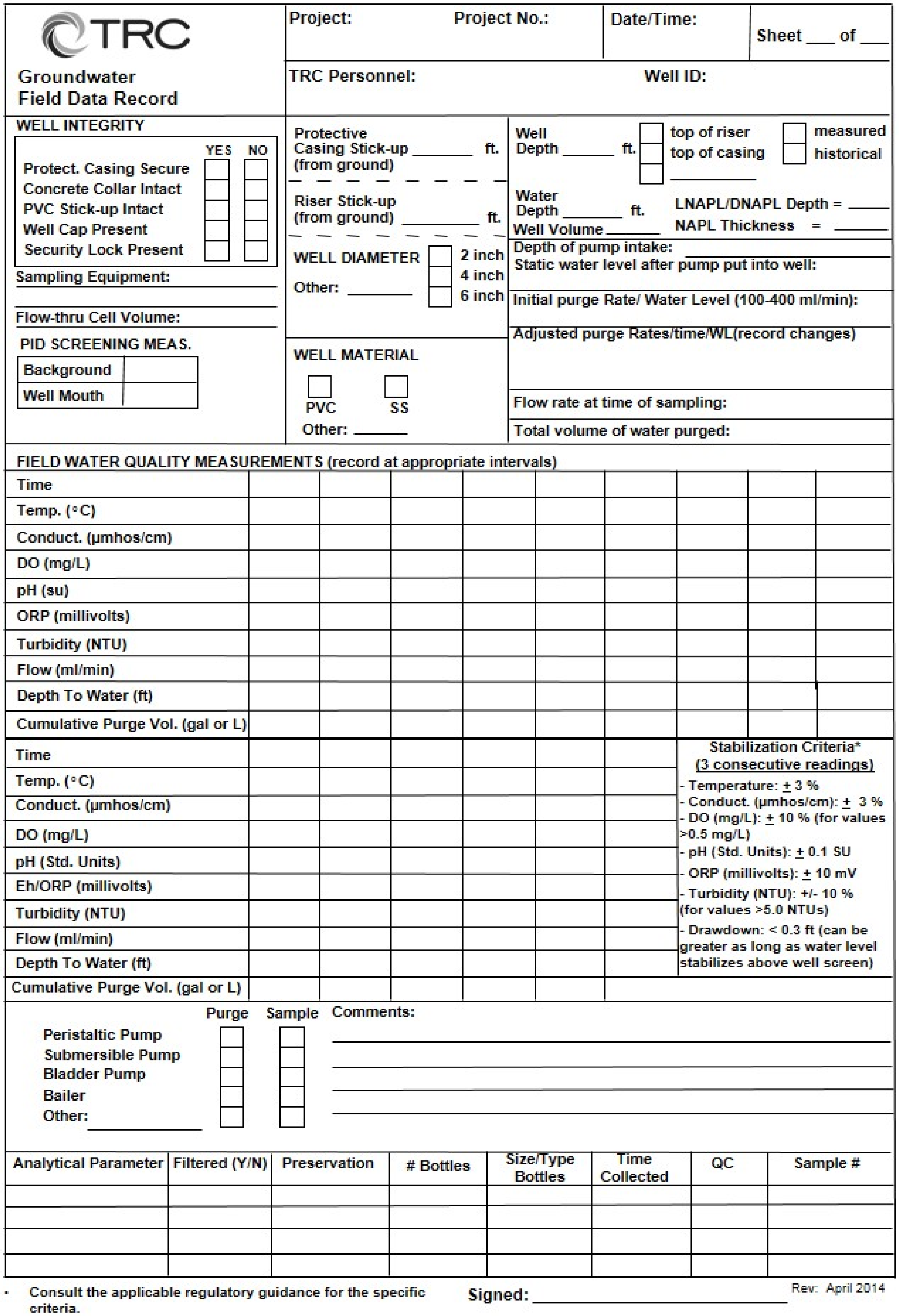
Groundwater Field Parameter Stabilization Criteria for Selected Jurisdictions

Jurisdiction	Information Source	Applicable Stabilization Criteria
USEPA Region 1	Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells; U.S. Environmental Protection Agency Region 1, January 19, 2010. http://www.epa.gov/region1/lab/qa/pdfs/EQASOP-GW001.pdf (for low flow PDF) http://www.epa.gov/region1/lab/qa/qualsys.html (for EPA's Quality System Documents)	pH: ±0.1 unit Specific Conductance: ±3% Temperature: ±3% Turbidity: ±10% if >5 NTUs; if three Turbidity values are <5 NTU, consider the values as stabilized Dissolved Oxygen: ±10% if >0.5 mg/L, if three Dissolved Oxygen values are <0.5 mg/L, consider the values as stabilized Oxidation/Reduction Potential: ±10 millivolts
USEPA Region 2	Groundwater Sampling Procedure: Low Stress (Low Flow) Purging and Sampling, SOP # SST-7, Revision No. 1, November 2010.	Same as above
USEPA Region 4	USEPA Region 4 SOPs: http://www.epa.gov/region4/sesd/fbqstp/index.html See Chemical Parameter Stabilization Criteria (section 3.2.1.1.2 of Groundwater Sampling SOP, revision 3/6/2013: http://www.epa.gov/region4/sesd/fbqstp/Groundwater-Sampling.pdf	pH: ±0.1 unit Specific Conductance: ±5% Temperature: Not used Turbidity: "Stabilized" (no criteria specified) if >10 NTUs ; if three Turbidity values are <10 NTUs, consider the values as stabilized Dissolved Oxygen (optional parameter): ±0.2 mg/L or ±10% of saturation, whichever is greater Oxidation/Reduction Potential: Not used
USEPA Region 5	Ground Water Forum Issue Paper (May 2002, Yeskis and Zavala) http://www.epa.gov/superfund/remedytech/tsp/download/gw_sampling_guide.pdf A minimum set of parameters would include pH, conductivity, and turbidity or DO. Puls and Barcelona, 1996 (pH, specific conductance, ORP, turbidity) Wilde et al., 1998 (pH, turbidity, DO)	pH: ±0.1 unit Specific Conductance: ±3% Temperature: Not used Turbidity: ±10% if >10 NTUs Dissolved Oxygen: ±0.3 mg/L Oxidation/Reduction Potential: ±10 millivolts
USEPA Region 9	See USEPA Region 1 (above)	
USEPA Region 10	See USEPA Region 5 (above)	
Alabama	Alabama Environmental Investigation and Remediation Guidance (section C.3.1) http://www.adem.state.al.us/MoreInfo/pubs/AEIRGInvestigation.pdf	pH: ±0.1 unit Specific Conductance: ±10% Temperature: "Constant" (no criteria specified) Turbidity: Stabilized (no criteria specified), or <10 NTUs Dissolved Oxygen: No criteria specified Oxidation/Reduction Potential: No criteria specified

Jurisdiction	Information Source	Applicable Stabilization Criteria
Indiana	Indiana Department of Environmental Management The Micro-Purge Sampling Option http://www.in.gov/idem/files/remediation_tech_guidance_micro-purge.pdf The parameters normally measured for stability (listed in increasing order of sensitivity) are pH, temperature, specific conductivity, oxidation-reduction potential, DO and turbidity. At least one of the last three listed must be used.	pH: ±0.1 unit Specific Conductance: ±3% Temperature: ±3% Turbidity: ±10% Dissolved Oxygen: ±10% Oxidation/Reduction Potential: ±10 millivolts (document says microvolts, but that may be an error)
Michigan	MDEQ Part 201 Op Memo 2, Attachment 5 http://www.michigan.gov/documents/deq/deq-rrd-OpMemo_2_Attachment5_249853_7.pdf	No specific values to determine stabilization are listed, but the Op Memo lists several other groundwater sampling guidance documents. If a valid reference exists, then it can be used to justify a sampling approach and stabilization parameters.
New Jersey	New Jersey Department of Environmental Protection http://www.state.nj.us/dep/srp/guidance/fspm/	pH: ± 0.1 unit Specific Conductance: ± 3% Temperature: ± 3% Dissolved Oxygen: ± 10% Turbidity: ± 10% for values greater than 1 NTU ORP/Eh: ± 10 millivolts
Ohio	Ohio EPA SOPs: http://www.epa.state.oh.us/portals/30/rules/FSOPs.pdf See Purging Stabilization Criteria (SOP 2.2.4, dated January 2, 2007, review in progress)	pH: ±0.1 unit Specific Conductance: ±3% Temperature: No criteria specified Turbidity: Below 10 NTUs ideal; ±10% if greater than 10 NTUs Dissolved Oxygen: ±0.3 mg/L Oxidation/Reduction Potential: ±10 millivolts
This table was last updated in July 2014.		

Attachment B:

Example Groundwater Field Data Records



Groundwater Field Data Record

Project: Project No.: Date/Time: Sheet ___ of ___

TRC Personnel: Well ID:

WELL INTEGRITY

	YES	NO
Protect. Casing Secure	☐	☐
Concrete Collar Intact	☐	☐
PVC Stick-up Intact	☐	☐
Well Cap Present	☐	☐
Security Lock Present	☐	☐

Sampling Equipment:

Flow-thru Cell Volume:

PID SCREENING MEAS.

Background	
Well Mouth	

Protective Casing Stick-up _______ ft. (from ground)

Riser Stick-up (from ground) ________ ft.

WELL DIAMETER ☐ 2 inch ☐ 4 inch ☐ 6 inch
Other: ________

WELL MATERIAL ☐ PVC ☐ SS
Other: ______

Well Depth ______ ft. ☐ top of riser ☐ top of casing ☐ __________ ☐ measured ☐ historical

Water Depth _______ ft. LNAPL/DNAPL Depth = _____

Well Volume ______ NAPL Thickness = ______

Depth of pump intake: ____________________

Static water level after pump put into well:

Initial purge Rate/ Water Level (100-400 ml/min):

Adjusted purge Rates/time/WL(record changes)

Flow rate at time of sampling:

Total volume of water purged:

FIELD WATER QUALITY MEASUREMENTS (record at appropriate intervals)

Time									
Temp. (°C)									
Conduct. (µmhos/cm)									
DO (mg/L)									
pH (su)									
ORP (millivolts)									
Turbidity (NTU)									
Flow (ml/min)									
Depth To Water (ft)									
Cumulative Purge Vol. (gal or L)									

Time						Stabilization Criteria* (3 consecutive readings) - Temperature: ± 3 % - Conduct. (µmhos/cm): ± 3 % - DO (mg/L): ± 10 % (for values >0.5 mg/L) - pH (Std. Units): ± 0.1 SU - ORP (millivolts): ± 10 mV - Turbidity (NTU): +/- 10 % (for values >5.0 NTUs) - Drawdown: < 0.3 ft (can be greater as long as water level stabilizes above well screen)
Temp. (°C)						
Conduct. (µmhos/cm)						
DO (mg/L)						
pH (Std. Units)						
Eh/ORP (millivolts)						
Turbidity (NTU)						
Flow (ml/min)						
Depth To Water (ft)						
Cumulative Purge Vol. (gal or L)						

	Purge	Sample
Peristaltic Pump	☐	☐
Submersible Pump	☐	☐
Bladder Pump	☐	☐
Bailer	☐	☐
Other: ____________	☐	☐

Comments:

Analytical Parameter	Filtered (Y/N)	Preservation	# Bottles	Size/Type Bottles	Time Collected	QC	Sample #

- Consult the applicable regulatory guidance for the specific criteria.

Signed: ______________________________

Rev: April 2014

WATER SAMPLE LOG

PROJECT NAME:		PREPARED				CHECKED			
PROJECT NUMBER:		BY:		DATE:		BY:		DATE:	

SAMPLE ID:		WELL DIAMETER:	☐ 2"	☐ 4"	☐ 6"	☐ OTHER	________
WELL MATERIAL:	☐ PVC	☐ SS	☐ IRON	☐ GALVANIZED STEEL		☐ OTHER	________
SAMPLE TYPE:	☑ GW	☐ WW	☐ SW	☐ DI	☐ LEACHATE	☐ OTHER	________

PURGING	TIME:		DATE:	
PURGE METHOD:	☐ PUMP	________		
	☐ BAILER	________		
DEPTH TO WATER:	________	T/ PVC	FLOW-THRU CELL VOLUME	
DEPTH TO BOTTOM:	________	T/ PVC		
PUMP INTAKE DEPTH:	________	T/ PVC	________	LITERS
WELL VOLUME:	________	☐ LITERS	☐ GALLONS	
VOLUME REMOVED:	________	☐ LITERS	☐ GALLONS	
COLOR:	________	ODOR: ________		
TURBIDITY				
☐ NONE	☐ SLIGHT	☐ MODERATE	☐ VERY	
DISPOSAL METHOD:	☐ GROUND	☐ DRUM	☐ OTHER	

SAMPLE	TIME:		DATE:		
PH:	________	SU	CONDUCTIVITY:	________	umhos/cm
ORP:	________	mV	DO:	________	mg/L
TURBIDITY:	________	NTU			
☐ NONE	☐ SLIGHT	☐ MODERATE	☐ VERY		
TEMPERATURE:	________	°C	OTHER:	________	
COLOR:	________		ODOR:	________	
FILTRATE (0.45 um)	☐ YES	☐ NO			
FILTRATE COLOR:	________		FILTRATE ODOR:	________	
QC SAMPLE:	☐ MS/MSD	☐ DUP-	________		
COMMENTS:					

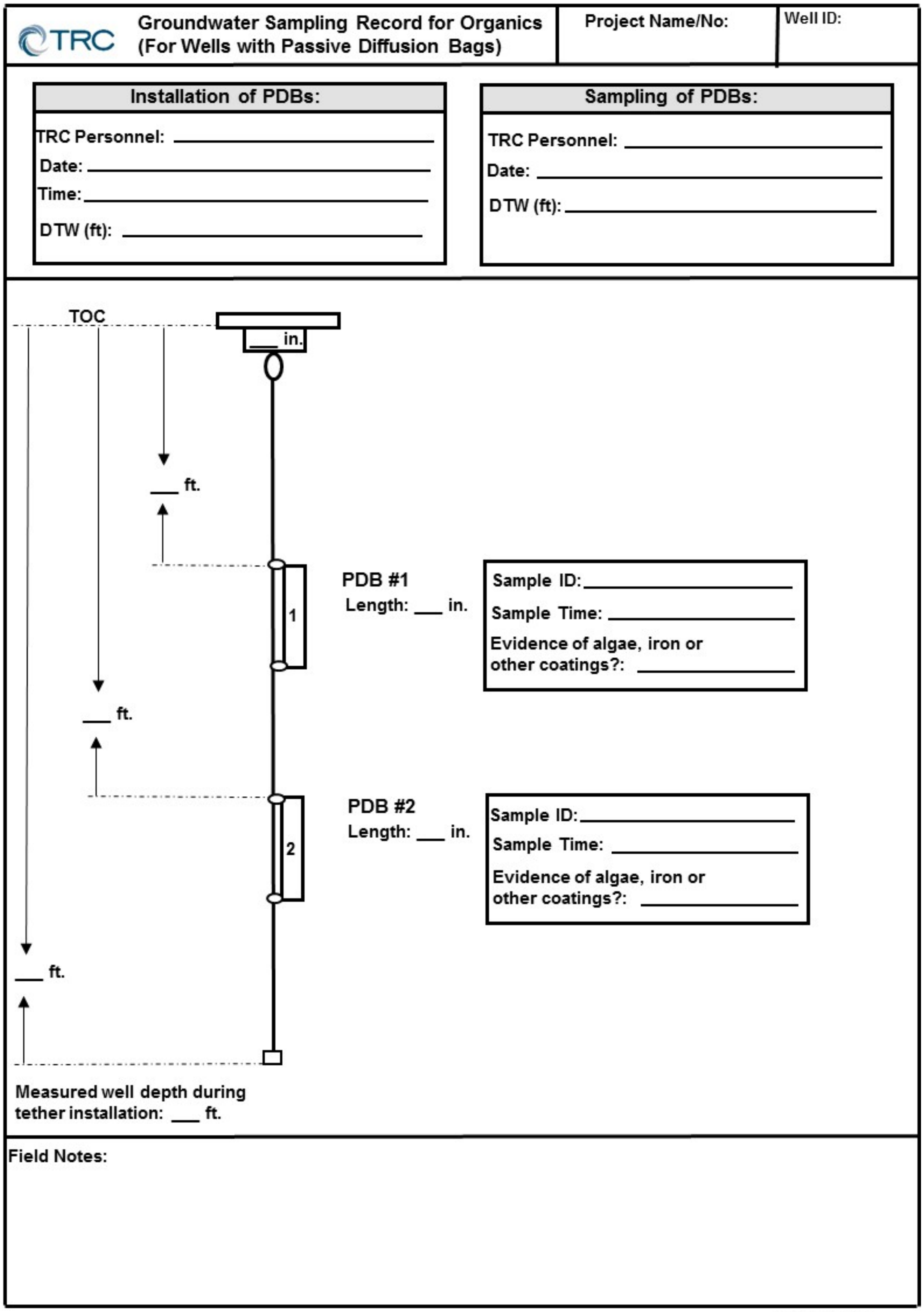
TIME	PURGE RATE (ML/MIN)	PH (SU)	CONDUCTIVITY (umhos/cm)	ORP (mV)	D.O. (mg/L)	TURBIDITY (NTU)	TEMPERATURE (°C)	WATER LEVEL (FEET)	CUMULATIVE PURGE VOLUME (GAL OR L)
									INITIAL

NOTE: STABILIZATION TEST IS COMPLETE WHEN 3 SUCCESSIVE READINGS ARE WITHIN THE FOLLOWING LIMITS:

pH: +/- **10 %** COND.: +/- **10 %** ORP: +/- **10 %** D.O.: +/- **10 %** TURB: +/- **10 %** or </= **5** TEMP.: +/- **0.5°C**

BOTTLES FILLED	PRESERVATIVE CODES	A - NONE		B - HNO3	C - H2SO4	D - NaOH		E - HCL	F - ________
NUMBER	SIZE	TYPE	PRESERVATIVE	FILTERED	NUMBER	SIZE	TYPE	PRESERVATIVE	FILTERED
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N

SHIPPING METHOD:	________	DATE SHIPPED:	________	AIRBILL NUMBER:	________
COC NUMBER:	________	SIGNATURE:	________	DATE SIGNED:	________



Groundwater Sampling Record for Organics (For Wells with Passive Diffusion Bags)

Project Name/No:

Well ID:

Installation of PDBs:

TRC Personnel: ____________________
Date: ____________________
Time: ____________________
DTW (ft): ____________________

Sampling of PDBs:

TRC Personnel: ____________________
Date: ____________________
DTW (ft): ____________________

TOC

___ in.

___ ft.

___ ft.

___ ft.

PDB #1
Length: ___ in.

Sample ID: ____________________
Sample Time: ____________________
Evidence of algae, iron or other coatings?: ____________

PDB #2
Length: ___ in.

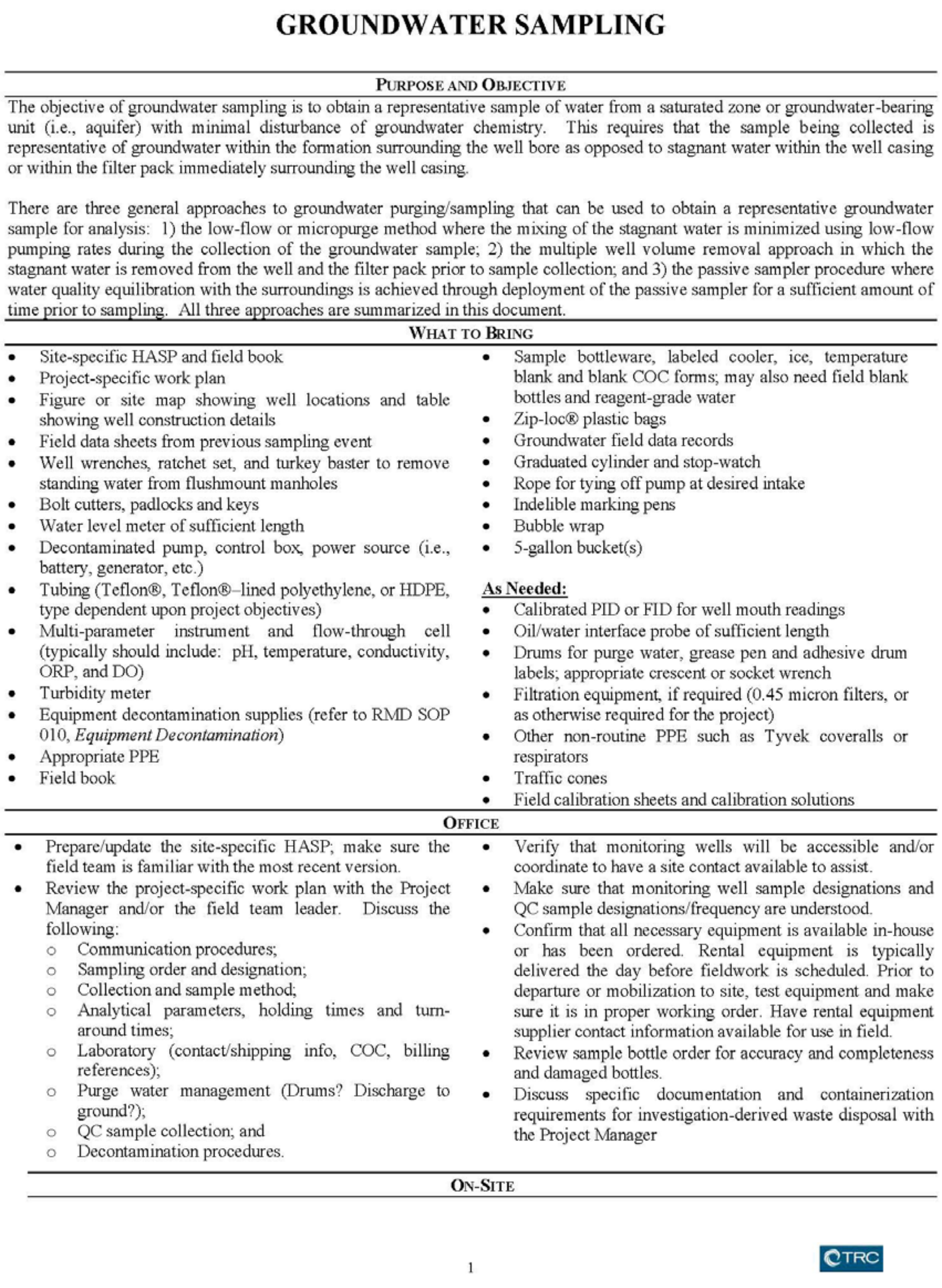
Sample ID: ____________________
Sample Time: ____________________
Evidence of algae, iron or other coatings?: ____________

Measured well depth during tether installation: ___ ft.

Field Notes:

Rev: April 2014

Attachment C: SOP Fact Sheet



GROUNDWATER SAMPLING

PURPOSE AND OBJECTIVE

The objective of groundwater sampling is to obtain a representative sample of water from a saturated zone or groundwater-bearing unit (i.e., aquifer) with minimal disturbance of groundwater chemistry. This requires that the sample being collected is representative of groundwater within the formation surrounding the well bore as opposed to stagnant water within the well casing or within the filter pack immediately surrounding the well casing.

There are three general approaches to groundwater purging/sampling that can be used to obtain a representative groundwater sample for analysis: 1) the low-flow or micropurge method where the mixing of the stagnant water is minimized using low-flow pumping rates during the collection of the groundwater sample; 2) the multiple well volume removal approach in which the stagnant water is removed from the well and the filter pack prior to sample collection; and 3) the passive sampler procedure where water quality equilibration with the surroundings is achieved through deployment of the passive sampler for a sufficient amount of time prior to sampling. All three approaches are summarized in this document.

WHAT TO BRING

- Site-specific HASP and field book
- Project-specific work plan
- Figure or site map showing well locations and table showing well construction details
- Field data sheets from previous sampling event
- Well wrenches, ratchet set, and turkey baster to remove standing water from flushmount manholes
- Bolt cutters, padlocks and keys
- Water level meter of sufficient length
- Decontaminated pump, control box, power source (i.e., battery, generator, etc.)
- Tubing (Teflon®, Teflon®–lined polyethylene, or HDPE, type dependent upon project objectives)
- Multi-parameter instrument and flow-through cell (typically should include: pH, temperature, conductivity, ORP, and DO)
- Turbidity meter
- Equipment decontamination supplies (refer to RMD SOP 010, *Equipment Decontamination*)
- Appropriate PPE
- Field book
- Sample bottleware, labeled cooler, ice, temperature blank and blank COC forms; may also need field blank bottles and reagent-grade water
- Zip-loc® plastic bags
- Groundwater field data records
- Graduated cylinder and stop-watch
- Rope for tying off pump at desired intake
- Indelible marking pens
- Bubble wrap
- 5-gallon bucket(s)

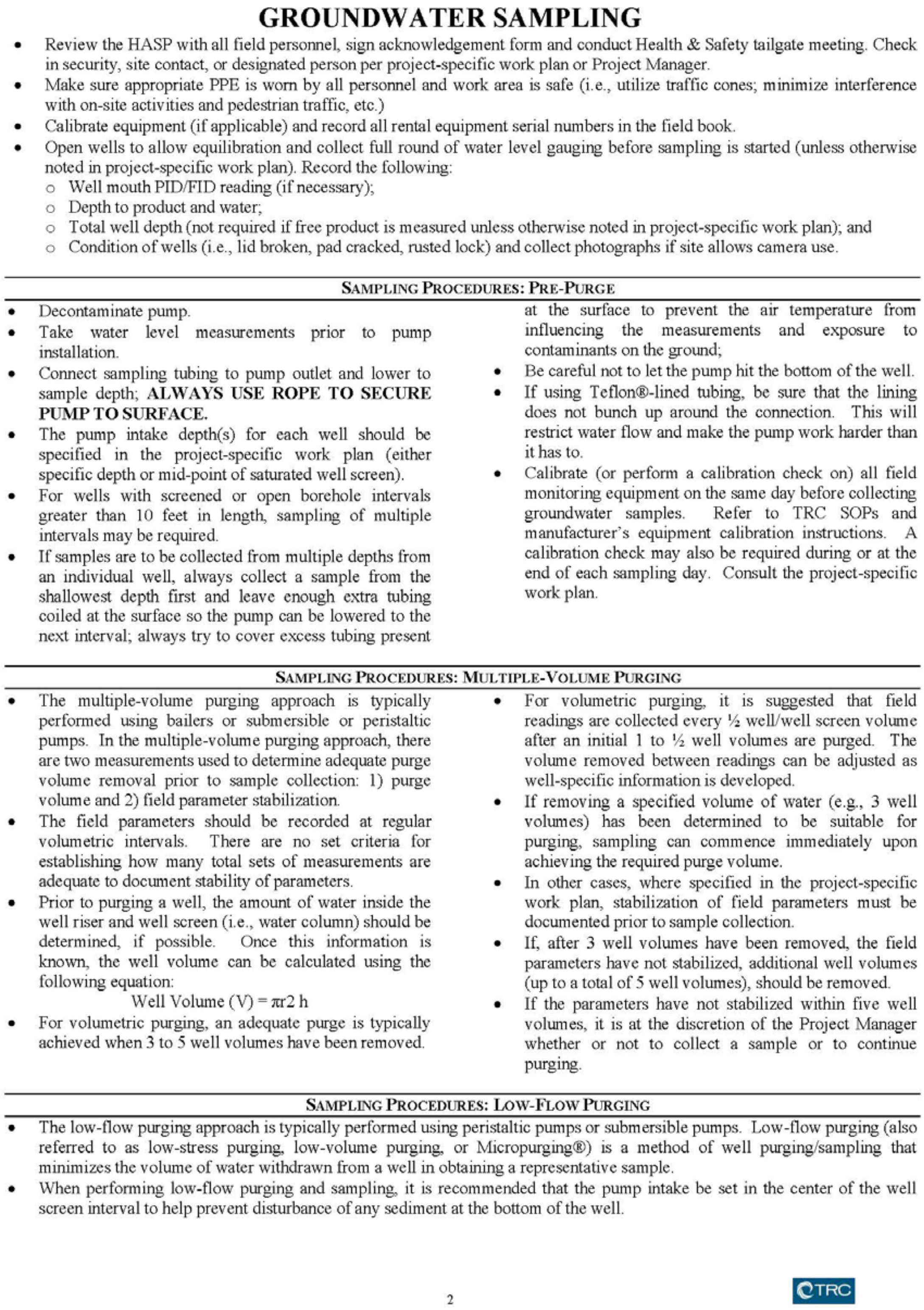
As Needed:

- Calibrated PID or FID for well mouth readings
- Oil/water interface probe of sufficient length
- Drums for purge water, grease pen and adhesive drum labels; appropriate crescent or socket wrench
- Filtration equipment, if required (0.45 micron filters, or as otherwise required for the project)
- Other non-routine PPE such as Tyvek coveralls or respirators
- Traffic cones
- Field calibration sheets and calibration solutions

OFFICE

- Prepare/update the site-specific HASP; make sure the field team is familiar with the most recent version.
- Review the project-specific work plan with the Project Manager and/or the field team leader. Discuss the following:
  - Communication procedures;
  - Sampling order and designation;
  - Collection and sample method;
  - Analytical parameters, holding times and turn-around times;
  - Laboratory (contact/shipping info, COC, billing references);
  - Purge water management (Drums? Discharge to ground?);
  - QC sample collection; and
  - Decontamination procedures.
- Verify that monitoring wells will be accessible and/or coordinate to have a site contact available to assist.
- Make sure that monitoring well sample designations and QC sample designations/frequency are understood.
- Confirm that all necessary equipment is available in-house or has been ordered. Rental equipment is typically delivered the day before fieldwork is scheduled. Prior to departure or mobilization to site, test equipment and make sure it is in proper working order. Have rental equipment supplier contact information available for use in field.
- Review sample bottle order for accuracy and completeness and damaged bottles.
- Discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager

ON-SITE



GROUNDWATER SAMPLING

- Review the HASP with all field personnel, sign acknowledgement form and conduct Health & Safety tailgate meeting. Check in security, site contact, or designated person per project-specific work plan or Project Manager.
- Make sure appropriate PPE is worn by all personnel and work area is safe (i.e., utilize traffic cones; minimize interference with on-site activities and pedestrian traffic, etc.)
- Calibrate equipment (if applicable) and record all rental equipment serial numbers in the field book.
- Open wells to allow equilibration and collect full round of water level gauging before sampling is started (unless otherwise noted in project-specific work plan). Record the following:
  - Well mouth PID/FID reading (if necessary);
  - Depth to product and water;
  - Total well depth (not required if free product is measured unless otherwise noted in project-specific work plan); and
  - Condition of wells (i.e., lid broken, pad cracked, rusted lock) and collect photographs if site allows camera use.

SAMPLING PROCEDURES: PRE-PURGE

- Decontaminate pump.
- Take water level measurements prior to pump installation.
- Connect sampling tubing to pump outlet and lower to sample depth; **ALWAYS USE ROPE TO SECURE PUMP TO SURFACE.**
- The pump intake depth(s) for each well should be specified in the project-specific work plan (either specific depth or mid-point of saturated well screen).
- For wells with screened or open borehole intervals greater than 10 feet in length, sampling of multiple intervals may be required.
- If samples are to be collected from multiple depths from an individual well, always collect a sample from the shallowest depth first and leave enough extra tubing coiled at the surface so the pump can be lowered to the next interval; always try to cover excess tubing present at the surface to prevent the air temperature from influencing the measurements and exposure to contaminants on the ground;
- Be careful not to let the pump hit the bottom of the well.
- If using Teflon®-lined tubing, be sure that the lining does not bunch up around the connection. This will restrict water flow and make the pump work harder than it has to.
- Calibrate (or perform a calibration check on) all field monitoring equipment on the same day before collecting groundwater samples. Refer to TRC SOPs and manufacturer's equipment calibration instructions. A calibration check may also be required during or at the end of each sampling day. Consult the project-specific work plan.

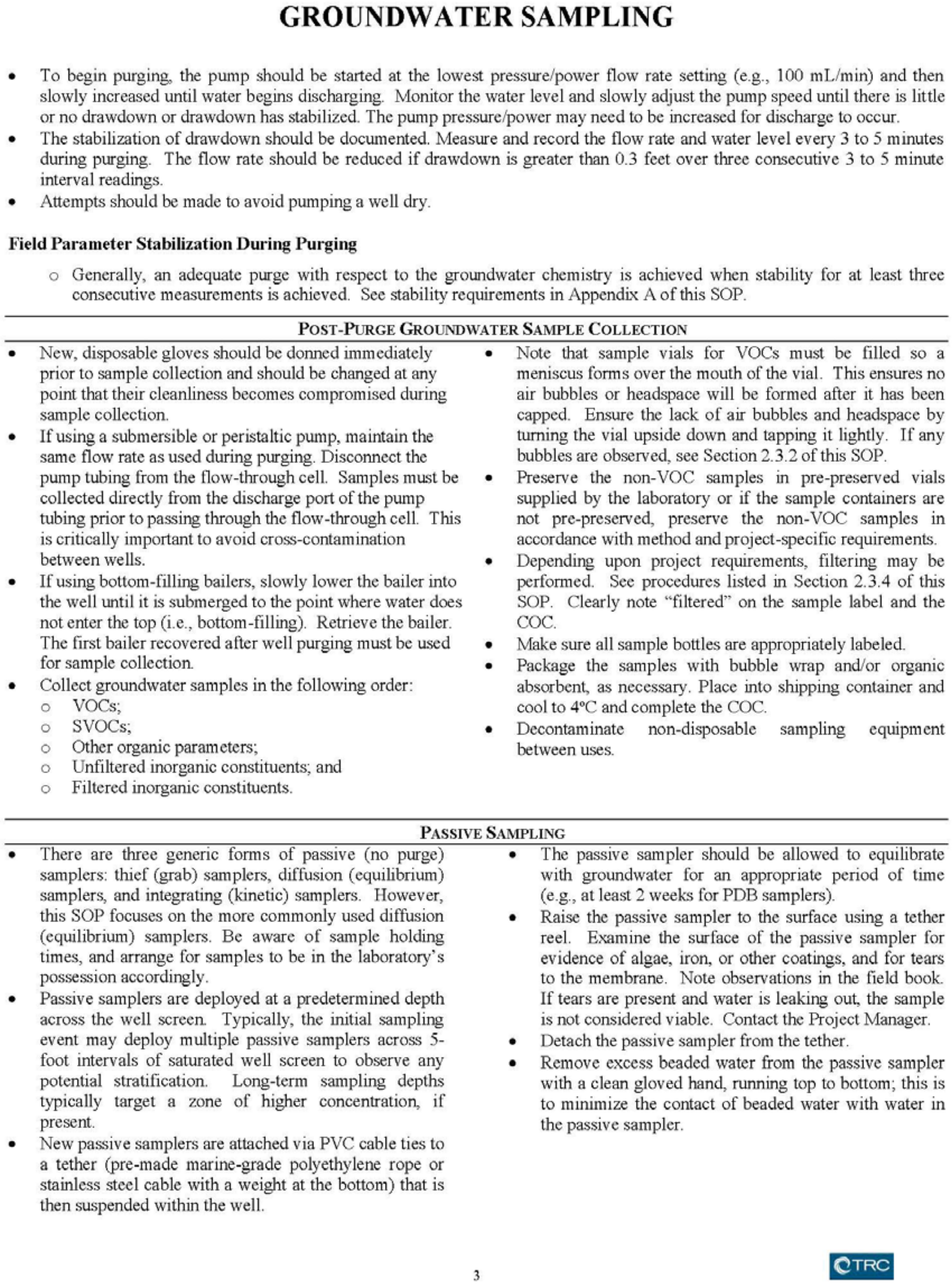
SAMPLING PROCEDURES: MULTIPLE-VOLUME PURGING

- The multiple-volume purging approach is typically performed using bailers or submersible or peristaltic pumps. In the multiple-volume purging approach, there are two measurements used to determine adequate purge volume removal prior to sample collection: 1) purge volume and 2) field parameter stabilization.
- The field parameters should be recorded at regular volumetric intervals. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters.
- Prior to purging a well, the amount of water inside the well riser and well screen (i.e., water column) should be determined, if possible. Once this information is known, the well volume can be calculated using the following equation:

  Well Volume (V) = $\pi r2\ h$
- For volumetric purging, an adequate purge is typically achieved when 3 to 5 well volumes have been removed.
- For volumetric purging, it is suggested that field readings are collected every ½ well/well screen volume after an initial 1 to ½ well volumes are purged. The volume removed between readings can be adjusted as well-specific information is developed.
- If removing a specified volume of water (e.g., 3 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume.
- In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection.
- If, after 3 well volumes have been removed, the field parameters have not stabilized, additional well volumes (up to a total of 5 well volumes), should be removed.
- If the parameters have not stabilized within five well volumes, it is at the discretion of the Project Manager whether or not to collect a sample or to continue purging.

SAMPLING PROCEDURES: LOW-FLOW PURGING

- The low-flow purging approach is typically performed using peristaltic pumps or submersible pumps. Low-flow purging (also referred to as low-stress purging, low-volume purging, or Micropurging®) is a method of well purging/sampling that minimizes the volume of water withdrawn from a well in obtaining a representative sample.
- When performing low-flow purging and sampling, it is recommended that the pump intake be set in the center of the well screen interval to help prevent disturbance of any sediment at the bottom of the well.



GROUNDWATER SAMPLING

- To begin purging, the pump should be started at the lowest pressure/power flow rate setting (e.g., 100 mL/min) and then slowly increased until water begins discharging. Monitor the water level and slowly adjust the pump speed until there is little or no drawdown or drawdown has stabilized. The pump pressure/power may need to be increased for discharge to occur.
- The stabilization of drawdown should be documented. Measure and record the flow rate and water level every 3 to 5 minutes during purging. The flow rate should be reduced if drawdown is greater than 0.3 feet over three consecutive 3 to 5 minute interval readings.
- Attempts should be made to avoid pumping a well dry.

Field Parameter Stabilization During Purging

  - Generally, an adequate purge with respect to the groundwater chemistry is achieved when stability for at least three consecutive measurements is achieved. See stability requirements in Appendix A of this SOP.

POST-PURGE GROUNDWATER SAMPLE COLLECTION

- New, disposable gloves should be donned immediately prior to sample collection and should be changed at any point that their cleanliness becomes compromised during sample collection.
- If using a submersible or peristaltic pump, maintain the same flow rate as used during purging. Disconnect the pump tubing from the flow-through cell. Samples must be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. This is critically important to avoid cross-contamination between wells.
- If using bottom-filling bailers, slowly lower the bailer into the well until it is submerged to the point where water does not enter the top (i.e., bottom-filling). Retrieve the bailer. The first bailer recovered after well purging must be used for sample collection.
- Collect groundwater samples in the following order:
  - VOCs;
  - SVOCs;
  - Other organic parameters;
  - Unfiltered inorganic constituents; and
  - Filtered inorganic constituents.
- Note that sample vials for VOCs must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, see Section 2.3.2 of this SOP.
- Preserve the non-VOC samples in pre-preserved vials supplied by the laboratory or if the sample containers are not pre-preserved, preserve the non-VOC samples in accordance with method and project-specific requirements.
- Depending upon project requirements, filtering may be performed. See procedures listed in Section 2.3.4 of this SOP. Clearly note "filtered" on the sample label and the COC.
- Make sure all sample bottles are appropriately labeled.
- Package the samples with bubble wrap and/or organic absorbent, as necessary. Place into shipping container and cool to 4°C and complete the COC.
- Decontaminate non-disposable sampling equipment between uses.

PASSIVE SAMPLING

- There are three generic forms of passive (no purge) samplers: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers. However, this SOP focuses on the more commonly used diffusion (equilibrium) samplers. Be aware of sample holding times, and arrange for samples to be in the laboratory's possession accordingly.
- Passive samplers are deployed at a predetermined depth across the well screen. Typically, the initial sampling event may deploy multiple passive samplers across 5-foot intervals of saturated well screen to observe any potential stratification. Long-term sampling depths typically target a zone of higher concentration, if present.
- New passive samplers are attached via PVC cable ties to a tether (pre-made marine-grade polyethylene rope or stainless steel cable with a weight at the bottom) that is then suspended within the well.
- The passive sampler should be allowed to equilibrate with groundwater for an appropriate period of time (e.g., at least 2 weeks for PDB samplers).
- Raise the passive sampler to the surface using a tether reel. Examine the surface of the passive sampler for evidence of algae, iron, or other coatings, and for tears to the membrane. Note observations in the field book. If tears are present and water is leaking out, the sample is not considered viable. Contact the Project Manager.
- Detach the passive sampler from the tether.
- Remove excess beaded water from the passive sampler with a clean gloved hand, running top to bottom; this is to minimize the contact of beaded water with water in the passive sampler.

GROUNDWATER SAMPLING

- Use a small diameter discharge tube (<0.15 inch diameter to reduce volatilization) and pierce near the bottom, allowing water to smoothly flow into the VOA vial. The VOA vials must be filled within the first several minutes of passive sampler retrieval.
- A small amount of water may remain within the passive sampler after filling the VOA vials and can be used for field parameter measurements if required.
- Dispose of the passive sampler after use.
- Note that sample vials for VOCs must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, see Section 2.3.2 of this SOP.
- Make sure all sample bottles are appropriately labeled.
- Package the samples with bubble wrap and/or organic absorbent, as necessary. Place into shipping container and cool to 4°C and complete the COC.

DOs AND DO NOTs OF GROUNDWATER PURGING AND SAMPLING

DOs:

- DO have the following items when going into the field: site-specific work plan; site-Specific HASP; appropriate PPE (steel-toed boots, safety glasses, etc.) as required by the Site-Specific HASP; field book and a water-proof ball-point pen; business cards; nitrile gloves; well keys; copies of well installation forms and field data forms from previous sampling event.
- DO make sure that the equipment is set up properly and the bottleware is nearby and ready to be filled. There is little time between taking parameters.
- DO look at the water quality parameters from the previous round of sampling. If there is a large deviation from the previous round's measurements, make sure the meters are properly calibrated and the parameter units are the same. Otherwise, consult the Project Manager or field team leader.
- DO fill sample bottles slowly to make sure that they are not overfilled and that preservative does not become diluted. If collecting filtered samples, fill all non-filtered first, then fill filtered samples - if water is very silty, more than one filter might be required to fill sample bottles.
- DO record the time that purging begins and ends. "Purge Stop" and sample start time are the same.
- DO call your Project Manager or field team leader if unexpected conditions are encountered or at least daily to update them. It is also recommended to call when sampling is winding down for the day to make sure that the project-specific work plan has been fully implemented and there are no additional tasks to complete. Provide shipping tracking numbers to the Project Manager and laboratory contact.
- DO have the numbers for laboratory, vehicle rental and equipment rental providers readily available while in the field.
- DO record sample locations and parameters in the field book and the Groundwater Field Data Records as you purge.
- DO check on the purging setup frequently to make sure proper equipment function is maintained.
- DO bring ice to the site in the morning so that samples are kept cool throughout the entire event. Storing samples in a warm cooler can invalidate sample results and may result in re-sampling on your own time.

DO NOTs:

- DO NOT sign anything in the field. This includes disposal documentation, statements, etc.; call the Project Manager if this is an issue.
- DO NOT allow the pump or sampling equipment to hit the bottom of the well - If the pump hits the bottom of the well, it can stir up mud. Remember, the goal of low-flow sampling is to collect non-turbid samples.
- DO NOT use non-indelible ink to label samples or record field notes – if the field book gets wet, notes become illegible.
- DO NOT leave air bubbles in VOA vials.
- DO NOT pour any extracted water back down into the well.
- DO NOT lean over wells with pens, keys, cell phones, tools, etc. in your pocket.
- DO NOT use clear tape to cover labels on certain analyses (e.g., 40-mL vials for VOC analysis) due to potential interference with analytical equipment.

Attachment D: SOP Modifications for PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
1.3	• Do not use equipment utilizing Teflon® or low density polyethylene (LDPE)[1] during sample handling or mobilization/demobilization. This includes bailers, tubing, bladders, bailer cord/wire, waterproof/resistant paper products, certain personal protective equipment (PPE) (see below), and Teflon® tape. High density polyethylene (HDPE) or silicone tubing should be used in lieu of Teflon® or Teflon®-lined tubing. • Passive diffusion bags (PDBs) should not be used due to the presence of LDPE material in PDBs. • Blue Ice® (chemical ice packs) must not be used to cool samples or be used in sample coolers. Regular ice in Ziploc® bags can be used. • Do not use LDPE or glass sample containers or containers with Teflon-lined lids. HDPE or polypropylene containers are acceptable for sample storage. HDPE or polypropylene caps are acceptable. • Do not use aluminum foil. • Field notes should be recorded on loose paper field forms maintained in aluminum or Masonite clipboards. Waterproof field books, plastic clipboards and spiral bound notebooks should not be used. • Do not use Post-It Notes during sample handling or mobilization/demobilization. • Refer to TRC's SOP ECR-010 Equipment Decontamination for PFAS-specific decontamination protocols. Ensure that PFAS-free water is used during the decontamination procedure.
1.5	Always consult the Site Specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to field preparation during PFAS sampling: • Tyvek® suits should not be worn during PFAS sampling events. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Stain resistant clothing should not be worn. • Food and drink should not be allowed within the exclusion area. Pre-wrapped food or snacks should not be in the possession of sampling personnel during sampling. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only. • Personnel involved with sample collection and handling should wear

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
	nitrile gloves at all times while collecting and handling samples or sampling equipment. Avoid handling unnecessary items with nitrile gloves. A new pair of gloves must be donned prior to collecting each sample. • Wash hands with Alconox or Liquinox and deionized water after leaving vehicle before setting up to sample a well.
1.6.1	• Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended 6 washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering on the day of sampling. • Avoid using sunscreens or insect repellants that are not natural or chemical free.
2.2.5	Tubing used to purge and sample groundwater for PFAS must not be LDPE or Teflon®. HDPE and silicone are acceptable.
2.3 and 2.3.3	LDPE and/or glass containers should not be used for sampling. Teflon®-lined caps should also not be used during sample collection. Instead, HDPE or polypropylene containers are acceptable for sample storage. HDPE or polypropylene caps are acceptable.
2.4	Due to LDPE material in PDBs, PDBs cannot be used for PFAS sampling.
2.5 (e)	Avoid using waterproof labels for sample bottles. The use of paper labels covered with clear tape or placed in Ziploc® bags to avoid moisture on the sample label is acceptable.
2.5 (f)	Samples for PFAS analysis must be shipped at <10°C. Standard coolers are acceptable.
4.3	Due to low reporting limit requirements for PFAS, trip blanks for PFAS analysis should be included in sample coolers if PFAS are being analyzed for in the associated groundwater samples.

Notes:

[1] – PFAS have been used as an additive in the manufacturing of LDPE to smooth rough surfaces and, in the case of LDPE tubing, to allow for less turbulent flow along the surface of the tubing.

Title: **Equipment Decontamination**	Procedure Number: **ECR 010**
	Revision Number: **1**
	Effective Date: **December 2016**

Authorization Signatures			
		Elizabeth Denly	
Technical Reviewer	Date	ECR Practice Quality Coordinator	Date
James Peronto	12/15/16	Elizabeth Denly	12/15/16

TABLE OF CONTENTS

Page No.

ATTACHMENTS

Attachment A	SOP Fact Sheet
Attachment B	SOP Modifications for PFAS

1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) was prepared to direct TRC personnel in the procedures needed for decontamination of equipment used in the field during environmental investigations (e.g., sediment, soil, groundwater investigations). Other state or federal requirements may be above and beyond the scope of this SOP and will be followed, if applicable. In all instances, the actual procedures used should be documented and described in the field notes. Preventing or minimizing potential cross-contamination of samples is important for the collection of representative samples, avoiding the possible introduction of sampling error into sample results, and for protecting the health and safety of site personnel.

Removing or neutralizing potential contaminants that may have accumulated on equipment and vehicles ensures protection of personnel, reduces or eliminates potential transfer of contaminants to clean areas, and minimizes the likelihood of sample cross-contamination.

The use of dedicated, disposable, new sampling equipment (e.g., disposable liners, plastic spoons, plastic or aluminum bowls) should be considered as an alternative to equipment decontamination and the subsequent generation of decontamination fluids.

1.2 Summary of Method

Equipment decontamination is used to remove potential contaminants from a sampling device or piece of field equipment prior to and between the collection of samples and is also used to limit personnel exposure to residual contamination that may be present on used field equipment.

Contaminants can be physically removed from equipment or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and nonabrasive methods. These include the use of brushes, air and wet blasting, and high-pressure water, followed by a wash/rinse process using appropriate cleaning solutions. A solvent rinse may be required when organic contamination is present, and an acid rinse may be required when metals are parameters of interest. Equipment decontamination procedures can vary depending on the media being sampled and the type of sampling equipment being used. Disposal of decontamination fluids will be handled on a project-specific basis and will be in accordance with all applicable regulations.

1.3 Equipment

The following equipment may be utilized when decontaminating equipment. Project-specific conditions or requirements may warrant the use of additional equipment or deletion of items from this list. For specialized sampling programs involving per- and polyfluorinated alkyl substances (PFAS), refer to Attachment B for further details.

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific Health and Safety Plan (HASP)

- Alconox®, Liquinox® or other nonphosphate concentrated laboratory-grade soap
- Simple Green® or other nontoxic biodegradable cleaner
- Deionized, distilled, or organic-free water, as appropriate (may be supplied by the laboratory or purchased from commercial vendors depending on project requirements)
- Pump sprayer
- Pressure sprayer
- Squeeze bottle filled with pesticide-grade hexane (option for organic analyses)
- Squeeze bottle filled with pesticide-grade methanol (option for organic analyses)
- Squeeze bottle filled with pesticide-grade isopropanol (option for organic analyses)
- Squeeze bottle filled with 10 percent nitric acid (option for metals analyses and stainless-steel equipment)
- Squeeze bottle filled with 1 percent nitric acid (option for metals analyses)
- Container (squeeze bottle to 5-gallon bucket) filled with potable water and a nonphosphate, laboratory-grade soap (approximately 1 tablespoon of soap to 5 gallons of water)
- Extra quantities of above listed liquids
- Potable water
- Containers, such as buckets or wash basins (the type and number of containers is dependent on the procedure)
- Scrub brushes
- Small wire brush
- Aluminum foil
- Polyethylene sheeting
- A container for decontamination of pumps and associated tubing.

1.4 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific HASP. TRC personnel will use the appropriate level of PPE as defined in the HASP.

Samples containing chemical contaminants may be handled during implementation of this SOP. Certain decontamination fluids, including solvents and/or acids, are considered hazardous materials, and TRC employees will appropriately handle and store them at all times. Appropriately manage chemicals that pose specific toxicity or safety concerns, and follow any other relevant requirements as appropriate. Hazardous substances may be incompatible or may react to produce heat, chemical reactions, or toxic products. Some hazardous substances may be incompatible with clothing or equipment and can permeate or degrade protective clothing or equipment. Also, hazardous substances may pose a direct health hazard to workers through inhalation or skin contact or if exposed to heat/flame and they combust. Safety data sheets for chemicals handled by TRC personnel should be maintained in a designated location at the project site.

1.5 Cautions and Potential Problems

Special care should be taken when decontaminating equipment used for sampling for PFAS. Please refer to Attachment B for details.

- The use of deionized, distilled or organic-free water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been certified by the vendor as analyte-free and/or meets the project-specific requirements.

- Alconox®, Liquinox®, or other nonphosphate, concentrated, laboratory-grade soap may contain trace quantities of perchlorate.

- Avoid using an excessive amount of soap during decontamination procedures, as this could result in difficulty rinsing the soap residue off of the equipment. Typically the soap solution is prepared using 1 tablespoon of soap to 5 gallons of water.

- Use sufficient amount of decontamination fluid (e.g., acid or solvent rinses) so that the fluid flows over the equipment and runs off. Spraying the equipment with a minimal amount of decontamination fluid that does not run off is ineffective.

- Spent decontamination solutions are considered investigation-derived waste (IDW) and must be managed as directed by the site-specific field program. Project and regulatory requirements, chemical compatibility, ambient conditions and professional judgment should be used to determine the appropriate decontamination process with respect to combining and/or segregating decontamination fluids. Section 3 of this SOP provides more guidance on the disposal procedures.

- Several procedures can be established to minimize the potential for cross-contamination or analytical interference by decontamination fluids. For example:

  - The use of methanol in the decontamination procedure may not be appropriate if methanol is a contaminant of concern.

  - Isopropanol may be used as a substitute for methanol but may not be appropriate when collecting samples for volatile organic compound (VOC) analyses. Residual isopropanol on the equipment may cause substantial interferences in subsequent VOC analyses and may result in unnecessary dilutions and/or false positive results if isopropanol is not removed in subsequent decontamination steps. It should also be noted that the application of isopropanol to hot metal surfaces (e.g., a steam-cleaned split spoon) may cause oxidation of the isopropanol to acetone.

  - If hexane is used in the decontamination procedure, caution should be used to ensure that the hexane is completely volatilized and the equipment is subsequently rinsed when samples are to be analyzed for VOCs and volatile petroleum hydrocarbons (VPH). Residual hexane on equipment could interfere with the VOC and VPH analyses and may result in unnecessary dilutions and/or false positive results.

  - Cover monitoring and sampling equipment with protective material (i.e., aluminum foil, polyethylene sheeting, or Ziploc® bags) to minimize potential re-contamination after decontamination.

  - Use disposable sampling equipment when appropriate to minimize the need for decontamination. Although disposable sampling tools are encouraged in order to minimize the generation of decontamination fluids, it should be noted that plastic tools may not be appropriate for collection of samples to be analyzed for semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Potential phthalate contamination may cause significant interferences in the subsequent analyses and may result in unnecessary dilutions and/or false positive results.

- After decontamination, equipment should be handled only by personnel wearing clean disposable powder-free nitrile gloves to prevent recontamination.
- If equipment decontamination is performed in the field, the equipment should be moved away (preferably upwind) from the decontamination area to prevent recontamination.
- Equipment that is not decontaminated properly may result in potentially high biased results in field samples. **Note:** Equipment blank collection may be appropriate after decontamination of equipment used to collect highly contaminated samples.

1.6 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project work plan. These requirements may include:

- Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers
- 8-hour annual HAZWOPER refresher training.

2.0 PROCEDURES

Refer to the site-specific sampling plan and/or Quality Assurance Project Plan (QAPP), if applicable, for site-specific procedures. Other state or federal requirements may be above and beyond the scope of this SOP and will be followed if applicable. In all instances, the actual procedures used should be documented and described in the field notes.

2.1 General

All personnel, sample containers, and equipment leaving the contaminated area of a site must be decontaminated. Various decontamination methods will either physically remove contaminants by abrasive and/or washing actions, inactivate contaminants by disinfection or sterilization, or both. Decontamination procedures should be documented in the field book.

2.2 Physical Decontamination Procedures

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques appropriate for equipment decontamination can be grouped into two categories: abrasive methods and nonabrasive methods. In general, heavy equipment decontamination is conducted by drilling and construction subcontractors and not by TRC personnel. However, TRC personnel will typically need to document such decontamination efforts as part of project work.

ABRASIVE CLEANING METHODS APPROPRIATE FOR DRILLING EQUIPMENT (DRILLING RIGS, ETC.)

Abrasive cleaning methods involve rubbing and wearing away the top layer of the surface containing the contaminant. The following abrasive methods are available but are not commonly used:

- *Mechanical:* Mechanical cleaning methods use brushes of metal or nylon. The amount and type of contaminants removed will vary with the hardness of bristles, length of brushing time, and degree of brush contact.

- *Air Blasting:* Air blasting is used for cleaning large equipment, such as bulldozers, drilling rigs, or auger bits. The equipment used in air blasting employs compressed air to force abrasive material through a nozzle at high velocities. The distance between the nozzle and the surface cleaned, as well as the pressure of air, the time of application, and the angle at which the abrasive material strikes the surface, determines cleaning efficiency. Air blasting has several disadvantages, including it is unable to control the amount of materials removed, it can aerate contaminants, and it generates large amounts of waste.

- *Wet Blasting:* Wet blasting, also used to clean large equipment, involves use of a suspended fine abrasive delivered by compressed air to the contaminated area. The amount of materials removed can be carefully controlled by using very fine abrasives. One disadvantage of this method is the generation of a large amount of waste.

NONABRASIVE CLEANING METHODS APPROPRIATE FOR FIELD EQUIPMENT (DRILLING AUGERS AND RIGS, ETC.)

Nonabrasive cleaning methods involve forcing the contaminant off of a surface with pressure. In general, less of the equipment surface is removed using nonabrasive methods. Special care should be taken during decontamination procedures following sampling for PFAS. Please refer to Attachment B for details. The following non-abrasive methods are available:

- *High-pressure Potable Water:* This method consists of a high-pressure pump, an operator-controlled directional nozzle, and a high-pressure hose. Flow rates typically range from 20 to 140 liters per minute.

  This procedure is used the majority of the time and is more appropriate for equipment with painted surfaces.

- *Ultrahigh-Pressure Potable Water:* This system produces a pressurized water jet. The ultrahigh-pressure spray removes tightly adhered surface film. The water velocity ranges from 500 meters per second (m/sec) to 900 m/sec. Additives can enhance the method. This method is not applicable for hand-held sampling equipment.

  This procedure is not commonly used but would be appropriate for carbon steel drilling rods and augers.

2.3 Procedure for Sampling Equipment

Sampling equipment, such as split-spoon samplers, shovels, hand augers, trowels, spoons, spatulas, bailers, tethers, dippers, and pumps, will be cleaned using the following procedure. Special care should be taken during decontamination procedures following sampling for PFAS. Please refer to Attachment B for details. **Note:** The overall number of containers needed for collection of decontamination fluids may vary depending on chemical compatibilities, project and regulatory requirements, and ultimate disposal methods for these fluids.

1. Lay out sufficient polyethylene sheeting on the ground or floor to allow placement of the necessary number of containers (e.g., plastic wash basins or buckets) and an air drying area. The number of decontamination steps and designated containers should be determined prior to field sampling based on the site-specific sampling plan. At a minimum, one container should be designated for the detergent wash. A second container should be designated for water rinsing. A third container may be designated for nonwater rinsing. If more than one, the nonwater rinsate fluids may need to be separated. Nonwater rinsate fluids should not be combined with the detergent wash during decontamination. Place the containers on the polyethylene sheeting. The decontamination line should progress from “dirty” to “clean”.

   Note: In instances where acid or solvent rinses are required, additional containers may be needed to manage collection and subsequent disposal of the spent decontamination fluids.

2. Fill the first container with potable water. Add sufficient nonphosphate concentrated laboratory-grade soap to cause suds to form in the container. Do not use an excessive amount of the soap (approximately 1 tablespoon of soap to 5 gallons of water), or rinsing the soap residue off of the equipment will be difficult.

3. Brush any visible dirt off of the sampling equipment into a designated area before getting equipment wet.

4. Using a clean, coarse scrub brush, submerge and wash the sampling equipment in the soap solution in the first container, removing all dirt or visible hydrocarbons. Allow excess soap to drain off the equipment into the container when finished. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

5. Rinse the equipment with potable water over an appropriate container, using a coarse scrub brush or pressure sprayer to aid in the rinse if necessary. If an additional acid or solvent rinse is not required, proceed to Step 8.

6. ******If sampling for metals and if required by the project, rinse the equipment with nitric acid over an appropriate container. Consider using a container dedicated to acidic solutions to minimize the volume of liquid that needs to be neutralized later. A 10 percent nitric acid solution is used on stainless steel equipment. A 1 percent nitric acid solution is used on all other equipment. If not required, this step may be omitted.

   Rinse the equipment over an appropriate container using deionized, distilled or organic-free water. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

7. ******If sampling for organic parameters and if required by the project, rinse the equipment over an appropriate container using pesticide-grade methanol or isopropanol (see Cautions and Potential Problems). If oily, a pesticide-grade hexane rinse should follow the methanol/isopropanol rinse, or as an alternative, Simple Green® can be used if approved by the Project Manager. Consider using an appropriate container dedicated to volatile solvents to minimize the volume of liquid that subsequently needs to be managed as IDW. If not required, this step may be omitted.

   Allow the equipment to completely air dry prior to proceeding to the next step.

   **** Steps 6 and 7 are optional and may be used on a site-specific basis. The site-specific sampling plan or QAPP, if available, should be consulted. In the absence of a sampling plan or QAPP, the Project Manager will decide upon the necessity of these steps.**

8. Rinse the equipment over an appropriate container using deionized, distilled or organic-free water. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

9. Allow the equipment to completely air dry on a clean surface (e.g., polyethylene sheeting or a clean container) (See*NOTE).

   ***NOTE** that if temperature or humidity conditions preclude air drying equipment, sufficient spares, if possible, should be available so that no item of sampling equipment need be used more than once. If an ample amount of spare equipment is not available and the equipment will not completely air dry, additional rinses with deionized, distilled or organic-free water should be used. The inability of equipment to air dry and the usage of additional rinses should be recorded in the field book or on the appropriate form.

10. Reassemble equipment, if necessary, and wrap completely in clean, unused, protective material. Reuse of equipment on the same day without wrapping in protective material is acceptable.

11. Spent decontamination fluids are considered IDW and must be managed as directed by the site-specific field program.

12. Record the decontamination procedure in the field book or on the appropriate form.

2.4 Procedure for Measuring Equipment

Measuring equipment, such as pressure transducers, water level indicators, oil/water interface probes, and soil moisture/pH meters will be cleaned using the following procedure, unless it conflicts with the manufacturer's recommendations. Special care should be taken during decontamination procedures following sampling for PFAS. Please refer to Attachment B for details.

1. Fill two clean containers (e.g., plastic wash basins or buckets) with potable water.

2. Add sufficient nonphosphate concentrated laboratory-grade soap to one container to form a thin layer of soap suds. If oily residues are apparent, the use of Simple Green® may be required.

3. Brush any visible dirt off of the measuring equipment before getting the equipment wet.

4. Either spray rinse the device with the soap solution over the first container, or for heavily soiled equipment, immerse the device in the container containing soap and gently agitate. Scrub device if it is soiled. Do not submerse any electrical controls or take-up reels. Submerse only that portion of the device that came in contact with potential contaminants.

5. Immerse the device in the container containing the potable water and gently agitate. Do not submerse any electrical connectors or take-up reels. Submerse only that portion of the device that came in contact with potential contaminants.

6. Spray rinse equipment with deionized, distilled, or organic-free water over the last container used.

7. Allow the equipment to air dry if time allows.

8. Record the decontamination procedure in the field book or on the appropriate form.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for IDW disposal with the Project Manager.

Each project must consider IDW disposal methods and have a plan in place prior to performing the field work. Provisions must be in place regarding what will be done with IDW. If IDW cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

One type of quality control sample specific to the field decontamination process is the equipment blank. The equipment blank provides information about the effectiveness of the decontamination process employed in the field. An equipment blank can detect contamination that may arise from potentially contaminated equipment or equipment that has not been decontaminated effectively.

Equipment blanks consist of a sample of analyte-free (i.e., deionized, distilled, organic-free) water that is poured over and through a decontaminated sampling device and placed in a clean sample container. Ideally, the reagent water should come from the laboratory and be certified as clean. If the blank water is not certified as clean and/or not supplied by the laboratory performing the analyses, a separate water blank that has not run through the sampling equipment should also be sent to the laboratory for analysis.

Equipment blanks are typically collected for all parameters of interest at a minimum rate of 1 per 20 samples for each parameter. The frequency of equipment blank collection will vary from project to project, depending upon the data quality objectives, and will be specified in either the site-specific sampling plan or QAPP. Equipment blanks are typically not required if dedicated sampling equipment is used.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

All reagents used must be documented in the field book or on the appropriate form. Any deviations from the decontamination procedures specified in the sampling plan or QAPP must be approved by the Quality Assurance (QA) Officer and Project Manager and documented in the field book. The lot number and vendor of each reagent used should be documented in the field book. Refer to RMD SOP 001 for field documentation procedures.

6.0 REFERENCES

USEPA. December 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001.

USEPA. January 1991. *Compendium of ERT Groundwater Sampling Procedures*. OSWER Directive 9360.4-06. PB91-9211275.

USEPA. November 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance*. EPA/530-R-93-001. USEPA Office of Solid Waste.

USEPA. January 1999. *Compendium of ERT Groundwater Sampling Procedures*. EPA/540/P-91/007. OSWER Directive 9360.4-06. PB91-921275.

USEPA. December 20, 2011. *Field Equipment Cleaning and Decontamination*. SESDPROC-205-R2. Region 4. Science and Ecosystems Support Division. Athens, Georgia.

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
1	DECEMBER 2016	ADDED ATTACHMENT B TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFAS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.

Attachment A: SOP Fact Sheet

EQUIPMENT DECONTAMINATION

Purpose and Objective

Removing or neutralizing potential contaminants that may have accumulated on equipment and vehicles ensures protection of personnel, reduces or eliminates potential transfer of contaminants to clean areas, and minimizes the likelihood of sample cross-contamination. Preventing or minimizing potential cross-contamination of samples is important for the collection of representative samples, avoiding the possible introduction of sampling error into sample results, and for protecting the health and safety of site personnel.

What to Bring

- Field book
- Appropriate PPE
- Site-specific HASP
- Alconox®, Liquinox® or other nonphosphate concentrated laboratory-grade soap
- Simple Green® or other nontoxic biodegradable cleaner
- Deionized, distilled, or organic-free water, as appropriate
- Potable water (or water containers if potable water source on site or nearby)
- Pump or pressure sprayer
- Squeeze bottles filled with appropriate decontamination chemicals (e.g., organic solvents, nitric acid)
- Containers, such as buckets or wash basins (type and number is dependent on the procedure)
- Scrub brushes
- Aluminum foil
- Polyethylene sheeting

Office

- Prepare/update the site-specific HASP; make sure the field team is familiar with the latest version.
- Review site-specific sampling plan/QAPP for decontamination procedures and procedures for management of investigation-derived waste (IDW) (e.g., used decontamination solutions).
- Confirm all required decontamination supplies are in stock or order as needed.

On-Site

- Verify project HASP including safety data sheets for decontamination chemicals used on site.
- Conduct daily Health & Safety tailgate meetings, as appropriate.
- Establish a designated equipment and personnel decontamination area.
- Provide for the proper collection and management of all IDW.
- Verify that appropriate PPE is worn by all site personnel (including subcontractors) and the work area is safe.

Sampling Equipment Decontamination - Procedures

Sampling equipment, such as split-spoon samplers, shovels, hand augers, trowels, spoons, spatulas, bailers, tethers, dippers, and pumps, will be cleaned using the following procedure. **A more simplified procedure for decontamination of measuring equipment is presented in the SOP.** Note: The overall number of containers needed for collection of decontamination fluids may vary depending on chemical compatibilities, project and regulatory requirements, and ultimate disposal methods for these fluids.

1. Lay out sufficient polyethylene sheeting on the ground or floor and the necessary number of containers (e.g., plastic wash basins or buckets) and an air drying area. At a minimum, one container should be designated for the detergent wash. A second container should be designated for water rinsing. A third container may be designated for nonwater rinsing. Nonwater rinsate fluids should not be combined with the detergent wash during decontamination. The decontamination line should progress from "dirty" to "clean".
   Note: In instances where acid or solvent rinses are required, additional containers may be needed to manage collection and subsequent disposal of the spent decontamination fluids.
2. Fill the first container with potable water. Add sufficient nonphosphate concentrated laboratory-grade soap to cause suds to form in the container.
3. Brush any visible dirt off of the sampling equipment before getting equipment wet.
4. Using a clean, coarse scrub brush, submerge and wash the sampling equipment in the soap solution in the first container.

EQUIPMENT DECONTAMINATION

5. Rinse the equipment with potable water over an appropriate container. If an additional acid or solvent rinse is not required, proceed to Step 8.
6. **If sampling for metals and if required by the project, rinse the equipment with nitric acid over an appropriate container. Consider using a container dedicated to acidic solutions to minimize the volume of liquid that needs to be neutralized later. A 10 percent nitric acid solution is used on stainless steel equipment. A 1 percent nitric acid solution is used on all other equipment. If not required, this step may be omitted.
7. **If sampling for organic parameters and if required by the project, rinse the equipment over an appropriate container using pesticide-grade methanol or isopropanol (see Caution and Potential Problems). If oily, a pesticide-grade hexane rinse should follow the methanol/isopropanol rinse, or as an alternative, Simple Green® can be used if approved by the Project Manager. Consider using an appropriate container dedicated to volatile solvents to minimize the volume of liquid that subsequently needs to be managed as IDW. If not required, this step may be omitted.

   Allow the equipment to completely air dry prior to proceeding to the next step.

   ** Steps 6 and 7 are optional and may be used on a site-specific basis. The site-specific sampling plan or QAPP, if available, should be consulted. In the absence of a sampling plan or QAPP, the Project Manager will decide upon the necessity of these steps.
8. Rinse the equipment over an appropriate container using deionized, distilled or organic-free water.
9. Allow the equipment to completely air dry on a clean surface (e.g., polyethylene sheeting or a clean container).

   *NOTE that if temperature or humidity conditions preclude air drying equipment, sufficient spares, if possible, should be available so that no item of sampling equipment need be used more than once. If an ample amount of spare equipment is not available and the equipment will not completely air dry, additional rinses with deionized, distilled or organic-free water should be used. The inability of equipment to air dry and the usage of additional rinses should be recorded in the field logbook or on the appropriate form.
10. Reassemble equipment, if necessary, and wrap completely in clean, unused, protective material. Reuse of equipment on the same day without wrapping in protective material is acceptable.
11. Spent decontamination fluids are considered IDW and must be managed as directed by the site-specific field program.

INVESTIGATION DERIVED WASTE (IDW) DISPOSAL

Field personnel should review the project work plan and ensure project-specific IDW management documentation and containerization requirements are specified or discussed with the Project Manager before going to the project site.

DATA MANAGEMENT AND RECORDS MANAGEMENT

All reagents used must be documented in the field book or an appropriate field form. Any deviations from the decontamination procedures specified in the work plan, sampling plan or QAPP must be approved by the Quality Assurance (QA) Officer and Project Manager and documented in the field book. The lot number and vendor of each reagent used should be documented in the field logbook. Refer to RMD SOP 001 for field documentation procedures.

DOs AND DO NOTs OF EQUIPMENT DECONTAMINATION

DOs:

- DO call the Project Manager or field team leader if unexpected conditions are encountered or at least daily to update them on site work.
- DO manage and collect IDW in accordance with project requirements.
- DO use deionized, distilled or analyte free water that is provided by the laboratory, is certified analyte-free, and/or meets project requirements.
- DO use sufficient amount of decontamination fluids so that the fluid flows over the equipment and runs off.
- DO use new wrapped disposable dedicated sampling equipment when appropriate to minimize the need for decontamination.

DO NOTs:

- DO NOT use an excessive amount of soap during decontamination.
- DO NOT sign anything in the field unless authorized in writing by client. This includes waste disposal documentation, statements, etc.; call PM if this issue arises.

Attachment B: SOP Modifications for PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

PFAS Equipment Decontamination Protocols	
SOP Section Number	**Modifications to SOP**
1.3	• Use only Alconox® or Liquinox® soap; do not use Decon 90. • Use new plastic buckets for wash and rinse water. • Ensure that PFAS-free water is used during the decontamination procedure. • Do not use aluminum foil.
1.5	Always consult the Site-specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to decontamination procedures: • Tyvek® suits should not be worn. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Food and drink should not be allowed within the decontamination area. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only. • Personnel involved with decontamination should wear a new pair of nitrile gloves after each decontamination procedure when handling equipment to avoid re-contamination. Avoid handling unnecessary items with nitrile gloves. • Do not store on or cover equipment with aluminum foil after decontamination. Use of polyethylene sheeting is acceptable. • Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended six washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering the morning of sampling and decontamination field work.
2.2	• New nylon or metal bristle brushes should be used for mechanical cleaning methods. • If high-pressure water is used, it must be tested prior to use for presence of PFAS.
2.3	• Ensure that PFAS-free water is used during the decontamination procedure.
2.4	• Ensure that PFAS-free water is used during the decontamination procedure.

Title: Determination of VOCs in Ambient Air EPA Compendium Methods TO15, & TO3

Approval Signatures:

Don Dawicki Laboratory Director	Bill Desjardins Department Manager
Luke Orchard Quality Assurance Manager	Ben Kirchner EHS Coordinator/CLP-SVOA Dept. Manager

Approval Date: November 13, 2017

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1.0 Scope and Application

This SOP describes the laboratory procedure for the analysis of polar and non-polar volatile organic compounds (VOCs) in ambient and non-ambient air. The procedure is applicable to those VOCs that have been evaluated by the laboratory for their consistent performance in meeting the control criteria put forth in Compendium Method TO-15. While the compendium method is specifically written for the analysis of ambient air samples collected in leak-free passivated stainless steel canisters, it may be applied to the analysis of samples that have employed the use of other collection devices such as Tedlar bags, and are from sources other than ambient air such as soil gas, landfill gas, gas cleaning apparatuses and stack emissions.

This procedure may be also be used to report a variety of carbon ranges, constituent groups like TVOC (total volatile organic compounds), or as unresolved complex mixtures (e.g. Total Hydrocarbons).

1.1 Analytes, Matrix(s), and Reporting Limits

The target compound list and reporting limits for each compound are provided in Table 1A and Table 1B.

2.0 Summary of Method

An aliquot of sample is pulled from the canister through a solid multi sorbent bed trap which reduces the water content of the sample. The sample is thermally desorbed and the VOCs are carried onto a GC column coupled to a mass spectrometer. Compounds are identified by comparison of the mass spectra for individual peaks in the total ion chromatogram to the fragmentation patterns of ions corresponding to VOCs including the intensity of primary and secondary ions as well as the patterns of stored spectra acquired under similar conditions. The concentration of the target compound is calculated by internal standard technique using the average response factor of that compound as determined by the initial calibration.

This procedure is based on EPA Compendium Method TO-15 "Determination of Volatile Organic Compounds in Ambient Air using Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry", US EPA, January, 1999 and Method TO-3 “Method for the Determination of Volatile Organic Compounds In Ambient Air Using Cryogenic Pre Concentration Techniques and Gas Chromatography with Flame Ionization and Electron Capture Detection”, USEPA, April 1984.

If the laboratory has modified the method, a list of these modifications may be found in Section 16.0.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

Contamination may occur if canisters or other equipment is not properly cleaned before use. The laboratory procedures for canister and flow controller cleaning procedures are provided in Appendices C and D.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

The analytical system contains zones with elevated or depressed temperatures that are capable of causing injury upon direct contact. The analyst needs to be aware of the locations of those zones, and allow them to return to room temperature prior to maintenance activities or take measures to avoid contact with hot and/or cold surfaces. There are areas of high voltage in the analytical system. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

Liquid nitrogen (LN_2) is used for cryogenic purposes. In addition to avoiding contact with LN_2 cooled surfaces, analysts must be aware of the potential for oxygen depletion in a confined space in the event of an unexpected large release of the product. Users should evacuate a confined space in which large amounts of LN_2 have been released.

Sample canisters are occasionally pressurized for cleaning or sample dilution purposes. Lab systems are designed to ensure that the cans are not pressurized above 40 psi. Eye protection must be worn when cans are pressurized in the event of a canister failure.

5.2 Primary Materials Used

There are no materials used in this method which have a serious or significant hazard rating
NOTE: This list does not include all materials used in the method. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment meets the specification of this SOP.

6.1 Sampling Equipment

- 6L and 1L SUMMA® Canisters: Leak-Free, Passivated Stainless Steel, with Swagelok DSS4 Valves, or equivalent. Maximum rated pressure 40 psig.
- 6L SUMMA® Canisters: Silicon lined-Leak-Free, Passivated Stainless Steel, with Swagelok DSS4 valves or equivalent. Maximum rated pressure 40 psig.
- Flow Controllers: Restek Catalog #24239 or equivalent.
- Flow Controller Orifice: Various sizes ranging from 0.008” to 0.060”, Restek or equivalent.
- Flow Controller Vacuum Gauges: Capable of measuring vacuum to an absolute vacuum of -30” of HG, and pressure up to 30 psi, Grainger Catalog #5WZ37 or equivalent
- Rain Guard: Stainless Steel Tubing ¼”, 10ft. Grainger or Equivalent. Cut 8” and bend into a J shape using a pipe bender.
- Stainless Steel Pre-Filter (7 um): Swagelok Catalog# SS-4F-T7-7 or equivalent
- Teflon Tape: Home Depot Brand or equivalent.

6.2 Analytical System

- Mass Spectrometer: Agilent 5973, 5975 MSD or equivalent.
- Gas Chromatograph: Agilent 6890, 7890, or equivalent.
- VOC Autosampler: Entech 7016CA or equivalent.
- Cryogenic Concentrator: Equipped with an electronic mass flow controller that maintains a constant flow for carrier gas and sample over a range of 0-200 cc/min. Entech 7100A, 7200, or equivalent.

- Low Pressure Liquid Nitrogen: Air Gas or equivalent.
- Glass Bead Cryotrap: Capable of effectively removing water while trapping polar and non-polar compounds. Entech catalog# 01-04-11320.
- TENAX Sorbent Trap: Capable of removing CO2 and trapping the polar and non-polar compounds. Entech catalog # 01-04-11330.Primary Column: Fused silica capillary column (60 m x 0.32 mm x 1.8 µm), Restek RTX-624 or equivalent.
- Data System: PC software for Entech instrumentation. Hewlett-Packard ChemStation data acquisition software, TestAmerica Chrom and TestAmerica LIMS (TALS).
- NIST Mass Spectral Library and Search Program, 2014 release or newer

6.3 Cleaning System

- Canister Cleaner Module and Software: Capable of filling canisters with humidified air and evacuating canisters to 50 mtorr, Entech Model 3100A or equivalent.
- Vacuum Pump: Capable of evacuating sample canisters to full vacuum. Vacuubrand or equivalent.
- Cleaning Manifold: Equipped with stainless steel and Teflon transfer lines and connections for cleaning up to twelve canisters simultaneously.
- Heating Belts: Individual thermal-stated heating belts used to heat canisters to 100ºC during the manifolds cleaning cycles. Entech or equivalent.
- Cleaning oven: Capable of cleaning 6 Summa Cans simultaneously at a temperature of 100ºC. Entech or equivalent.
- Flow Controller Cleaning Manifold: Capable of flushing hot Nitrogen through 24 flow controllers simultaneously for cleaning.

6.4 Miscellaneous Supplies

- Mass Flow Controller, NIST Traceable: Capable of flow rate of 70 mL/min, McMillan Company 80SD or equivalent. Use for the preparation of calibration and working standards.
- Syringes: Gas tight with a Luer-Lok tip, assorted sizes ranging from 1.0 mL to 1.0 L, SGE or equivalent.
- Digital Pressure Gauges, NIST Traceable: Capable of measuring pressure in the range of -30" Hg to 100 psi, Dwyer Models DPGA-12 and 67100 or equivalent
- Digital Flow Meter, NIST Traceable: Alltech or equivalent.
- Nitrogen Gas

7.0 Reagents and Standards

7.1 Reagents

Nitrogen- Gas off bulk Liquid Nitrogen tank. Air Gas or equivalent vendor

7.2 Standards

Purchase the following stock standard mixtures from commercial vendors:

- Mixed Gas Stock Standard: - Commercially prepared standard that includes internal standard and tune standard compounds: Bromofluorobenzene, Bromochloromethane, 1,4-Difluorobenzene, and Chlorobenzene-d5, at a concentration of 100 ppbv each. Spectra Gas or equivalent.

- Calibration Stock Standard: - Commercially prepared custom gaseous stock standard used by all network facilities that includes all target analytes at a concentration of 1.0 ppmv. Spectra Gases or equivalent.

- Calibration Ethanol Neat Material. >99.5 %

- ICV / LCS Stock Standard: - Custom made gaseous stock standard prepared from a different lot(s) of the source material(s) used to manufacture the calibration stock standard. The ICV/LCS stock standard includes all target analytes at a concentration of 1.0 ppmv. Spectra Gases.

- ICV/LCS Ethanol Neat material. >99.5% from a source other than the calibration source.

Prepare calibration and working standards mixtures by diluting a known volume of the stock standard with ultra pure zero air to a specified volume into a humidified summa canister. The summa canister is humidified by adding 100ul of VOA free reagent water. The volume of the standard added to the canister is calculated using the set flow rate of 70mL/min using a mass flow meter multiplied by the time of the standard addition, plus the inclusion of the 25ml volume for the tubing connecting the mass flow meter to the summa canister. The formulations for standard preparation are provided in Appendix B along with recommended expiration dates and storage conditions.

Each stock standard is assigned a 1 year expiration date from manufacture and recertified annually. See BR-QA-002 for details on the recertification process. The ethanol neat material is assigned the expiration date given by the manufacturer.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP. Sampling requirements may be found in the published reference method.

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time	Reference
Air	1L or 6L Passivated Summa Canister*	1L	NA	30 days from collection	EPA TO-15

*1 liter Tedlar bags are only provided upon client request, however clients are discouraged from using Tedlar bags due to the shortened holding time of 72 hours from collection.

All samples should be collected in passivated stainless steel canisters that have been certified clean prior to sampling. The laboratory will provide certified clean canisters to the client upon request. The procedures for clean canister certification are provided in Laboratory SOP BR-AT-011.

The laboratory can also provide flow controllers set to the appropriate flow rate for the sampling time required by the client.

The laboratory ships air canisters in custom made boxes. The boxes are equipped with custom-made foam inserts to hold the pre-set flow-controllers. The shipping materials are designed to prevent damage of equipment to and from the sampling site. The laboratory checks the equipment to ensure it is in proper working order before shipment to the client and additional checks are performed on return of the equipment to the laboratory. Sampling instructions are provided with each sampling kit. The sampling crew is advised to handle the sampling equipment using the instructions provided by the laboratory to ensure optimum performance.

The laboratory's sample acceptance policy for air samples in canisters requires that the sampling crew record the ID of the flow controller used for sample collection on the tag attached to each canister, but the association may also be recorded on the Field Test Data Sheet or a COC. With this information the laboratory can review the history of use of the FC as needed to troubleshoot potential equipment problems. Without the association, the history of use of the FC is unknown. The laboratory strongly recommends that field samplers be instructed to provide this information for each sampling event.

The return pressure of each canister should be between -10” Hg to -1”Hg, except for “grab” samples or samples with a collection rate of 100 or 200 mL/min, which must have a pressure greater than or equal to -10” Hg. The residual vacuum criteria ensure that the sample was collected over the time period the flow controller was calibrated for.

9.0 Quality Control

9.1 Sample QC

The following quality control samples are prepared with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Table 3
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Table 3
Internal Standard (ISTD)	Every Sample	See Table 3
Laboratory Control Sample Duplicate (LCSD)	Client request	See Table 3
Sample Duplicate (SD)	Client Request Required for DoD, 1 in 20 or fewer samples	See Table 3
Trip Blank (TB)	Client Request	See Table 3

NOTE: The compendium reference method does not require the analysis of a laboratory control sample (LCS) or provide criteria for the evaluation of an LCS. The laboratory performs an LCS at the above mentioned frequency as an evaluation of percent recovery in a blank matrix. The laboratory uses statistically derived control limits for the LCS.

Unless otherwise specified by the client during project initiation, the LCSD will be used to measure precision only. The LCS will be used for evaluations for percent recovery and to determine if corrective action is necessary.

9.2 Instrument QC

The following instrument QC is performed:

QC Item	Frequency	Acceptance Criteria
Tune Standard (BFB)	Each Analytical Window	See Section 10.0
Initial Calibration (ICAL)	Initially; when ICV or CCV fail	See Section 10.0
Initial Calibration Verification (ICV)	Once, after each ICAL	See Section 10.0
RT Window Establishment	Once per ICAL	See Section 10.0
Relative Retention Time (RRT)	With each sample	See Section 10.0
Continuing Calibration Verification (CCV)	Daily, after each BFB	See Section 10.0

10.0 Procedure

10.1 Support Equipment Calibration

Verify the calibration of the mass flow controller used to prepare standards, the calibration of the digital flow meter used to set and check the flow rates of the FC(s) used for sample collection, the calibration of the digital pressure gauges used to check return canister pressure, and the calibration of the stop watch used to measure standard addition time is current to the year. Immediately notify the QA department if the calibration is not current and wait for further instruction. Equipment whose calibration has expired may not be used without documented approval from the QA department.

NOTE: The QA department schedules the annual calibrations of the support equipment and maintains all Certificates of Calibration. The flow controllers are checked against a NIST traceable standard. This check is performed by the manufacturer of the equipment, when possible, or by an approved vendor that provides certification service.

10.2 Instrument Calibration

10.2.1 Tune Standard

Analyze a tune standard (BFB) prior at the beginning of each analytical window. The tune standard is a commercially prepared mixed gas stock standard that includes bromofluorobenzene (BFB) at a concentration of 100 ppbv.

To analyze the tune standard:

1) Establish the instrument operating conditions specified in Section 10.4.1.

2) Attach the mixed gas stock standard to the Entech concentrator by attaching the cylinder to the line dedicated for introduction of the internal standard (ISTD). The concentrator directly injects 20 mL of the 100 ppbv stock standard onto the instrument to yield an on column concentration of 10 ppbv.

3) Acquire the data and evaluate the results against the acceptance criteria given in Table 2. Criteria must be met prior to further analysis. The official start time of the 24 hour analytical window is the injection time of a passing tune standard. All samples must be injected within 24 hours of that time.

NOTE: The data processing system averages three scans (apex scan, scan prior, and scan following) and performs background subtraction of the single scan prior to the elution of BFB.

10.2.2 Initial Calibration (ICAL)

The instrument must be calibrated with a minimum of five calibration standards for each target analyte at concentrations that span the working range of the method.

The laboratory routinely analyzes 8 standards at the recommended concentrations of 0.04, 0.20, 0.50, 5.0, 10.0, 15.0, 20 and 40 ppbv, except for Ethanol. For Ethanol, a 6 point curve is analyzed at the following concentrations: 5, 10, 15, 20, 40, and 100 ppbv. Even though eight calibration standards are routinely analyzed not every calibration standard is used for each analyte. Each analyte has been assigned to an analyte group that includes a calibration range of at least five standards. The analyte group associations for each target analyte are provided in Table 1A and Table 1B. The calibration range for each analyte group is as follows:

- Group A: This analyte group is associated with a seven point calibration curve. The calibration range is 0.20 to 40 ppbv with the 0.04 ppbv standard excluded. The limit of quantitation (LOQ) for this group of analytes is 0.20 ppbv

- Group B: This analyte group is associated with a six point calibration curve. The calibration range is 0.50 to 40 ppbv with the 0.04 and 0.20ppbv standards excluded. The limit of quantitation (LOQ) for this group of analytes is 0.50 ppbv.

- Group C: This analyte group is associated with a five point calibration curve. The calibration range is 5.0 to 40 ppbv with the 0.04, 0.20, and 0.50ppbv standards excluded. The limit of quantitation (LOQ) for this group of analytes is 5.0 ppbv.

- Group D: This analyte group is an eight point calibration curve. The calibration range is 0.04 to 40 ppbv. The limit of quantitation (LOQ) for this group of analytes is 0.04 ppbv.

- Group E: (Ethanol): This analyte has a six point calibration curve. The calibration range is 5 to 100 ppbv. The limit of quantitation (LOQ) for this analyte is 5 ppbv.

Prepare the calibration standards using the formulations provided in Appendix B.

Analyze the standards in a sequence from lowest to highest concentration using the instructions provided in Section 10.4.2.

The data processing system calculates a relative response factor (RRF), for each analyte and isomer pair using the assigned internal standard. The internal standard associations for each target analyte are provided in Table 1A and 1B. The data processing system also calculates a mean relative response factor, relative standard deviation (RSD), relative retention time (RRT) and the mean RRT.

The following criteria must be met for a calibration to be considered acceptable:

- The RSD for each target analyte must be <30% with at most 2 exceptions up to a limit of 40%**.**

- The area response for the primary quantitation ion for the internal standard for each ICAL standard must be within 40% of the mean area response over the calibration range for each internal standard.

- The RRT for each target compound at each calibration level must be within 0.06 RRT units of the mean RRT for the compound. The retention time shift for each of the internal standards at each calibration level must be within 20 seconds of the mean retention time over the initial calibration range for each internal standard.

If these criteria are not met inspect the system for problems and perform corrective action. Recommended corrective actions are provided in Section 10.2.5 and in Table 3.

Repeat initial calibration whenever instrument operating conditions are changed, a new column is installed, when significant instrument maintenance has been performed, and when the result of the CCV indicate the calibration is no longer valid.

10.2.3 Second Source Calibration Verification (ICV)

Immediately following an acceptable initial calibration verify the accuracy of the calibration by the analysis of the second source calibration verification standard (ICV).

Prepare the ICV following the formulation provided in Appendix B.

Analyze the ICV following the instructions provided in Section 10.4.2.

The percent recovery (%R) for each target analyte must be within 70-130%. If criteria are not met, perform corrective action. Recommended corrective actions are provided in Table 3. If corrective action is not successful, remake your standards and recalibrate.

If after successful analysis of the ICV, time remains in the 24-hour analytical window, QC and field samples may be analyzed without analysis of a continuing calibration verification check standard. If time does not remain in the analytical window, a new analytical sequence must be initiated with a Tune Standard followed by daily calibration (CCV).

10.2.4 Continuing Calibration Verification (CCV)

Analyze the CCV immediately after the tune standard unless the analytical window includes ICAL, in which case, a CCV is not required.

Prepare the CCV standard using the formulation given in Appendix B. The recommended concentration of the CCV for each target analyte is 10.0 ppbv.

Analyze the CCV following the instructions provided in Section 10.4.2. The data system calculates a response factor for each analyte and calculates the percent difference (%D) of the RRF relative to the mean RRF in the most recent initial calibration.

- The %D for each target analyte must be within ±30%. If the above criteria are not met, repeat the analysis of the CCV once. If the second CCV meets criteria, continue with the analytical sequence. If it fails, evaluate the data to determine if one of the following conditions is met. If these conditions are not met corrective action must be taken. Guidance for troubleshooting is provided in Section 10.2.5. After corrective action the analytical sequence may be continued only if two immediate, consecutive CCVs at different concentrations are within acceptance criteria. If these two CCVs do not meet the criteria, recalibration is required prior to further analysis.
- DoD QSM 5.1 requires that the closing CCV recover within ±30%. EPA Methods TO-14 and TO-15 do not include a closing CCV requirement, but they do have an opening CCV with a +/- 30% limit. If these criteria are not met, immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) until a passing CCV is attained, and then reanalyze all associated samples since last acceptable CCV. If necessary, perform a new initial calibration and then reanalyze all associated samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative.

Note: Per DoD QSM5.1, if samples cannot be re-analyzed, the data MUST be qualified with a Q flag and an explanation must be provided in the case narrative. With client permission, closing CCV criteria of 50% can be utilized.

- If the CCV criteria are exceeded high, indicating a high bias, and the associated samples have non-detects for those analytes, the analytical data may be considered usable. In the absence of instructions otherwise, proceed with analysis.

- If the CCV criteria are exceeded low, indicating a low bias, analytical results may be reported if those results exceed the project's regulatory decision level. In other words, if the analytical results are sufficiently high to counter the low bias, results may be reported. Consult with the project manager to determine if the exception is allowable for each project.

10.2.5 Troubleshooting

Check the following items in case of calibration failures:

- Loss of sensitivity or unstable ISTD recoveries are usually the result of a leak. Check the union between the GC column and Entech transfer line.

- Loss of sensitivity for individual compounds may be a result of either an active site in a transfer line or a bad trap. Troubleshoot and perform maintenance as necessary.

- Poor chromatography usually requires GC column maintenance, perform as necessary.

- Carryover is usually caused by excessive amounts of analyte introduced to the system. Analyze blanks until the system is cleaned or replace the traps and transfer lines if necessary.

Refer to corporate policy CA-Q-S-005 for additional information of procedures to establish and troubleshoot initial calibration curves.

10.3 Sample Preparation

10.3.1 Post Sampling Canister Pressure Check Procedure

The post-sampling canister pressure check is performed at the time of sample login by sample management staff so that any problems found are quickly identified and communicated to the client.

Refer to the current version of SOP BR-SM-001 for the procedure to take and record the post sampling canister pressure check.

10.3.2 Sample Screening

At the laboratory's discretion unknown samples may be screened prior to initial analysis to determine if the sample requires dilution. Unless otherwise requested by the client the laboratory does not provide screen data with the data package report even when primary dilutions are performed based on the results of the screen analysis.

To prepare a sample for screen analysis, connect the sample canister to the autosampler connected to screening instrument and analyze 20 mL of sample. Acquire and evaluate the results. If the results of screen analysis indicate that a target compound is above its upper range of calibration, calculate a recommended dilution factor (DF) by dividing the concentration of analyte found by 30. Record the recommended DF on the screen worksheet.

NOTE: Samples are screened on a GC/MS instrument that is programmed with the operating conditions given in Section 10.4.1 of this SOP. The calibration is checked weekly with a single point calibration standard at a concentration of 10 ppbv for all target analytes. The calibration is checked more frequently when the results of instrument analysis do not correlate well with the results of the screen analysis.

10.3.3 Sample Dilutions & Pressure Adjustment

Field samples should be diluted prior to initial analysis when the screen results indicate that the concentrations are above calibration range and when the laboratory has sufficient knowledge of the sample (history) to know that the sample will require dilution. Field samples must be reanalyzed at a dilution initial analysis when the concentration of target compounds in initial analysis exceed of the upper range of calibration.

When the return negative pressure of a canister is greater than -10”Hg, make-up air may be added to provide sufficient volume of make-up air in order to have an adequate sample volume for analysis. The addition of make-up air is considered a canister dilution. Some concentrators are able to pull full sample volume even if the residual vacuum is lower than -10”Hg so make-up air may not be necessary.

For samples analyzed for constituent groups (e.g. TVOC as Toluene), ranges, and or unresolved complex mixtures (Total Hydrocarbons), samples must be diluted such that the maximum peak height of any sample constituent under consideration does not exceed the equivalent peak height generated by highest calibration level standard. For evaluation it may be useful to graphically overlay sample chromatograms with that of the high point calibration standard.

To dilute the sample:

1) Attach the sample canister to the nitrogen gas line equipped with a pressure gauge that reads negative pressure in (“Hg) and positive pressure in (psig).

2) Ensure the valve of the nitrogen gas line is closed then open the valve of the sample canister. Record the negative pressure reading in the Canister Dilution Worksheet or on the canister’s tag.

3) Slowly open the valve of the nitrogen gas line and fill the canister until canister pressure gauge reads -10”Hg. Do not open the valve to such an extent that the nitrogen gas line pressure drops below 15 psig and do not allow the nitrogen gas line to reach equilibrium otherwise you will contaminate the nitrogen gas line.

4) When the desired pressure is achieved, close the canister valve and the valve on the nitrogen gas line; wait 15 seconds. The pressure should not exceed 40 psig.

5) Open the canister valve and record the final pressure reading in psig.

6) Close the canister valve and remove the valve from the zero air line.

7) Record the initial and final pressure readings in the TALS canister dilution tracking module. If the final pressure is below ambient, the "HG reading must be converted to psig by dividing the value by 2 prior to entry into the TALS worksheet.

When the return pressure of a canister is positive, the pressure must be adjusted to near ambient (0"Hg) prior to analysis. To adjust the pressure to ambient, vent the canister to ambient in a fume hood by opening the canister value for ~4-5 seconds, close the valve. For higher pressure canisters, open the valve and listen for a release of air then close the valve when the sound recedes.

If a trip blank is provided, pressurize the trip blank canister to 10 psig. The pressurization of the trip blank is not considered a dilution.

10.3.4 QC Sample Preparation

To prepare the method blank (MB): Fill a clean canister that has never been used to collect environmental samples and has never left the laboratory to 20 psig with nitrogen gas. Continue to use this canister as the MB until the pressure of the canister reaches 0 psig, at which time, recharge with nitrogen gas to 20 psig and reuse.

To prepare the LCS: Follow the instructions provided in Appendix B for preparation of the working ICV/LCS standard. If an LCSD is requested, analyze the LCSD from the same canister as the LCS.

10.4 Sample Analysis

10.4.1 Instrument Operating Conditions

Optimize the GC and MS conditions for compound separation and sensitivity.

The recommended operating conditions are as follows:

Thermal Desorb:	Initial Trap #1 Temperature: -110ºC
	Desorb Temperature from Trap #1 to #2: 0 ºC
	Total Volume Transfer by Mass Flow Controller: 40 mL
	Initial Trap #2 Temperature: -15 ºC
	Desorb Temperature from Trap #2 to #3: 200ºC
	Transfer time 3.5 minutes
	Initial Trap #3 Temperature: -165 ºC
	Injection Trap #3 Temperature: 70ºC
	Injection Time: 1.5 minutes
	Trap #3 Temperature after Injection: -165 ºC
Carrier Gas:	Helium, Ultra High Purity
Cryogenic Focusing Gas:	Liquid Nitrogen
Flow Rate:	~1.5 mL/min
Temperature Program:	Initial Temperature: 40ºC
	Initial Hold Time: 4 minutes
	Ramp1 Rate: 20ºC/min. to 200ºC.
	Ramp 2 Rate: 40ºC/min. to 220ºC
	Final Temperature: 220ºC
	Final Hold Time: 6.5 minutes
Electron Energy:	70 electron volts

Mass Range:	35-265 amu
Scan Time:	≥1 scan per second

These operating conditions may be changed but once the operating conditions are established for initial calibration the same conditions must be used until a new calibration is performed.

10.4.2 Daily Instrument Maintenance

Prior to analysis initiate the flushing sequence using the Entech software. Then initiate the bake program using the Entech software.

10.4.3 Bi-Weekly Instrument Maintenance

At a minimum frequency of once every two weeks, perform an autosampler leak check. Cap all autosampler ports and initiate the leak check program using the Entech software. Record this check in the instrument maintenance log.

10.4.4 Analytical Sequence

An example analytical sequence that includes initial calibration (ICAL) is provided below. When ICAL is not performed, the sequence begins with the tune standard and is followed by the CCV, LCS, LCSD, and method blank. If sufficient time remains in the 24 hours analytical window after initial calibration, QC and field samples may be analyzed without the CCV and the ICV will serve as the LCS for the sequence. The MB, LCS and LSCD must be analyzed at a frequency of every 20 samples or with each analytical sequence whichever is more frequent.

1. Tune Standard (BFB)
2. ICAL
3. ICV
4. CCV
5. LCS (repeat every 20 samples)
6. LCSD (when requested)
7. MB (repeat every 20 samples)
8. Field Samples (including trip blanks)

Attach the canisters to the autosampler inlet in the order of the analytical sequence then initiate the analytical sequence. The autosampler introduces 200 mL of sample volume from each canister to the instrument system and adds 20 mL of the mixed gas standard to each sample.

Acquire the data and evaluate the results to confirm qualitative identification and quantification.

11.0 <u>Calculations / Data Reduction</u>

11.1 Qualitative Identification

The data processing system tentatively identifies target analytes by comparing the retention time of the peaks to the window set around the continuing calibration standard, and searches in that area for the primary ion and up to two secondary ions characteristic of the target analyte.

All tentative identifications made by the computer are reviewed and either accepted or rejected by the primary analyst. The identification made by the system is accepted when the following criteria are met:

- The target analyte is identified by comparison of its background subtracted mass spectrum to a reference spectrum in the NIST14 database. In general, all ions that are present above 10% relative abundance in the mass spectrum of the standard should be present in the mass spectrum of the sample component and their relative abundances should agree within 20%. For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample spectrum should be in the range of 10-50%. Some ions, particularly the molecular ion, are of special importance if a tentative identification is to be made, and should be evaluated even if they are below 10% relative abundance.

- The GC retention time for the target analyte should be within 0.06 RRT units of the daily standard.

Identification requires expert judgment when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), appropriate analyte spectra and background spectra can be selected by examining plots of characteristic ions for tentatively identified components. When analytes coelute (i.e., only one GC peak is apparent), the identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. If the data system does not properly integrate a peak, perform manual integration. All manual integration must be performed and documented in accordance with corporate SOP CA-Q-S-002*Manual Integration*.

11.2 Quantification of Target Analytes

After a compound has been identified, the data system quantifies the on-column concentration of the target compound based on the integrated abundance of the characteristic ion from the EICP. If there is matrix interference with the primary ion, a secondary ion may be used for quantification by calculating a mean RF factor for that ion and using that ion to quantify the analyte in the sample. When secondary ion calculations are required, include this information in the non-conformance report and project narrative.

Samples analyzed for constituent groups, ranges, and or unresolved complex mixtures are quantified as follows;

11.2.1 TVOC as Toluene

An internal standard type quantification response factor is generated using the RIC peak response measured for Toluene and its associated internal standard (as detailed in the calculation section). That response factor is used to quantify all RIC chromatographic sample response with the exception of those peak responses associated with internal standards. The results are reported as 'TVOC (as Toluene)'.

Retention Time Range: Propene to Naphthalene

11.2.2 GRO as Octane

An internal standard type quantification response factor is generated using the RIC peak response measured for Octane and its associated internal standard (as detailed in the calculation section). That response factor is used to quantify all RIC chromatographic sample response with the exception of those peak responses associated with internal standards that eluted within the retention time range as defined by the elution of 2-Methyl-Butane through Decane (C5-C10). The results are reported as ‘GRO (as Octane).

Retention Time Range: 2-Methyl-Butane to n-Decane

11.2.3 Unresolved Complex mixtures

An internal standard type quantification response factor is generated using the RIC peak response measured for the un-resolved complex mixture (i.e. the gasoline envelope) and its associated internal standard (as detailed in the calculation section). That response factor is used to quantify all similarly chromatographing RIC sample response with the exception of those peak responses associated with internal standards. The results are reported using the name of the unresolved complex mixture used in the calibration (e.g. Total Hydrocarbons).

Retention Time Range: Propene to Naphthalene

Final results are calculated in TALS.

11.3 Calculations

Analytical results are calculated as follows:

- **Dilution Factor**

$$DF = \frac{V_2}{V_1} x \frac{V_4}{V_3}$$

Where:
V_1 = Pre-Dilution Canister Volume
V_2 = Post-Dilution Canister Volume
V_3 = Sample Amount (mL)
V_4 = Base Sample Amount (200 mL)

Relative Response Factor (RRF)

$$RRF = \frac{(A_x)(C_{is})}{(A_{is})(C_x)}$$

Where:
A_x = Area of the quantitation ion of the analyte
A_{is} = Area of the quantitation ion of the internal standard
C_x = Concentration of analyte in concentration units (ppbv)
C_{is} = Concentration of internal standard in concentration units (ppbv)

- **Percent Relative Standard Deviation (%RSD)**

$$\%RSD = \frac{SD}{Mean} x100$$

Where:

SD = Standard deviation individual response factors
Mean = Average of five response factors

- **Sample Concentration**

$$C_x = \frac{(A_x)(C_{IS})}{(A_{IS})(\overline{RRF})}(DF)$$

Where:
C_x = Compound concentration (ppbv)
C_{IS} = Concentration of associated internal standard (ppbv)
A_{IS} = Area of quantitation ion for associated internal standard
A_x = Area of quantitation ion for compound
DF = Dilution Factor
Mean RRF = Average Relative Response Factor from initial calibration.

- **Unit Conversion from ppbv to ugm3**

$$\text{Analytical Result (ug/m3)} = \text{Result(ppbv)} \times \left(\frac{\text{mw}}{24.45}\right)$$

Where:
mw = molecular Weight

Example:
Benzene Result = 56 ppbv
Benzene mw = 78.108

$$\text{Analytical Result (ug/m3)} = 56\ \text{ppbv} \times \left(\frac{78.108}{24.45}\right)$$

Result(ug/m3) = 178.9 ug/m3 reported as 180 ug/m3

- **Percent Recovery (%R)**

$$\%R = \frac{C_s}{C_n} \times 100\%$$

Where:
C_s = Concentration of the spiked sample (ppbv)
C_n = Nominal concentration of spike added (ppbv)

- **Precision (%RPD)**

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

Where:
C_1 = Measured concentration of the first sample aliquot
C_2 = Measured concentration of the second sample aliquot

Formula of Standard Addition:

Volume (mL) = (FR x T) + 25 mL

Where:
FR = flow rate in mL/min
T= time in minutes

Example FR = 70ml/min
Time = 10.69 minutes
Volume = 25+ (70 x 10.69) = 773 mL

Total Volume of diluted standard

Volume (mL) = CV x P

Where:
CV = canister volume in mL
P = pressure in Bar (14.7psi per Bar)

Example: CV = 6185 mL
P= 2.5 Bar
Volume = 15462 mL

11.4 Data Review

11.4.1 Primary Review (Performed by Primary Analyst)

Upload the data files to TALS. Enter batch editor information and add the standards and reagents to the TALS batch. Review the results against acceptance criteria. If acceptance criteria are not met, make arrangements to perform corrective action.
Check the results of samples analyzed immediately after high concentration samples for signs of carry-over. Reanalyze the sample if carry over is suspected.

Dilute and reanalyze samples whose results exceed the calibration range. The diluted analysis should result in a determination within the upper half of the calibration curve.

Set results to primary, secondary, acceptable or rejected as appropriate.

Verify corrective action was taken for all results not within acceptance criteria. If corrective action is not taken or was unsuccessful, record all instances where criteria are not met with a nonconformance memo (NCM). Be sure to provide explanation of your decision making in the internal comment section of the NCM. The internal comment section should list the reason the NCM is suspected, which action (if any) was taken and why and the outcome of the action taken.

Review project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Set the batch to 1st level review.

Record your review on the data review checklist.

11.4.2 Secondary Review (Performed by Peer Reviewer)

Review the project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements and verify project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Review records (these records include but are not limited to the Pre-Shipment Clean Canister Certification Report, Flow Controller Set Flow Rate and Leak Check Record, Field Test Data Sheets, and the Air Canister Return Pressure Check Record) associated with release and return of air sampling equipment to ensure all anomalies are properly recorded. Compare any problems noted in these documents with the analytical results and record any findings in the narrative note program or otherwise communicate your findings to the PM for inclusion in the project narrative.

Review the TALS batch editor to verify information is complete. Review the batch to verify that the procedures in this SOP were followed. If discrepancy is found, resolve the discrepancy and verify any modifications to the SOP are were approved and are properly documented.

Spot-check 15% of samples in the batch to verify quantitative and qualitative identification. If the samples are being analyzed under DoD methods 100% of data must be checked during secondary review.

If manual integrations were performed:

- Review each manual integration to verify that the integration is consistent and compliant with the requirements specified in corporate SOP CA-Q-S-002.

- Check to ensure an appropriate technical reason code is provided for each manual integration. Acceptable technical reason codes are provided in corporate SOP CA-Q-S-002.

- Generate a “before” and “after” chromatogram for every manual integration performed on an instrument performance check standard (Tune, ICAL, ICV, CCV), QC sample (MB, LCS) and for any manual integration performed on any surrogate or internal standard in any field sample, if not already performed automatically by the software..
- Generate the Manual Integration Summary Report if not automatically generated by the software. Document your review of manual integrations on the summary report and obtain any review signatures of integrations performed during secondary review as required.

  If the reviewer disagrees with the integration performed by the primary analyst, the secondary data reviewer should not change the integration. Instead, he/she should consult with the primary analyst that performed the integration and both the reviewer and the primary analyst should agree the integration should be changed. If consensus between the primary analyst and the peer reviewer cannot be achieved; both should consult with the Technical Manager or department management for resolution. Any changes to the

integration should be performed by the primary analyst. If it is necessary for the secondary reviewer to perform the manual integration because the primary analyst is out of the office; the integration made by the peer reviewer must be reviewed by another peer reviewer or by department management to verify the integration was performed and documented in compliance to SOP CA-Q-S-002. If the original analyst that performed the integration is out of the office, the data reviewer may consult with the Department Manager (DM), Department Supervisor (DS) or the Technical Manager (TM) to verify the change he/she thinks is needed is warranted and should be made.

Verify that the performance criteria for the QC items listed in Table 1A or 1B were met. If the results do not fall within the established limits verify that corrective actions were performed. If corrective action was not performed; verify the reason is provided and that the situation is properly documented with an NCM. Set samples to 2nd level review.

Run the QC checker and fix any problems found. Run and review the deliverable. Fix any problems found. When complete set the method chain to lab complete and forward any paperwork to report/project management.

Record second level review on the data review checklist.

11.5 Data Reporting

Report analytical results above the reporting limit (RL) as the value found. Report analytical results less than the RL, to the adjusted RL with a “U” data qualifier. Adjust the RL for sample dilution/concentration. The unadjusted RL for each target analyte is provided in Table 1A and 1B. For Method TO3 the laboratory does not report values below the reporting limit.

Data reporting and creation of the data deliverable is performed by TALS using the formatters set by the project manager during project initiation.

Electronic and hardcopy data are maintained as described in laboratory SOP BR-QA-014 Laboratory Records.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

Perform a method detection limit (MDL) study at initial method set-up following the procedures specified in laboratory SOP BR-QA-005,

12.2 Demonstration of Capabilities (DOC)

Perform a method demonstration of capability at initial set-up and when there is a significant change in instrumentation or procedure.

Each analyst that performs the analytical procedure must complete an initial demonstration of capability (IDOC) prior to independent analysis of client samples. Each analyst must demonstrate on-going proficiency (ODOC) annually thereafter. DOC procedures are further described in the laboratory’s quality system manual (QAM) and in the laboratory SOP for employee training.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

Instrument analysts, prior to independent analysis of client samples, must also have documentation of demonstration of initial proficiency (IDOC) and annual on-going proficiency (ODOC) in their employee training files.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001 *Hazardous Waste*.

The following waste streams are produced when this method is carried out:

- None

15.0 References / Cross-References

- EPA Compendium Method TO-15, "Determination of Volatile Organic Compounds in Ambient Air using Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry", US EPA, January, 1999.
- USEPA Compendium Method TO-3 "Method for the Determination of Volatile Organic Compounds In Ambient Air Using Cryogenic Pre Concentration Techniques and Gas Chromatography with Flame Ionization and Electron Capture Detection", USEPA, April 1984
- New Jersey Department of Environmental Protection Site Remediation Program Vapor Intrusion Technical Guidance, Version 3.1, March 2013.
- Laboratory SOP BR-QA-005, Procedures for the Determination of Limits of Detection (LOD), Limits of Quantitation (LOQ) and Reporting Limits (RL).
- Laboratory SOP BR-QA-011 Employee Training
- Laboratory SOP BR-EH-001 Hazardous Waste
- Laboratory SOP BR-QA-014 Laboratory Records
- Laboratory SOP BR-SM-001 Sample Management
- Laboratory Quality Assurance Manual (QAM)
- Corporate SOP CA-Q-S-002 *Manual Integration Practices*

16.0 Method Modifications

- This SOP utilizes and alternative detector (mass spectrometer) vs that of a FID and/or ECD as listed in the published method**.**
- This SOP describes a method where an aliquot of a whole air sample collected in a passivated

stainless steel canister is cryogenically trapped and concentrated prior to injection into the MS detector equipped GC.

- This Method SOP utilizes an RTX-624 capillary column (60M x 0.32 mm ID x 0.18*u*m).
- Additional quality control aspects are employed in the use of this method based on the alternative detector type, specifically, the detector tune is verified at the beginning of each period of analysis prior to the acquisition on any standard, blank, QC sample or field sample.
- This Method SOP does not utilize sub ambient column oven temperature programming.
- Sample traps consist of a multi bed system employing Tenax and glass beads (see manufactures system description: Entech Model 7100 Sample pre Concentrator).
- Sampling apparatus consists of passivated stainless steel canister specifically design for the collection of ambient air samples for volatile analysis
- Nafion dryers are not used. The analytical pre-concentration system employs a moisture control system consisting of multi sorbent bed traps.
- System calibration is verified every 24 hour within which samples are analyzed. System linearity is not verified every 4-6 hours as described.
- Published Method requires weekly multi-point calibration be performed. Laboratory performs multi-point calibrations as necessary see section 10.2
- System linearity is determined through multi point calibration utilizing average response factors and internal standard technique quantification (see Section 10).

17.0 Attachments

- Table 1A: Target Compound List, RL, Internal Standard and Ion Assignments for TO15
- Table 1B: Target Compound List, RL, Internal Standard and Ion Assignments for TO13
- Table 2: Ion Abundance Criteria (BFB)
- Table 3: QC Summary & Recommended Corrective Action
- Table 4: LCS Control Limits
- Appendix A: Terms and Definitions
- Appendix B: Standard Preparation Tables
- Appendix C: DoD QSM LCS and MS/MSD Limits

18.0 Revision History

BR-AT-004r12.0
Title Page: Updated copyright date and signatories.
Throughout: Removed Zero Air and replaced with Nitrogen Gas.
Throughout: Removed references to TO14 (no longer performed)
Throughout: Added TO3 requirements and verbiage
Throughout: Added DoD QSM5.1 requirements
Section 18: removed older history and added statement that previous revisions are retained.

Previous revisions are retained by the QA department.

Table 1A: Routine Compound List, Reporting Limit, Internal Standard and Ion Assignments

Analyte	CAS No.	6L RL (ppbv)	1L RL (ppbv)	Quantifier Mass	Qualifier Mass	Qualifier Mass	ISTD Group	Analyte Group
Dichlorodifluoromethane	75-71-8	0.5	5	85	87		1	B
Freon-22	75-45-6	0.5	5	51	67	69	1	B
1,2-Dichlorotetrafluoroethane	76-14-2	0.2	2	85	135	87	1	A
Chloromethane	74-87-3	0.5	5	50	52		1	B
n-Butane	106-97-8	0.5	5	43	41	58	1	B
Vinyl Chloride	75-01-4	0.04	0.40	62	64		1	D
1,3-Butadiene	106-99-0	0.04	5	54			1	D
Bromomethane	74-83-9	0.2	2	94	96		1	A
Chloroethane	75-00-3	0.5	5	64	66		1	B
Isopentane	78-78-4	0.2	2	43	57	56	1	A
Bromoethene (Vinyl Bromide)	593-60-2	0.2	2	106	108	81	1	A
Trichlorofluoromethane	75-69-4	0.2	2	101	103		1	A
Pentane	109-66-0	0.5	5	43	57	72	1	B
EthylEther	60-29-7	0.2	2	59	45	74	1	A
Acrolein	107-02-8	5	50	56	55	37	1	C
Freon TF	76-13-1	0.2	2	101	151	103	1	A
1,1-Dichloroethene	75-35-4	0.2	2	96	61	63	1	A
Acetone	67-64-1	5	50	43	58		1	C
Isopropyl Alcohol	67-63-0	5	50	45	43		1	C
Carbon Disulfide	75-15-0	0.5	5	76			1	B
3-Chloropropene (Allyl Chloride)	107-05-1	0.5	5	41	76		1	B
Acetonitrile	75-05-8	5	50	41	40	39	1	C
Methylene Chloride	75-09-2	0.5	5	49	84	86	1	B
tert-Butyl Alcohol	75-65-0	5	50	59	41	43	1	C
Methyl tert-Butyl Ether	1634-04-4	0.5	5	73	43		1	B
trans-1,2-Dichloroethene	156-60-5	0.2	2	61	96		1	A
n-Hexane	110-54-3	0.5	5	57	86		1	B
1,1-Dichloroethane	75-34-3	0.2	2	63	65	83	1	A
Methyl Ethyl Ketone	78-93-3	0.5	5	72	43		1	B
cis-1,2-Dichloroethene	156-59-2	0.2	2	96	98		1	A
Tetrahydrofuran	109-99-9	5	50	42	72		2	C
Chloroform	67-66-3	0.2	2	83	85		1	A
1,1,1-Trichloroethane	71-55-6	0.2	2	97	99	61	2	A
Cyclohexane	110-82-7	0.2	2	84	56		2	A
Carbon Tetrachloride	56-23-5	0.04	2	117	119		2	D
2,2,4-Trimethylpentane	540-84-1	0.2	2	57	41	43	2	A
1,2-Dichloroethene (total)	540-59-0	0.2	2	61	96		1	A
Benzene	71-43-2	0.2	2	78	77		2	A
1,2-Dichloroethane	107-06-2	0.2	2	62	98		2	A
n-Heptane	142-82-5	0.2	2	43	71		2	A
Trichloroethene	79-01-6	0.04	0.40	95	130	132	2	D
Methyl Methacrylate	80-62-6	0.5	5	69	41	39	2	B
1,2-Dichloropropane	78-87-5	0.2	2	63	41		2	A
1,4-Dioxane	123-91-1	5	50	88	58		2	C

Analyte	CAS No.	6L RL (ppbv)	1L RL (ppbv)	Quantifier Mass	Qualifier Mass	Qualifier Mass	ISTD Group	Analyte Group
Dibromomethane	74-95-3	0.2	2	174	93	172	2	A
Bromodichloromethane	75-27-4	0.2	2	83	85		2	A
cis-1,3-Dichloropropene	10061-01-5	0.2	2	75	110		2	A
Methyl Isobutyl Ketone	108-10-1	0.5	5	43	58		2	B
n-Octane	111-65-9	0.2	2	43	57	114	2	A
Toluene	108-88-3	0.2	2	92	91		3	A
trans-1,3-Dichloropropene	10061-02-6	0.2	2	75	110		2	A
1,1,2-Trichloroethane	79-00-5	0.2	2	83	97	85	3	A
Tetrachloroethene	127-18-4	0.04	0.40	166	168	129	3	D
Methyl Butyl Ketone	591-78-6	0.5	5	43	58		3	B
Dibromochloromethane	124-48-1	0.2	2	129	127		3	A
1,2-Dibromoethane	106-93-4	0.2	2	107	109		3	A
Nonane	111-84-2	0.2	2	57	71	128	3	A
Chlorobenzene	108-90-7	0.2	2	112	77	114	3	A
Ethylbenzene	100-41-4	0.2	2	91	106		3	A
Xylene (m,p)	1330-20-7	0.5	5	106	91		3	A
Xylene (o)	95-47-6	0.2	2	106	91		3	A
Styrene	100-42-5	0.2	2	104	78		3	A
Bromoform	75-25-2	0.2	2	173	175	171	3	A
Cumene	98-82-8	0.2	2	105	120	77	3	A
1,1,2,2-Tetrachloroethane	79-34-5	0.2	2	83	131	85	3	A
Xylene (total)	1330-20-7	0.2	2	106	91		3	A
n-Decane	124-18-5	0.5	5	57	71	142	3	B
n-Propylbenzene	103-65-1	0.2	2	91	120	92	3	A
1,2,3-Trichoropropane	96-18-4	0.5	5	75	110	112	3	B
4-Ethyltoluene	622-96-8	0.2	2	105	120		3	A
1,3,5-Trimethylbenzene	108-67-8	0.2	2	105	120		3	A
2-Chlorotoluene	95-49-8	0.2	2	91	63		3	A
tert-Butylbenzene	98-06-6	0.2	2	119	91	134	3	A
1,2,4-Trimethylbenzene	95-63-6	0.2	2	105	120		3	A
sec-Butylbenzene	135-98-8	0.2	2	105	134	91	3	A
4-Isopropyltoluene	99-87-6	0.2	2	119	134	91	3	A
1,3-Dichlorobenzene	541-73-1	0.2	2	146	111	148	3	A
1,4-Dichlorobenzene	106-46-7	0.2	2	146	111	148	3	A
n-Undecane	1120-21-4	5	50	57	71	156	3	C
Benzyl Chloride	100-44-7	0.2	2	91	126	65	3	A
n-Butylbenzene	104-51-8	0.2	2	91	134	92	3	A
1,2-Dichlorobenzene	95-50-1	0.2	2	146	111	148	3	A
n-Dodecane	112-40-3	5	50	57	71	170	3	C
1,2,4-Trichlorobenzene	120-82-1	0.5	5	180	182		3	B
1,3-Hexachlorobutadiene	87-68-3	0.2	2	225	223		3	A
Naphthalene	91-20-3	0.5	5	128			3	B
1,2,3-Trichlorobenzene	87-61-6	0.2	2	180	182	145	3	A
Propylene	115-07-1	5	50	41	42	39	1	C
Vinyl Acetate	108-05-4	5	50	43	86		1	C

Analyte	CAS No.	6L RL (ppbv)	1L RL (ppbv)	Quantifier Mass	Qualifier Mass	Qualifier Mass	ISTD Group	Analyte Group
Ethyl Acetate	141-78-6	5	50	43	74		1	C
Ethanol	64-17-5	5	50	46	45		1	E
Bromochloromethane	74-97-5	NA	NA	128	49	130	1	NA
1,4-Difluorobenzene	540-36-3	NA	NA	114			2	NA
Chlorobenzene-d5	3114-55-4	NA	NA	117			3	NA

Table 1B: TO-3 Analyte List, Reporting Limit, Internal Standard and Ion Assignments

Analyte	CAS No.	RL (ppbv)	Qualifier Ion	Qualifier Ion	Qualifier Ion	ISTD Group
n-Octane	111-65-9	0.2	43	57	114	2
Toluene	108-88-3	0.2	92	91		3
TVOC as Toluene	NA	11				NA
GRO as Octane	NA	14				NA
Total Hydrocarbons	NA	76 ug/m3				NA
Internal Standards						
Bromochloromethane	74-97-5	NA	128	49	130	1
1,4-Difluorobenzene	540-36-3	NA	114			2
Chlorobenzene-d5	3114-55-4	NA	117			3

Table 2: Tune Standard Criteria

Mass	Ion Abundance Criteria
50	8.0 to 40.0 percent of mass 95
75	30.0 to 66.0 percent of mass 95
95	Base Peak, 100 percent relative abundance
96	5.0 to 9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	50.0 to 120.0 percent of mass 95
175	4.0 to 9.0 percent of mass 174
176	93.0 to 101.0 percent of mass 174
177	5.0 to 9.0 percent of mass 176

Table 3: TO15 QC Summary & Recommended Corrective Action (Routine and DoD)

QC Check	Frequency	Acceptance Critera	Recommended Corrective Action
Tune Standard	Prior to calibration and every 24 hours	See Table 2	Correct Problem. Reanalyze. No samples may be analyzed without a valid tune.
ICAL	Prior to sample analysis and when CCV fails	RSD for each analyte ≤ 30% with 2 exceptions up to 40%	Correct problem and repeat calibration
ICV	Once after each ICAL	%R for all analytes within 70-130	Correct Problem. Reanalyze, re-make, re-verify & re-analyze. If that fails, re-make all standards and repeat calibration.
Retention Time Window	Once per ICAL	NA	NA
RRT	With each sample	RRT of each target analyte in each calibration standard within ± 0.06 RRT units.	Correct Problem. Repeat ICAL
CCV	Daily before sample analysis after tune standard	%D ≤ 30	Correct Problem. Reanalyze once. If that fails, see section 10.2.5 for instruction.
Closing CCV	At the end of the analytical sequence, within 24 hours of opening tune acquisition.	%D ≤ 30	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) until a passing CCV is attained, and then reanalyze all associated samples since last acceptable CCV. If necessary, perform a new initial calibration and then reanalyze all associated samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. With client permission, closing CCV criteria of 50% can be utilized.
LCS	Each batch or every 20 samples, whichever is sooner.	**Routine**: %R for all analytes by statistically generated limits. See Table 4. **DoD**: %R for all analytes by QSM 5.1 limits, see Appendix C.	Reanalyze LCS or re-prep and reanalyze LCS and all associated samples if sufficient sample volume is available. If corrective action not successful, initiate nonconformance report and qualify sample results.
LCSD	Per Client Request	RPD ≤ 25	Reanalyze LCSD or re-prep and reanalyze LCSD and all associated samples if sufficient sample volume is available. If corrective action is not successful, initiate nonconformance report and qualify sample results.
Method Blank	Each batch or every 20 samples, whichever is sooner.	No analytes detected above RL	Reanalyze along with associated samples, unless detects for same compounds found in blank are greater than 10X the concentration found in the blank.
Internal Standard	All standards, field and QC samples	+/- 40% area response from last acceptable calibration. RT +/- 0.33 min (20 seconds) from last acceptable calibration.	Inspect system for malfunction. Reanalyze samples. Qualify data.
Sample Duplicate	Per Client Request	RPD ≤ 25 when one or both results are greater than five times the RL.	Consult with PM. Reanalyze or qualify data.

Table 4: In-house LCS limits*

Analyte	In-House Limits %R	RPD
1,1,1-Trichloroethane	70 - 130	25%
1,1,2,2-Tetrachloroethane	70 - 130	25%
1,1,2-Trichloro-1,2,2-trifluoroethane	70 - 130	25%
1,1,2-Trichloroethane	70 - 130	25%
1,1-Dichloroethane	70 - 130	25%
1,1-Dichloroethene	70 - 130	25%
1,2,3-Trichlorobenzene	55 - 130	25%
1,2,3-Trichloropropane	70 - 130	25%
1,2,4-Trichlorobenzene	62 - 130	25%
1,2,4-Trimethylbenzene	70 - 130	25%
1,2-Dichloro-1,1,2,2-tetrafluoroethane	70 - 136	25%
1,2-Dichlorobenzene	70 - 130	25%
1,2-Dichloroethane	70 - 130	25%
1,2-Dichloropropane	70 - 130	25%
1,3,5-Trimethylbenzene	70 - 130	25%
1,3-Dichlorobenzene	70 - 130	25%
1,4-Dichlorobenzene	70 - 130	25%
1,4-Dioxane	70 - 130	25%
2-Butanone (MEK)	70 - 130	25%
2-Chlorotoluene	70 - 130	25%
2-Hexanone	66 - 131	25%
2-Methyl-2-propanol	61 - 130	25%
2-Methylbutane	58 - 150	25%
3-Chloro-1-propene	54 - 140	25%
4-Ethyltoluene	70 - 130	25%
4-Isopropyltoluene	70 - 130	25%
4-Methyl-2-pentanone (MIBK)	66 - 132	25%
Acetone	66 - 138	25%
Acetonitrile	57 - 150	25%
Acrolein	70 - 150	25%
Acrylonitrile	64 - 144	25%
Alpha Methyl Styrene	70 - 130	25%
Benzene	70 - 130	25%
Benzyl chloride	70 - 135	25%
Bromoform	66 - 150	25%
Bromomethane	70 - 130	25%
Butadiene	59 - 132	25%
Butane	56 - 141	25%
Carbon disulfide	70 - 143	25%
Carbon tetrachloride	68 - 132	25%
Chlorobenzene	70 - 130	25%
Chlorodibromomethane	70 - 130	25%
Chlorodifluoromethane	68 - 131	25%
Chloroethane	62 - 136	25%
Chloroform	70 - 130	25%

Chloromethane	58 - 133	25%
cis-1,2-Dichloroethene	70 - 130	25%
cis-1,3-Dichloropropene	70 - 130	25%
Cyclohexane	70 - 130	25%
Dibromomethane	70 - 130	25%
Dichlorobromomethane	70 - 130	25%
Dichlorodifluoromethane	70 - 130	25%
Dodecane	66 - 142	25%
Ethanol	59 - 140	25%
Ethyl acetate	70 - 131	25%
Ethyl ether	70 - 148	25%
Ethylbenzene	70 - 130	25%
Ethylene Dibromide	70 - 130	25%
Hexachlorobutadiene	69 - 130	25%
Hexane	70 - 130	25%
Isooctane	70 - 130	25%
Isopropyl alcohol	51 - 130	25%
Isopropylbenzene	70 - 130	25%
Methyl methacrylate	70 - 130	25%
Methyl tert-butyl ether	70 - 130	25%
Methylene Chloride	62 - 131	25%
m-Xylene & p-Xylene	70 - 130	25%
Naphthalene	52 - 130	25%
n-Butanol	68 - 130	25%
n-Butylbenzene	70 - 130	25%
n-Decane	70 - 131	25%
n-Heptane	69 - 130	25%
n-Nonane	70 - 130	25%
n-Octane	70 - 130	25%
N-Propylbenzene	70 - 130	25%
o-Xylene	70 - 130	25%
Pentane	60 - 150	25%
Propene	61 - 136	25%
sec-Butylbenzene	70 - 130	25%
Styrene	70 - 130	25%
tert-Butylbenzene	70 - 130	25%
Tetrachloroethene	70 - 130	25%
Tetrahydrofuran	61 - 140	25%
Toluene	70 - 130	25%
trans-1,2-Dichloroethene	70 - 130	25%
trans-1,3-Dichloropropene	70 - 130	25%
Trichloroethene	70 - 130	25%
Trichlorofluoromethane	70 - 130	25%
Undecane	66 - 134	25%
Vinyl acetate	62 - 141	25%
Vinyl bromide	70 - 130	25%
Vinyl Chloride	62-130	25%

TPH GRO as Octane	70 - 130	25%
TVOC as Toluene	70 - 130	25%
Total Hydrocarbons.	60-140	25%

*The limits in this table are those in effect as of the published date of this SOP. These limits are based on historical data and are subject to change. Current in-house limits are populated in the LIMS database. Contact a laboratory representative for the most current set of limits. Limit Ref: 2012CC3

Appendix A: Terms and Definitions

Acceptance Criteria: Specified limits placed on characteristics of an item, process or service defined in requirement documents.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: Environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Calibration: a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values realized by the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): An analytical standard gas mixture containing all target analytes and internal standard compounds that is used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Cryogen: A refrigerant used to obtain very low temperatures in the cryogenic trap of the analytical system. A typical cryogen is liquid nitrogen (bp -195.8℃) or liquid argon (bp -185.7℃).

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Initial Calibration Verification (ICV): An analytical standard mixture containing all target analytes and internal standard compounds that are prepared from a source independent of the source of the initial calibration standards. The purpose of the ICV is to verify that the initial calibration is in control.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Internal Standards (IS): Non-target analytes that are similar to the target analytes but are not expected to be found in environmental media (generally, isotopically labeled target analytes are used for this purpose). IS are added to every standard, quality control sample, and field sample at a known concentration prior to analysis. IS responses are used as the basis for quantitation of target analytes.

Laboratory Control Sample (LCS) – A QC sample of known composition spiked with analytes of interest. The LCS evaluates method performance and ability to successfully recover target analytes from a clean matrix. LCS recovery is typically expressed as percent recovery and provides a measure of accuracy. A LCSD is a duplicate LCS prepared and analyzed from a separate canister to provide a measure of replicate precision.

Method Blank (MB): A canister of humidified ultra pure zero air that is treated exactly as a sample. The MBLK is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a <u>range</u> where qualitative detection occurs. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Stock Gas Mixture: A Commercially purchased concentrated gas mixture containing one or more method analytes

Appendix B: Standard Preparation Tables

The standard formulations contained in this appendix are recommended and are subject to change. If the concentration or volume of any of the stock standard changes, the standard preparation instructions must be adjusted accordingly. See laboratory SOP BR-QA-002 *Standard Preparation* for further guidance on the preparation of standard solutions.

Prepare all standards using the McMillan Company 80SD mass flow controller. Prepare the standard in zero air, demonstrated to be analyte free. Store the standard at ambient temperature. Unless otherwise specified, assign an expiration date of 30 days from date of preparation unless the parent standard expires earlier, in which case, use the earliest expiration date.

Intermediate Calibration Standard

Parent Standard	Vendor	Stock Standard Concentration (ppmv)	Volume Added (mL)	Final Volume (L)	Final Concentration (ppbv)
Custom Calibration Stock Standard	Spectra Gases Custom Made	1.0	7500	37.5	200

Prepare in 15 L Summa Canister Expiration Period 3months
This standard contains all the target analytes listed in table 1.

Working Calibration Standards

Parent Standard	Calibration Standard	Parent Standard Concentration (ppbv)	Volume Added (mL)	Final Volume (L)	Final Concentration (ppbv)
Cal Standard 20 ppbv	Cal Standard 0.2 ppbv	20	155	15.46	0.2
Cal Standard 20 ppbv	Cal Standard 0.5 ppbv	20	386	15.46	0.5
Intermediate Calibration Standard	Cal Standard 5 ppbv	200	386	15.46	5
Intermediate Calibration Standard	Cal Standard 10 ppbv	200	773	15.46	10
Intermediate Calibration Standard	Cal Standard 15 ppbv	200	1160	15.46	15
Intermediate Calibration Standard	Cal Standard 20 ppbv	200	1546	15.46	20
Intermediate Calibration Standard	Cal Standard 40 ppbv	200	3092	15.46	40

Prepare in 6 L Summa Canister Expiration Period 3 months
Each calibration standard contains all the analytes listed in table 1 at the above concentrations.

Intermediate ICV/LCS Standard

Parent Standard	Vendor	Stock Standard Concentration (ppmv)	Volume Added (mL)	Final Volume (L)	Final Concentration (ppbv)
ICV Stock Standard	Spectra Gases Custom Made	1.0	7500	37.5	200

Prepare in 15L Summa Canister Expiration period 3 months
This standard contains all target analytes listed in table 1.

Working ICV/LCS Standard

Parent Standard	Calibration Standard	Stock Standard Concentration (ppbv)	Volume Added (mL)	Final Volume (L)	Final Concentration (ppbv)
Intermediate ICV/LCS Standard	ICV Standard 10 ppbv	200	773	15.46	10

Prepare in 6L Summa Canister Expiration period 3 months
This standard contains all target analytes listed in table 1.

Initial Calibration Levels

Calibration Level	Working Calibration Standard	Volume Analyzed (mL)	Concentration on Column (ppbv)
Calibration Level 1	Cal Standard 0.2 ppbv	40	0.04
Calibration Level 2	Cal Standard 0.2 ppbv	200	0.2
Calibration Level 3	Cal Standard 0.5 ppbv	200	0.5
Calibration Level 4	Cal Standard 5 ppbv	200	5
Calibration Level 5	Cal Standard 10 ppbv	200	10
Calibration Level 6	Cal Standard 15 ppbv	200	15
Calibration Level 7	Cal Standard 20 ppbv	200	20
Calibration Level 8	Cal Standard 40 ppbv	200	40
ICV	Intermediate ICV 10ppb	200	10

Prepare in 6L Summa Canister

Intermediate Ethanol Calibration Standard at 500ppbv/v

1) Fill a 44 ml VOA vial with VOA free water. Remove 197ul of water from the vial.
2) Add 197 ul of >99.5% Ethanol neat material
3) Cap and shake/roll vial for 1 minute
4) Inject 10ul of the prepared water/ethanol mix into a fully evacuated 15 liter summa canister
5) Pump the syringe plunger 5 times to insure complete transfer of material
6) Immediately fill the canister to 22 psig with zero air.

Calibration Level	Working Calibration Standard	Volume added (mL)	Concentration on Column (ppbv)
Calibration Level 1	Cal Standard 0.5 ppbv	124	5
Calibration Level 2	Cal Standard 5.0 ppbv	309	10
Calibration Level 3	Cal Standard 10ppbv	464	15
Calibration Level 4	Cal Standard 15 ppbv	618	20
Calibration Level 5	Cal Standard 20 ppbv	1237	40
Calibration Level 6	Cal Standard 40 ppbv	3092	100

Appendix C: DOD QSM 5.1 LCS Limits

Analytes	CAS #	Lower Limit	Upper Limit	Units
Propene	115-07-1	57	136	%
Dichlorodifluoromethane	75-71-8	59	128	%
Chlorodifluoromethane	75-45-6	59	145	%
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	63	121	%
Chloromethane	74-87-3	59	132	%
Butane	106-97-8	64	129	%
Vinyl chloride	75-01-4	64	127	%
Butadiene	106-99-0	66	134	%
Bromomethane	74-83-9	63	134	%
Chloroethane	75-00-3	63	127	%
Vinyl bromide	593-60-2	71	126	%
Trichlorofluoromethane	75-69-4	62	126	%
Ethanol	64-17-5	59	125	%
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	66	126	%
1,1-Dichloroethene	75-35-4	61	133	%
Acetone	67-64-1	58	128	%
Isopropyl alcohol	67-63-0	52	125	%
Carbon disulfide	75-15-0	57	134	%
3-Chloro-1-propene	107-05-1	71	131	%
Methylene Chloride	75-09-2	62	115	%
2-Methyl-2-propanol	75-65-0	24	150	%
Methyl tert-butyl ether	1634-04-4	66	126	%
trans-1,2-Dichloroethene	156-60-5	67	124	%
Hexane	110-54-3	63	120	%
1,1-Dichloroethane	75-34-3	68	126	%
Vinyl acetate	108-05-4	56	139	%
Ethyl acetate	141-78-6	65	128	%
2-Butanone (MEK)	78-93-3	67	130	%
cis-1,2-Dichloroethene	156-59-2	70	121	%
Chloroform	67-66-3	68	123	%
Tetrahydrofuran	109-99-9	64	123	%
1,1,1-Trichloroethane	71-55-6	68	125	%
Cyclohexane	110-82-7	70	117	%
Carbon tetrachloride	56-23-5	68	132	%
Isooctane	540-84-1	68	121	%
Benzene	71-43-2	69	119	%

1,2-Dichloroethane	107-06-2	65	128	%
n-Heptane	142-82-5	69	123	%
Trichloroethene	79-01-6	71	123	%
Methyl methacrylate	80-62-6	70	128	%
1,2-Dichloropropane	78-87-5	69	123	%
1,4-Dioxane	123-91-1	71	122	%
Dichlorobromomethane	75-27-4	72	128	%
cis-1,3-Dichloropropene	10061-01-5	70	128	%
4-Methyl-2-pentanone (MIBK)	108-10-1	67	130	%
Toluene	108-88-3	66	119	%
trans-1,3-Dichloropropene	10061-02-6	75	133	%
1,1,2-Trichloroethane	79-00-5	73	119	%
Tetrachloroethene	127-18-4	66	124	%
2-Hexanone	591-78-6	62	128	%
Chlorodibromomethane	124-48-1	70	130	%
Ethylene Dibromide	106-93-4	74	122	%
Chlorobenzene	108-90-7	70	119	%
Ethylbenzene	100-41-4	70	124	%
m-Xylene & p-Xylene	179601-23-1	61	134	%
o-Xylene	95-47-6	67	125	%
Styrene	100-42-5	73	127	%
Bromoform	75-25-2	66	139	%
Isopropylbenzene	98-82-8	68	124	%
1,1,2,2-Tetrachloroethane	79-34-5	65	127	%
N-Propylbenzene	103-65-1	69	123	%
2-Chlorotoluene	95-49-8	74	130	%
tert-Butylbenzene	98-06-6	65	124	%
1,2,4-Trimethylbenzene	95-63-6	66	132	%
sec-Butylbenzene	135-98-8	68	125	%
4-Isopropyltoluene	99-87-6	67	130	%
1,3-Dichlorobenzene	541-73-1	65	130	%
1,4-Dichlorobenzene	106-46-7	60	131	%
Benzyl chloride	100-44-7	50	147	%
n-Butylbenzene	104-51-8	66	130	%
1,2-Dichlorobenzene	95-50-1	63	129	%
1,2,4-Trichlorobenzene	120-82-1	55	142	%

Hexachlorobutadiene	87-68-3	56	138	%
Naphthalene	91-20-3	57	138	%
1,2,3-Trichloropropane	96-18-4	76	124	%
Acetonitrile	75-05-8	63	132	%
Acrolein	107-02-8	62	126	%
n-Decane	124-18-5	70	118	%
n-Nonane	111-84-2	63	128	%
n-Octane	111-65-9	69	121	%
Dodecane	112-40-3	62	147	%
Undecane	1120-21-4	69	123	%
Pentane	109-66-0	63	131	%
Acrylonitrile	107-13-1	71	137	%
Alpha Methyl Styrene	98-83-9	67	128	%
n-Butanol	71-36-3	62	133	%

ATTACHMENT B

Chain of Custody Form

TestAmerica Edison
777 New Durham Road

Edison, NJ 08817-2859
phone 732.549.3900 fax 732.549.3679

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☑ Other:

TestAmerica Laboratories, Inc.

Client Contact	**Project Manager: Lindsay O'Hara**	**Site Contact:**	**Date:**	COC No:
TRC Engineers, Inc.	**Tel/Fax: 203-278-5305**	**Lab Contact: Jannel Franklin**	**Carrier:**	_______ of ______ COCs
1430 Broadway, 10th Floor	**Analysis Turnaround Time**			Sampler:
New York, New York 10024	☐ CALENDAR DAYS ☑ WORKING DAYS			**For Lab Use Only:**
212-221-7822	TAT if different from Below 5 days			Walk-in Client:
FAX 212-2217840	☐ 2 weeks			Lab Sampling:
Project Name: BCP Site No. C224266 Remedial Investigation	☐ 1 week			
Site: 168 8th Street, Brooklyn, NY	☐ 2 days			Job / SDG No.:
PO#: TBD	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)																		Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for__________ Months

Special Instructions/QC Requirements & Comments:
NYCSCA Project.
NYSDEC BCP Project

Custody Seals Intact: ☐ Yes ☐ No

Custody Seal No.:

Cooler Temp. (°C): Obs'd:_________ Corr'd:__________ Therm ID No.:____________

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.15, dated 9/27/2017

APPENDIX B

Community Air Monitoring Plan and Odor Monitoring and Mitigation Plan

COMMUNITY AIR MONITORING PLAN

The 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 at the Site. 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 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 do not spread contamination off-site through the air.

Community Air Monitoring Plan

Real-time air monitoring for VOCs and observations of particulate levels at the perimeter of the work areas will be completed during intrusive activities. Continuous monitoring and observations will be required during soil excavation activities. The downwind location will be just inside the fence line at the edge of the property.

VOC Monitoring, Response Levels, and Actions

VOCs will be monitored at the downwind perimeter of each designated work area on a continuous basis. Upwind concentrations will be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work will be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment will be calibrated daily. The equipment will 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 exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities will be temporarily halted and monitoring will continue. 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 persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring will continue. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the work area 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 will be recorded and will be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes will also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations will be monitored continuously at the upwind and downwind locations of the borings at temporary particulate monitoring stations. The particulate monitoring will 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 will be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration will be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques will be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 $\mu g/m^3$ 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 $\mu g/m^3$ above the upwind level, work will be stopped and a re-evaluation of activities will be initiated. Work will be able to be resumed provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration.

3. All readings will be recorded and be available for State (NYSDEC and NYSDOH) personnel to review.

ODOR MONITORING AND MITIGATION PLAN

The purpose of this Odor Monitoring and Mitigation Plan is to detail the monitoring and, if necessary, mitigation of odor potentially generated during the RI. Based on the scope of the RI, generation of significant odor is not anticipated. However, work activities will be performed to minimize the potential for generation of odor.

Odor Monitoring

Odor will be monitored within the work area and CAMP stations. If nuisance odors are identified at the Site boundary, or if odor complaints are received, work will be halted and the source of odors will be identified and corrected. Work will not resume until all nuisance odors have been abated. NYSDEC and NYSDOH will be notified of all odor events and of any other complaints about the project. Odor or dust complaints from any owner or occupant of an adjacent or nearby property will be immediately addressed and managed by the Environmental Monitor in a manner equivalent to an exceedance of an air monitoring action level.

Odor Mitigation

All necessary means will be employed to prevent on- and off-Site nuisances. These measures may include: containerizing drill cuttings immediately and using tarps to cover exposed odorous soil (if encountered). Soil will not be stockpiled as part of the implementation of the RI Work Plan. If odors develop and cannot be otherwise controlled, additional means to eliminate odor nuisances will include: use of chemical odorants in spray or misting systems; and, use of staff to monitor odors in surrounding neighborhoods. Based on the scope of the RI, it is anticipated that any nuisance odors developed during intrusive work can be corrected, without the use of a temporary containment structure equipped with appropriate air venting/filtering systems.

APPENDIX C

Health and Safety Plan

SITE-SPECIFIC HEALTH AND SAFETY PLAN

FOR

REMEDIAL INVESTIGATION

OF

PROPOSED PRE-KINDERGARTEN FACILITY
K710
168 8th Street
Brooklyn, New York 11215
BLOCK 1003, LOT 11

NYSDEC Brownfield Cleanup Program Site No C224266

Prepared by:

TRC Engineers, Inc.
1430 Broadway, 10th Floor
New York, New York 10018

TRC Project Number 287821

April 2018

DISCLAIMER

STRICT ADHERENCE TO THE HEALTH AND SAFETY GUIDELINES SET FORTH HEREIN WILL REDUCE, BUT NOT ELIMINATE, THE POTENTIAL FOR INJURY AT THESE SITES. THE HEALTH AND SAFETY GUIDELINES IN THIS HEALTH AND SAFETY PLAN WERE PREPARED SPECIFICALLY FOR THIS PROJECT AND SHOULD NOT BE USED ON ANY OTHER SITE OR PROJECT WITHOUT PRIOR RESEARCH AND EVALUATION BY TRAINED HEALTH AND SAFETY SPECIALISTS.

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1.0 SITE INFORMATION

1.1 Introduction

The following is the Health and Safety Plan (HASP) for Remedial Investigation (RI) activities in connection with the proposed Pre-Kindergarten Facility K710, located at 168 8th Street, Brooklyn, New York 11215 (the "Site"). The scope of work is described in the RI Work Plan (RI Work Plan)

The site-specific safety plan was developed from preliminary Site visits and performance of a site assessment. Revisions and/or alterations to this HASP may become necessary as more information becomes available. Any proposed changes to this HASP will be approved by the Health & Safety Coordinator prior to implementation. All on-site personnel are required to read, review and strictly comply with the HASP. It is the responsibility of the Project Manager or designee to ensure that the HASP is implemented and enforced.

1.2 Site Description and History

The Site encompasses approximately 13,500 square feet and is currently a concrete- and asphalt-paved vacant lot. Historically, the Site was occupied by an ink manufacturer from approximately 1888 to at least 1906, a storage facility from approximately 1906 to at least 1926, a chemical laboratory in 1926, a garage from approximately 1926 to at least 1951, a plumbing supply/metal products manufacturer from approximately 1945 to 1965, and a textile factory from approximately 1976 to at least 1992. The Site has been vacant since approximately 1992 and was acquired by NYCSCA in May 2017.

TRC conducted environmental due diligence activities at the Site between 2011 and 2013. Based on the results of due diligence activities, elevated concentrations of chlorinated volatile organic compounds (VOCs) are present in soil, soil vapor and groundwater. Several underground storage tanks (USTs) historically containing petroleum products were also identified at the Site.

2.0 SCOPE OF WORK

Work included in the RI Work Plan includes advancement of soil borings, installation, development, and surveying of permanent monitoring wells, installation of temporary soil vapor points, and collection and laboratory analysis of soil, groundwater, and soil vapor samples.

3.0 EMERGENCY AND TRC CONTACT NUMBERS

Ambulance: **911**

Fire Department: **911**

Police Department: **911**

Hospital: **New York Presbyterian Brooklyn Methodist Hospital**
Emergency Center No.: **(718) 780 3000**
Hospital Address: **506 6th Street, Brooklyn, NY**

HOSPITAL DIRECTIONS

NOTE: FOR ANY TYPE OF SERIOUS MEDICAL EMERGENCY, CALL 911 AND REQUEST AN AMBULANCE. NEW YORK CITY STREETS ARE OFTEN CONGESTED DUE TO HEAVY TRAFFIC, CONSTRUCTION AND DOUBLE-PARKED VEHICLES AND IT MAY BE DIFFICULT TO DRIVE TO THE EMERGENCY ROOM.

Refer to **Attachment C** for Hospital Route Directions with maps.

TRC Contacts

1. Project Manager
   Name: Lindsay O’Hara
   Office/Division: New York City
   Office Phone: 203-278-5305
   Cell Phone: 914-420-9649

2. Certified Industrial Hygienist

Name:	Jack Springston, CIH
Office/Division:	New York, NY
Office Phone:	212-221-7822 ext. 108

3. National Safety Director

Name:	Mike Glenn
Office/Division:	Irvine, CA
Office Phone:	949-727-7347
Cell Phone:	949-697-7418

4. Office Safety Coordinator (OSC)

Name:	Wes Lindemuth, CHMM, CSP
Office/Division:	New York City
Office Phone:	212-221-7822 ext. 103
Cell Phone:	347-738-1452

5. Work Care can provide assistance in providing first aid advice and directing an injured worker to non-emergency medical care. WorkCare is a service that provides 24/7 access to an Occupational Healthcare physician or clinician.

   Work Care Incident Intervention: 888-449-7787 (refer to **Attachment D)**

6. Human Resource Manager

Name:	Suzanne Micallef
Office/Division:	Administrative
Office Telephone:	978-656-3628

4.0 HAZARD ASSESSMENT

4.1 Contaminants of Concern

The analytical results of soil samples detected three volatile organic compounds (VOCs) (trichloroethene (TCE), 1,2,4-trimethylbenzene, and naphthalene), and five (5) metals (chromium, copper, mercury, nickel, and zinc) exceeding comparison criteria, which were attributed to evidence of petroleum contamination in the soil interval and/or evidence of fill material at the Site. One VOC, TCE, present in shallow soil samples may be attributable to former Site uses and/or to historic uses of the former drainage system.

Two VOCs (cis-1,2-dichloroethene and TCE) were detected in groundwater samples at concentrations exceeding the corresponding Class GA Values which may attributed to former Site uses. Additionally, elevated concentrations of metals (magnesium, manganese and sodium) were detected in groundwater at the Site, which are attributed to the characteristics of the fill and/or Site soils. Note that it is not anticipated that groundwater will be encountered during IRM or RI activities.

Sample bottles containing hazardous preservatives (e.g., hydrochloric acid, sulfuric acid) will be handled with care. Sample bottles will be checked for leaks and lids tightened. Nitrile chemical resistant gloves and safety glasses will be worn at all times when handling sample bottles.

Isobutylene gas will be used during a short time period at the beginning of each work day to calibrate the photoionization detector (PID). 100 parts per million (ppm) isobutylene will be primarily contained in a Tedlar bag. Any gas that is released to the air will quickly disperse and will not pose a threat to on-Site workers. No monitoring is required for isobutylene.

Similarly, helium gas will be used to confirm an adequate surface seal at each temporary soil vapor sampling point. 99.999% helium will be primarily contained within the annulus of the enclosure of each vapor point. Any gas that is released to the air will quickly disperse and will not pose a threat to on-Site workers. No monitoring is required for helium gas.

Safety Data Sheets (SDS) for compounds of concern are provided in **Attachment B**.

4.2 First Aid Procedures for Chemical Exposures

EYE: If any chemicals come in contact with eyes, immediately wash the eyes with large amounts of water, occasionally lifting lower and upper lids. Get medical attention immediately.

BREATH: If person breathes large amounts of any chemicals, remove person to fresh air. If breathing has stopped, perform artificial respiration. Keep affected person warm and rested. Get medical attention as soon as possible.

SKIN: If any chemicals except those listed below come in contact with the skin, immediately wash skin with soap and water. Get medical attention promptly. If chemical penetrates clothing, immediately remove clothing and wash with soap and water.

Soap should not be used if the following chemicals (sample preservatives) potentially encountered at the site contact skin or clothing, **water wash only**:

Hydrochloric acid

SWALLOW: If any chemicals are swallowed get medical attention immediately.

4.3 Biological Hazards

During the course of the project, there is a potential for workers to come into contact with biological hazards, such as animals and their scat.

During Site operations, wild animals such as birds, rats, stray dogs or cats, raccoons, and other rodents and their scat may be encountered. Workers will use discretion and avoid all contact with wild animals and their scat. Avoid areas and habitats inside and outside work areas that are contaminated with scat. If unsafe conditions are noted (e.g., gross accumulations of scat or vermin infestations), work in these areas will be halted and reevaluated.

4.4 Physical Hazards

The physical hazards are anticipated to be low and are outlined in Table A-1 below.

TABLE A-1
PHYSICAL HAZARDS

HAZARD TYPE	KNOWN	POTENTIAL
Heat Stress/Cold Stress		**X**
Severe Weather (lightning, snow, sleet)		**X**
Excessive Noise	**X**	
Facility Operations (machinery, structures)	**X**	
Unstable ground (wet and/or icy areas)		**X**
Site Operations (Excavation, drilling, hand and power tool use)	**X**	
Heavy lifting/moving	**X**	
Hazardous materials use & storage		**X**
Fire		**X**
Slips, trips, and falls	**X**	

HAZARD TYPE	KNOWN	POTENTIAL
Cuts, punctures	X	

TRC personnel can avoid most of the hazards listed above including hand tools, hazardous materials use, slips, trips and falls, and punctures and cuts by remaining alert and performing safe work practices during all site activities. Other proper work practices are outlined below.

1. To avoid falling objects:
    a. Do not walk or stand under suspended/overhead loads (including scaffolding).
    b. Be aware of falling objects in the work area.
    c. Secure overhead objects.
2. When using hand tools:
    a. Hand tools will meet the manufacturer's safety standards.
    b. Hand tools will not be altered in any way.
    c. Makeshift tools will not be used.
    d. At a minimum, eye protection will be used when working with hand tools.
    e. Wrenches, including adjustable, pipe, end and socket wrenches, will not be used when jaws are sprung to the point that slippage occurs.
    f. Impact tools such as drift pins, wedges and chisels, will be kept free of mushroom heads.
    g. Wooden handles will be free of splinters or cracks and secured tightly to the tool.
3. Slips, Trips and Falls:
    a. Proper lighting will be maintained at all times.
    b. Walkways will remain clear and unobstructed at all times.
    c. When possible, cords, hose lines, etc., will be raised to reduce or eliminate trip hazards.

4.5 Noise

Approved hearing protection will be required in work areas involving heavy equipment, impact tools, drilling, etc. In general, hearing protection should be worn if an individual cannot be heard in a normal speaking voice at a distance of two feet.

4.6 Mechanical Hazards

The mechanical hazards are anticipated to be associated with drilling operations. Mechanical equipment anticipated to be used to advance soil borings includes a hollow-stem auger rig with drive-rods. Drilling operations can present exposure to the following:

- Flying objects (chipped asphalt or concrete, soil) and dust. Measures used to control such exposures will include use of water misting apparatus to keep dust down, or use of a guard installed around the drill to protect against flying objects and dust.

- TRC understands that all subsurface utility lines in the area of drilling were identified by AKRF and its utility mark-out subcontractor and NYC One-Call Center during previous Site investigation work. An update of utility mark-outs by the NYC One-Call Center will be conducted prior to subsurface work.

- Underground utilities present fire, electrocution, burn and explosion hazards. If possible, all lines in the area of drilling will be de-energized, locked-out, and tested before work begins.

- Assembling and disassembling rigs.

- Perimeter protection in the form of barricades is necessary for the protection of employees and subcontractor personnel and the public. Such protection will meet requirements set forth in 29 CFR 1926, as well as in the New York City Building Code, Article 19.

A Job-Safety Analysis for drilling operations is provided in **Attachment E.**

5.0 Air Monitoring Requirements

An organic vapor photoionization detector (PID) will be used to evaluate airborne levels of VOCs during soil sampling. If ionizable total organic vapors are detected at 5 parts per million (ppm) or higher above ambient background levels in the breathing zone, TRC will follow the response actions, which may include establishing exclusion zones and/or upgrading personal protective equipment (PPE).

If the vapor levels continue to be elevated, other air monitoring devices may be utilized to measure airborne concentrations of specific suspected contaminants of concern (see below) and to assess the need to upgrade the respiratory PPE.

Exposure Limits

The OSHA Permissible Exposure Limit (PEL), for benzene, which will be used to determine the appropriate respiratory protection, is 1 part per million (ppm) over an 8-hour time-weighted average or 5 ppm over 15 minutes. This value is based upon the OSHA PEL for benzene, which, of the VOC constituents of petroleum compounds, has the lowest PEL.

The National Institute for Occupational Safety and Health (NIOSH) considers trichloroethene (TCE) to be a potential occupational carcinogen and the recommended exposure limit (REL) is 25 ppm (as a 10-hour TWA).

Respiratory Protection

It is unlikely that respiratory protection will be required during implementation of the work plan. If air monitoring measurements indicate that levels of organic vapors have reached 5 ppm, workers will cease work in the area until levels of organic vapors have decreased. If necessary, modifications to work practices will be implemented to reduce or avoid generating elevated levels of organic vapors.

6.0 General Safety Requirements

The general safety rules listed below apply to all TRC personnel present at the site.

- A tailgate health and safety meeting will be held with all field team members and subcontractors each day prior to the start of work (refer to Section 12.0).
- Adhere to all requirements of this health and safety plan (HASP).
- Wear protective clothing appropriate for the designated level of protection and decontaminate before entering clean areas when applicable.
- Use safety equipment in accordance with OSHA guidance and labeling instructions.
- Maintain safety equipment in good condition and proper working order and make sure that the equipment is calibrated prior to use.
- Immediately report unsafe acts or conditions to the Project Manager and OSC.
- Eating, drinking, and smoking are prohibited on site, except in designated areas.
- Maintaining a position upwind from intrusive activities is encouraged.
- The emergency shutoff switch should be demonstrated to be working prior to initiating drilling.
- An adequately stocked first-aid kit will be maintained at the work site.

Communication

TRC team-sampling members shall be equipped with cellular telephones. If an emergency occurs, and the team members are not in close proximity to each other, communication will occur via telephone.

7.0 Personal Protective Equipment (PPE)

TRC personnel will use Level D PPE as noted/modified below:

Level D Personal Protective Equipment

Item	Rationale/Notes
Hardhat	Appropriately rated hard hats will be worn by personnel for protection against overhead hazards, including electrical.
Hearing protection	Hearing protection will be worn by all personnel exposed to more than 85 dB of sound during the workday.
Safety boots	Safety boots will be worn by all personnel during project work described in this HASP and at all times on site.
Eye protection (safety glasses)	Eye protection will be worn when personnel are exposed to flying debris, chemical vapors or particulates. Chemical splash goggles will be worn for protection against chemical gases, vapors or particulates. Safety glasses will be worn for protection against flying objects.
Safety vest	Utilize in areas in or near vehicular traffic of any kind on or off property.
Gloves	Gloves to be changed between samples to avoid cross-contamination. Nitrile chemically resistant gloves will be worn when handling sample bottles.
Kevlar work gloves	As indicated herein, use Cut and Abrasion Resistance Level 4 or Level 5 gloves when necessary for hand protection during field tasks.

A basic first aid kit will be provided by the contractor and readily available on-Site in the event of an emergency.

A fire extinguisher should be present with the excavator. All personnel working on or around the excavator should know the location of and how to operate the fire extinguisher. TRC will confirm the location of the first aid kid and fire extinguisher during daily tailgate safety meetings.

8.0 DECONTAMINATION PROCEDURES

8.1 Minimization of Contact with Contaminants

During the completion of all Site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep "clean" during Site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination. This may ultimately minimize the degree of decontamination required and the generation of waste materials from Site operations.

8.2 Personnel Decontamination Procedures

The following describes procedures to be employed for personnel decontamination.

PERSONNEL DECONTAMINATION PROCEDURES FOR LEVEL D PROTECTION	
1.	Decontaminate equipment used on-Site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) with moist towel.
2.	Use boot brush to remove soil from treads of shoes.
2.	Remove PPE and wipe down with moist towel.
3.	Remove gloves and deposit in waste container.
4.	If inner clothing has become contaminated, remove it and place it into a poly bag.
5.	Wash hands and face.

8.3 Decontamination Procedures

All liquids used in the decontamination procedure will be collected, stored, and disposed in accordance with federal, state, and local regulations. Personnel performing this task will wear the proper PPE as prescribed in the table in Section 8.

8.4 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination; wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment.

If the person cannot be moved because of the extent of the injury (a back or neck injury) provisions will be made to ensure that emergency response personnel are able to respond to victim without being exposed to potentially hazardous atmospheric conditions. If the potential for inhalation hazards exist, such as with open excavation, this area will be covered with poly to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

8.5 Hand Held Equipment Decontamination

Hand held equipment includes all monitoring instruments, samples, hand tools, and field logbooks. To aid in decontamination, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using wipes or paper towels if contamination is visually evident.

Decontamination procedures for sampling equipment, hand tools, etc. will include a moist towel wipe, as appropriate for the Site conditions.

9.0 JOB SAFETY ANALYSIS

A Job Safety Analysis (JSA) is a safety management tool in which the risks or hazards of a specific job in the workplace are identified, and then measures to eliminate or control those hazards are determined and implemented. More specifically, a JSA is a process of systematically evaluating certain jobs, tasks, processes or procedures and eliminating or reducing the risks or hazards to as low as reasonably practical (ALARP) in order to protect workers from injury or illness. The JSA process is documented and the JSA document is used in the workplace or at the job site to guide workers in safe job performance. The JSA document is also a living document that is adjusted as conditions warrant.

The JSA process begins with identification of the potential hazards or risks associated with a particular job. Once the hazards are understood, the consequences of those hazards are then identified, followed by control measures to eliminate or mitigate the hazards.

Please refer to Attachment E for the Job Safety Analysis for soil borings and groundwater sampling.

10.0 REQUIRED PERSONNEL TRAINING

TRC field personnel will have the training outlined below before on-Site work activities:

Project Training Requirements

(* required for all sites; but minimum recommended)

Check "A" if training required for everyone, and check "T" if training required for specific task or per notations.

A	T	SUBJECT	REFERENCE	
			29 CFR 1910	29 CFR 1926 or Other
☒	☐	HAZWOPER 40 hour	1910.120	1926.65
☐	☐	3-Day HAZWOPER Supervised On-site	1910.120	1926.65
☒	☐	8-Hour HAZWOPER Refresher	1910.120	1926.65
☐	☒	8-Hour Supervisor HAZWOPER*	1910.120	1926.65
☐	☒	First Aid, CPR[1]	1910.151	1926.23,.50
☒	☐	Hazard Communication (HAZCOM)	1910.1200	1926.59
☐	☐	DOT / IATA Shipping Training	1910.1201	49 CFR 172.704
☒	☐	TRC Hand Protection Policy	1910.138	TRC Policy[2]
☒	☐	Defensive Driving	N/A	White Paper[3] TRC Manual[4]

Client-specific training: ☐ Not Applicable ☐ Specify

Client-specific training: ☐ Not Applicable ☐ Specify

Client-specific training: ☐ Not Applicable ☐ Specify

Note:

***** The on-site Health and Safety Officer shall have OSHA 8-hour supervisor training, in addition to 40-hour HAZWOPER.

1 Per the TRC Health and Safety Policy and Procedure Manual, each TRC project will have at least one certified CPR/first aid trained person on- Site at all times. All Project Managers, and anyone acting as the on-site Health and Safety Officer, must be current in First Aid/CPR.

2 TRC RMD Hand Protection Policy, August 2012

3 Guidelines for Employers to Reduce Motor Vehicle Crashes (joint white paper by NETS, NHTSA and OSHA)

4 TRC Driver and Vehicle Management Policy and Procedure Manual, Rev 1 (April 2012)

Project training requirements beyond those provided in the above table will require a HASP revision/upgrade or concurrence of the TRC Safety Director or Practice Safety Manager.

11.0 MEDICAL MONITORING

Medical monitoring will apply routinely to all employees who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year (40 CFR 1910.120[f][2][i]). Said TRC field personnel will have the medical surveillance outlined in the table below prior to commencing on-site work activities.

Medical Surveillance Required			
*Baseline is minimum recommended.			
	29 CFR 1910	**29 CFR 1926 or Other**	**Notes**
☒ HAZWOPER Physical - Baseline	1910.120	1926.65	
☒ HAZWOPER Physical – Annual	1910.120	1926.65	
☐ HAZWOPER Physical - Biennial	1910.120	1926.65	
Client-specific drug testing[1]	☒ Not Applicable ☐ Specify		
Client-specific medical monitoring[1]	☒ Not Applicable ☐ Specify		
Site-specific medical monitoring:	☒ Not Applicable ☐ Specify		

Note:
[1] Client required drug testing or medical monitoring should be coordinated through the Project Manager.

TRC has a Drug and Alcohol-Free Workplace Policy. TRC may require employees or subcontractors to be tested upon reasonable suspicion, following accidents or incidents during work activities, or during travel to or from a project Site. Client policies may be stricter in regard to procedures following an accident. Project Managers must be aware of these and inform employees and subcontractors of any additional requirements.

12.0 TAILGATE SAFETY MEETINGS

A tailgate safety meeting will be conducted daily prior to commencement of the work day (see Daily Pre-Job Safety Briefing Form provided in Attachment F) or if site conditions change.

Topics covered by the tailgate safety meeting will include, but not be limited to:

- Scope of work and who will conduct each task
- Potential hazards for the scope of work
- weather forecast
- PPE
- Emergency procedures and the route to the medical facility
- Site conditions and features
- Communication guidelines related to stakeholder engagement and visitors

Safety meetings will be held to address modifications to this HASP and any addenda prepared to supplement the HASP. Subcontractors and personnel present at the tailgate safety meeting shall be required to sign an acknowledgement form after each meeting.

13.0 INCIDENT REPORTING

In case of an incident, TRC personnel must report the incident immediately to their project manager/supervisor and/or OSC, and client's representative, and follow the TRC Incident Response and Reporting Process (see Attachment G). Required forms must be completed within 24 hours following the incident. If the forms are unavailable, the incident shall be reported to the TRC Safety Director (Mike Glenn). Accident/injury/exposure information must be recorded per TRC policy (see Attachment G) and will be the basis of any accident/incident investigations.

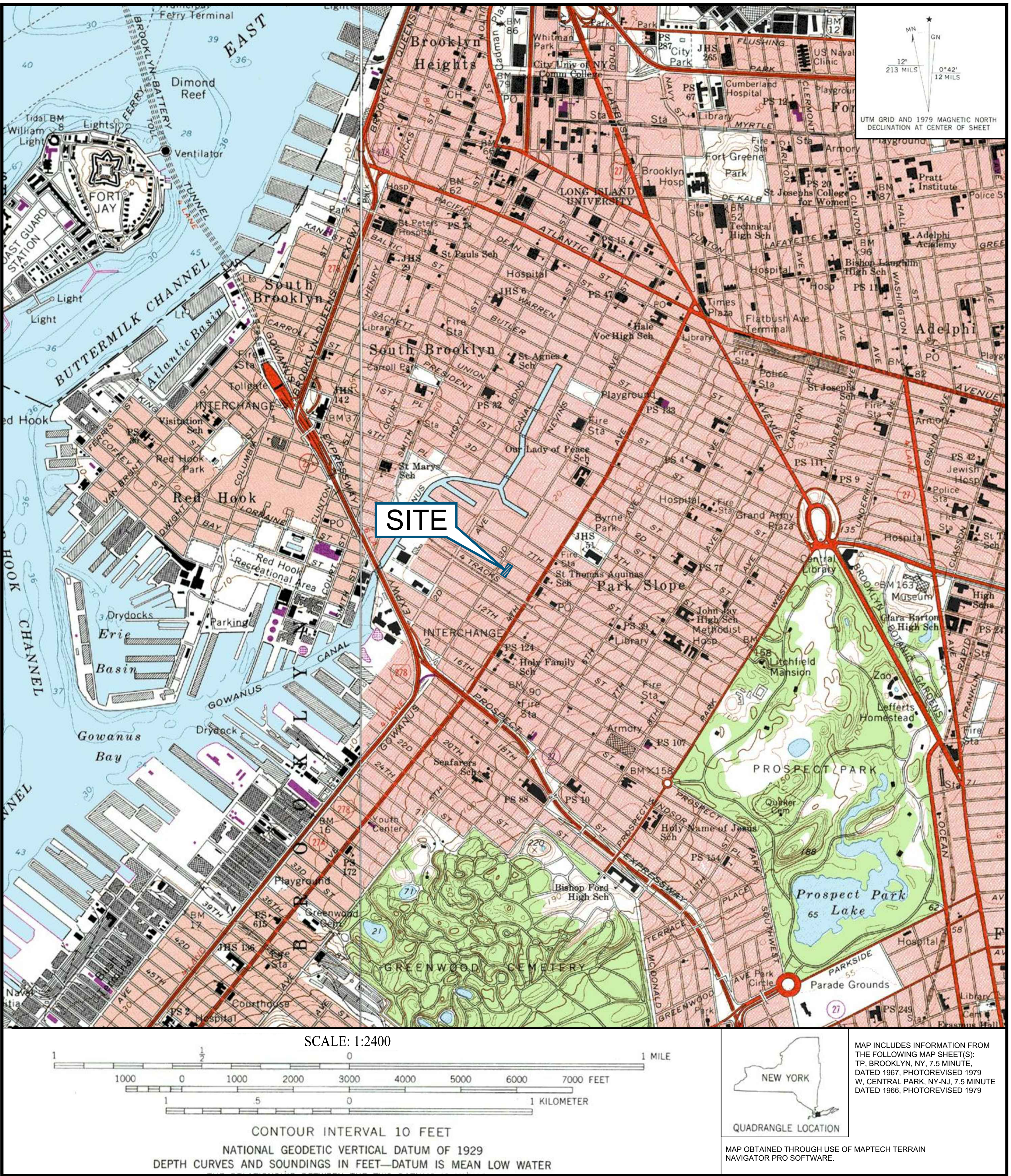
14.0 ACKNOWLEDGEMENT

All TRC personnel operating under this HASP must read the HASP and sign the acknowledgment page in Attachment A.

15.0 SUBCONTRACTORS AND HEALTH AND SAFETY PLANNING

TRC personnel must provide the complete HASP to all subcontractors for their reference in advance of the work. Subcontractors must prepare their own site-specific HASP and provide evidence of HASP preparation before the start of site work to ensure that the subcontractor has an understanding of the safety hazards associated with the work that they are performing. Subcontractor HASPs are not required to be included unless contractually/client required, of is so desired by the Project Manager or OSC.

Figures



MAP INCLUDES INFORMATION FROM THE FOLLOWING MAP SHEET(S):
TP, BROOKLYN, NY, 7.5 MINUTE, DATED 1967, PHOTOREVISED 1979
W, CENTRAL PARK, NY-NJ, 7.5 MINUTE DATED 1966, PHOTOREVISED 1979

MAP OBTAINED THROUGH USE OF MAPTECH TERRAIN NAVIGATOR PRO SOFTWARE.

8.5x11 --- ATTACHED XREFS: --- ATTACHED IMAGES: 197-203 9th street_01; 197-203 9th street_02;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 1 - Site Location Map.dwg --- PLOT DATE: April 02, 2018 - 12:26PM --- LAYOUT: 8.5x11P

TRC
1430 Broadway
10th Floor
New York, NY 10018
Phone: 212.221.7822

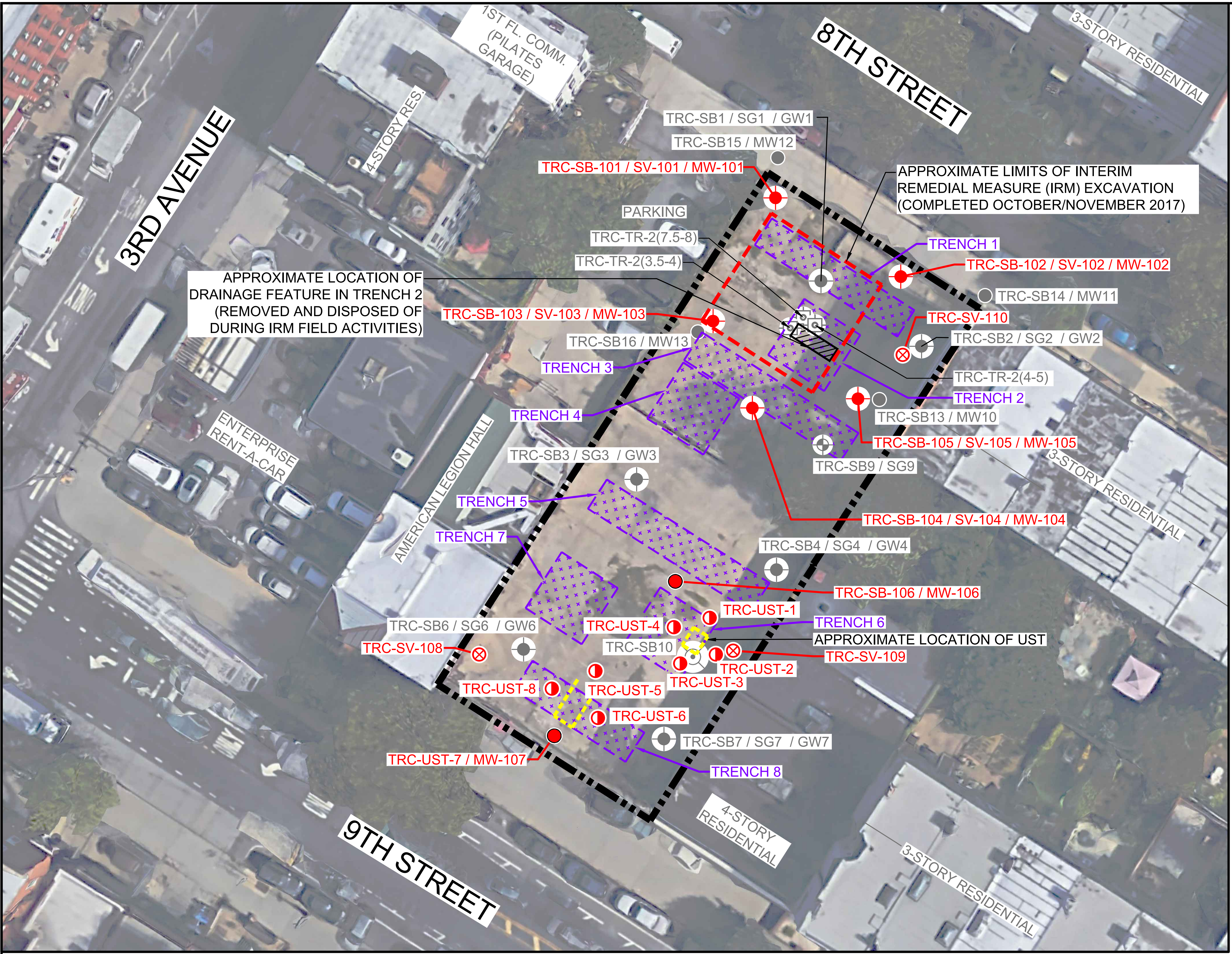
PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

TITLE:

SITE LOCATION MAP

DRAWN BY:	H. DELGADO
CHECKED BY:	L. O'HARA
APPROVED BY:	J. MIRANDA
DATE:	APRIL 2018
PROJ. NO.:	287821.0000.0000
FILE:	Figure 1 - Site Location Map.dwg

FIGURE 1



LEGEND (SYMBOLS NOT TO SCALE):

▬ ▪ ▬ ▪		SITE BOUNDARY
⌖	TRC-TR-2 (X-X)	TRENCH SAMPLE LOCATION AND IDENTIFICATION NUMBER (DEPTH IN FEET)
▨		TRENCH AREA LOCATION AND IDENTIFICATION (JUNE 2017 ARCHEOLOGICAL INVESTIGATION)
⊗	TRC-SBX	SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED IN 2012)
⌖	TRC-SBX / SGX	SOIL SAMPLING AND SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED 2012)
⌖	TRC-SBX / SGX / GWX	SOIL SAMPLING, SOIL VAPOR SAMPLING, AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED IN 2012)
●	TRC-SBX / MWX	SOIL SAMPLING AND GROUNDWATER SAMPLING LOCATION AND IDENTIFICATION NUMBER (TRC INVESTIGATION CONDUCTED IN 2013)
⌖	TRC-SB-X / SV-X / MW-X	PROPOSED SOIL AND SOIL VAPOR SAMPLING AND PERMANENT MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
●	TRC-SB-X / MW-X OR TRC-UST-X / MW-X	PROPOSED SOIL SAMPLING AND PERMANENT MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
⊗	TRC-SV-X	PROPOSED SOIL VAPOR SAMPLING LOCATION AND IDENTIFICATION NUMBER
◐	TRC-UST-X	PROPOSED SOIL SAMPLING LOCATION AND IDENTIFICATION NUMBER

N

0 30' 60'

SCALE: 1" = 30'
SHEET SIZE: 11" BY 17"

PROJECT: **NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY**
REMEDIAL INVESTIGATION WORK PLAN
PROPOSED PRE-KINDERGARTEN FACILITY K710
168 8TH STREET - BLOCK: 1003, LOT: 11
BROOKLYN, NY 11215

TITLE:

PROPOSED SAMPLE LOCATION PLAN

DRAWN BY:	H. DELGADO	PROJ NO.:	287821.0000.0000
CHECKED BY:	L. O'HARA	**FIGURE** 2	
APPROVED BY:	J. MIRANDA		
DATE:	APRIL 2018		

TRC

1430 Broadway
10th Floor
New York, NY 10018
Phone: 212.221.7822

FILE NO.: Figure 6 - Proposed Sample Location Plan.dwg

NOTES:

1. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
2. THE NORTHERN LIMITS OF THE TANKS IN TRENCH 8 WERE NOT IDENTIFIED SINCE TRENCH 8 WAS NOT EXCAVATED TO THE TANK LIMITS.

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES: 168 8TH STREET - GEPRO-600FT color;
DRAWING NAME: \\NTAPA-NYC\Projects\NYCSCA Contract C000014345\287821 - K710 168 8th St. BCP Application\BCP Application\2 RI Work Plan\Figures\TRC Working Drawings\ Figure 6 - Proposed Sample Location Plan.dwg --- PLOT DATE: April 02, 2018 - 12:33PM --- LAYOUT: 11X17L

Attachment A

Health and Safety Plan Acceptance

ATTACHMENT A

HEALTH AND SAFETY PLAN ACCEPTANCE

SITE: 168 8th Street, Brooklyn, NY

I have received a copy of the Health and Safety Plan for this site and have read, understand and will abide by the procedures set forth in this Health and Safety Plan and any amendments to this plan.

Printed Name	**Signature**	**Date**
____________________	___________________________	______________
____________________	___________________________	______________
____________________	___________________________	______________
____________________	___________________________	______________
____________________	___________________________	______________
____________________	___________________________	______________
____________________	___________________________	______________

Attachment B

Safety Data Sheets for Potential Contaminants of Concern

Material Safety Data Sheet
Trichloroethylene

ACC# 23850

Section 1 - Chemical Product and Company Identification

MSDS Name: Trichloroethylene
Catalog Numbers: AC158310000, AC158310025, AC421520000, AC421520040, AC421520200, AC421525000, 15831-0010, S80327ACS-1, S80327ACS-2, T340-4, T341-20, T341-4, T341-500, T341J4, T403-4
Synonyms: Ethylene trichloride; 1,1,2-Trichloroethylene; TCE.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
79-01-6	Trichloroethylene	99+	201-167-4

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: APHA: 15 max liquid.

Warning! Harmful to aquatic organisms; may cause long-term adverse effects in the aquatic environment. Breathing vapors may cause drowsiness and dizziness. Possible risks of irreversible effects. Cancer hazard. Causes eye and skin irritation. May cause respiratory tract irritation. May cause liver and kidney damage. May cause central nervous system effects.
Target Organs: Kidneys, central nervous system, liver, spleen, respiratory system, eyes, skin.

Potential Health Effects

Eye: Causes eye irritation. Contact with trichloroethylene causes pain but no permanent injury to the eyes. (Doc of TLV)
Skin: Causes skin irritation. May be harmful if absorbed through the skin.
Ingestion: May cause irritation of the digestive tract. May be harmful if swallowed. May cause central nervous system effects.
Inhalation: May cause respiratory tract irritation. May cause liver and kidney damage. May be harmful if inhaled. May cause central nervous system effects. The chief symptoms of TCE exposure were found to be abnormal fatigue, irritability, headache, gastric disturbances, and intolerance to alcohol. (Doc to TLV)
Chronic: Prolonged or repeated skin contact may cause defatting and dermatitis. May cause liver and kidney damage. May cause cancer in humans. Repeated exposure may cause damage to the spleen. Adverse reproductive effects have been reported in animals. Laboratory experiments have resulted in mutagenic effects. Possible risk of irreversible effects.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Get medical aid. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes.
Ingestion: Do not induce vomiting. Get medical aid.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.
Extinguishing Media: Use water spray, dry chemical, carbon dioxide, or chemical foam.
Flash Point: Not applicable.
Autoignition Temperature: 410 deg C (770.00 deg F)
Explosion Limits, Lower:7.9 Vol %
Upper: 90 Vol %
NFPA Rating: (estimated) Health: 2; Flammability: 1; Instability: 1

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Wear a self contained breathing apparatus and appropriate personal protection. (See Exposure Controls, Personal Protection section). Remove all sources of ignition. Use a spark-proof tool. Do not let this chemical enter the environment.

Section 7 - Handling and Storage

Handling: Do not get in eyes, on skin, or on clothing. Keep away from heat, sparks and flame. Do not ingest or inhale. Use only in a chemical fume hood.
Storage: Keep away from sources of ignition. Store in a cool, dry place. Store in a tightly closed container. Store protected from light.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use only under a chemical fume hood.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Trichloroethylene	10 ppm TWA; 25 ppm STEL	1000 ppm IDLH	100 ppm TWA; 200 ppm Ceiling

OSHA Vacated PELs: Trichloroethylene: 50 ppm TWA; 270 mg/m3 TWA
Personal Protective Equipment

Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear, colorless - APHA: 15 max
Odor: chloroform-like
pH: Not available.
Vapor Pressure: 77.3 mbar @ 20 deg C
Vapor Density: 4.5 (air=1)
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 87 deg C @ 760 mmHg
Freezing/Melting Point:-86 deg C
Decomposition Temperature: Not available.
Solubility: Insoluble.
Specific Gravity/Density:1.460
Molecular Formula:C_2HCl_3
Molecular Weight:131.39

Section 10 - Stability and Reactivity

Chemical Stability: Moisture sensitive. Light sensitive.
Conditions to Avoid: Incompatible materials, light, ignition sources, excess heat, exposure to moist air or water.
Incompatibilities with Other Materials: Strong oxidizing agents, strong reducing agents, bases, active metals, metals and metal compounds (toxic, e.g. beryllium, lead acetate, nickel carbonyl, tetraethyl lead).
Hazardous Decomposition Products: Hydrogen chloride, carbon monoxide, carbon dioxide.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 79-01-6: KX4550000
LD50/LC50:
CAS# 79-01-6:
  Draize test, rabbit, eye: 20 mg/24H Moderate;
  Draize test, rabbit, skin: 2 mg/24H Severe;
  Inhalation, mouse: LC50 = 8450 ppm/4H;
  Inhalation, mouse: LC50 = 220000 mg/m3/20M;
  Inhalation, mouse: LC50 = 262000 mg/m3/30M;
  Inhalation, mouse: LC50 = 40000 mg/m3/4H;
  Inhalation, rat: LC50 = 140700 mg/m3/1H;
  Oral, mouse: LD50 = 2402 mg/kg;
  Oral, mouse: LD50 = 2400 mg/kg;
  Oral, rat: LD50 = 4920 mg/kg;
  Skin, rabbit: LD50 = >20 gm/kg;

Skin, rabbit: LD50 = 20 mL/kg;

.

Carcinogenicity:
CAS# 79-01-6:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 4/1/88
- **NTP:** Suspect carcinogen
- **IARC:** Group 2A carcinogen

Epidemiology: Tumorigenic effects have been reported in experimental animals.
Teratogenicity: Teratogenic effects have occurred in experimental animals.
Reproductive Effects: Adverse reproductive effects have occurred in experimental animals.
Mutagenicity: Mutagenic effects have occurred in humans.
Neurotoxicity: No information available.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: Fish: Fathead Minnow: 41-67 mg/L; 96 hrs.; LC50Daphnia: Daphnia: 2.2-100 mg/L; 48 hrs.; LC50Mollusk Shrimp: 2 mg/L; 96 hrs.; LC50 Bluegill sunfish, LD50= 44,700 ug/L/96Hr. Fathead minnow, LC50=40.7 mg/L/96Hr.
Environmental: In air, substance is photooxidized and is reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water, it evaporates rapidly. Potential for mobility in soil is high.
Physical: No information available.
Other: Bioconcentration potential is low (BCF less than 100).

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series:
CAS# 79-01-6: waste number U228.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	TRICHLOROETHYLENE	TRICHLOROETHYLENE
Hazard Class:	6.1	6.1
UN Number:	UN1710	UN1710
Packing Group:	III	III

Section 15 - Regulatory Information

US FEDERAL

TSCA

CAS# 79-01-6 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 79-01-6: 100 lb final RQ; 45.4 kg final RQ

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 79-01-6: immediate, delayed, reactive.

Section 313

This material contains Trichloroethylene (CAS# 79-01-6, 99+%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

Clean Air Act:

CAS# 79-01-6 is listed as a hazardous air pollutant (HAP).
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 79-01-6 is listed as a Hazardous Substance under the CWA. CAS# 79-01-6 is listed as a Priority Pollutant under the Clean Water Act. CAS# 79-01-6 is listed as a Toxic Pollutant under the Clean Water Act.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 79-01-6 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

The following statement(s) is(are) made in order to comply with the California Safe Drinking Water Act:

WARNING: This product contains Trichloroethylene, a chemical known to the state of California to cause cancer.

California No Significant Risk Level: CAS# 79-01-6: 50 æg/day NSRL (oral); 80 æg/day NSRL (inhalation)

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

T

Risk Phrases:

R 36/38 Irritating to eyes and skin.
R 45 May cause cancer.
R 52/53 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 67 Vapours may cause drowsiness and dizziness.
R 68 Possible risk of irreversible effects.

Safety Phrases:

S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 53 Avoid exposure - obtain special instructions before use.
S 61 Avoid release to the environment. Refer to special instructions /safety data sheets.

WGK (Water Danger/Protection)

CAS# 79-01-6: 3

Canada - DSL/NDSL

CAS# 79-01-6 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of D1B, D2B.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 79-01-6 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 2/01/1999
Revision #9 Date: 6/03/2008

SAFETY DATA SHEET

Airgas

Nonflammable Gas Mixture: Isobutylene / Nitrogen / Oxygen

Section 1. Identification

GHS product identifier : Nonflammable Gas Mixture: Isobutylene / Nitrogen / Oxygen

Other means of identification : Not available.

Product use : Synthetic/Analytical chemistry.

SDS # : 002103

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : GASES UNDER PRESSURE - Compressed gas

GHS label elements

Hazard pictograms :

Signal word : Warning

Hazard statements : Contains gas under pressure; may explode if heated.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction.

Prevention : Use and store only outdoors or in a well ventilated place.

Response : Not applicable.

Storage : Protect from sunlight. Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Disposal : Not applicable.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Mixture

Other means of identification : Not available.

CAS number/other identifiers

CAS number : Not applicable.

Product code : 002103

Ingredient name	%	CAS number
Nitrogen	75 - 80.5	7727-37-9
oxygen	19.5 - 23.5	7782-44-7
2-methylpropene	0.0001 - 1.13	115-11-7

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Section 4. First aid measures

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician	: In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.
Specific treatments	: No specific treatment.
Protection of first-aiders	: No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	: Use an extinguishing agent suitable for the surrounding fire.
Unsuitable extinguishing media	: None known.

Specific hazards arising from the chemical	: Contains gas under pressure. In a fire or if heated, a pressure increase will occur and the container may burst or explode.
Hazardous thermal decomposition products	: Decomposition products may include the following materials: carbon dioxide carbon monoxide nitrogen oxides

Special protective actions for fire-fighters	: Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.
Special protective equipment for fire-fighters	: Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	: No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
For emergency responders	: If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions	: Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill	: Immediately contact emergency personnel. Stop leak if without risk.
Large spill	: Immediately contact emergency personnel. Stop leak if without risk. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures	: Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.
Advice on general occupational hygiene	: Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
Conditions for safe storage, including any incompatibilities	: Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

None.

Appropriate engineering controls	: Good general ventilation should be sufficient to control worker exposure to airborne contaminants.
Environmental exposure controls	: Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures	: Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.
Eye/face protection	: Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection	: Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Section 8. Exposure controls/personal protection

Body protection	: Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Other skin protection	: Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Respiratory protection	: Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state	: Gas.
Color	: Not available.
Melting/freezing point	: -140.7°C (-221.3°F) This is based on data for the following ingredient: 2-methylpropene. Weighted average: -211.14°C (-348.1°F)
Critical temperature	: Lowest known value: -146.95°C (-232.5°F) (nitrogen).
Odor	: Not available.
Odor threshold	: Not available.
pH	: Not available.
Flash point	: Not available.
Burning time	: Not applicable.
Burning rate	: Not applicable.
Evaporation rate	: Not available.
Flammability (solid, gas)	: Not available.
Lower and upper explosive (flammable) limits	: Not available.
Vapor pressure	: Not available.
Vapor density	: Highest known value: 1.94 (Air = 1) (2-methylpropene). Weighted average: 1.01 (Air = 1)
Gas Density (lb/ft^3)	: Weighted average: 0.07
Relative density	: Not applicable.
Solubility	: Not available.
Solubility in water	: Not available.
Partition coefficient: n-octanol/water	: Not available.
Auto-ignition temperature	: Not available.
Decomposition temperature	: Not available.
SADT	: Not available.
Viscosity	: Not applicable.

Section 10. Stability and reactivity

Reactivity	: No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	: The product is stable.
Possibility of hazardous reactions	: Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	: No specific data.
Incompatibility with various substances	: Extremely reactive or incompatible with the following materials: reducing materials and combustible materials.
Hazardous decomposition products	: Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization	: Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure	: Not available.

Section 11. Toxicological information

Potential acute health effects

Eye contact	: Contact with rapidly expanding gas may cause burns or frostbite.
Inhalation	: Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure.
Skin contact	: Contact with rapidly expanding gas may cause burns or frostbite.
Ingestion	: As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	: No specific data.
Inhalation	: No specific data.
Skin contact	: No specific data.
Ingestion	: No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects	: Not available.
Potential delayed effects	: Not available.

Long term exposure

Potential immediate effects	: Not available.
Potential delayed effects	: Not available.

Potential chronic health effects

Not available.

General	: No known significant effects or critical hazards.
Carcinogenicity	: No known significant effects or critical hazards.
Mutagenicity	: No known significant effects or critical hazards.
Teratogenicity	: No known significant effects or critical hazards.
Developmental effects	: No known significant effects or critical hazards.
Fertility effects	: No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Section 12. Ecological information

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	**TDG**	**Mexico**	**IMDG**	**IATA**
UN number	UN1956	UN1956	UN1956	UN1956	UN1956
UN proper shipping name	COMPRESSED GAS, N.O.S. (nitrogen, oxygen)	COMPRESSED GAS, N.O.S. (nitrogen, oxygen)	COMPRESSED GAS, N.O.S. (nitrogen, oxygen)	COMPRESSED GAS, N.O.S. (nitrogen, oxygen)	COMPRESSED GAS, N.O.S. (nitrogen, oxygen)
Transport hazard class(es)	2.2 	2.2 	2.2 	2.2 	2.2 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	-	**Explosive Limit and Limited Quantity Index** 0.125 **Passenger Carrying Road or Rail Index** 75	-	-	-

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): All components are listed or exempted.

Clean Air Act (CAA) 112 regulated flammable substances: 2-methylpropene

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Sudden release of pressure

Composition/information on ingredients

No products were found.

State regulations

Massachusetts : The following components are listed: NITROGEN; OXYGEN (LIQUID); 2-METHYLPROPENE

New York : None of the components are listed.

New Jersey : The following components are listed: NITROGEN; OXYGEN; ISOBUTYLENE; 1-PROPENE, 2-METHYL-

Pennsylvania : The following components are listed: NITROGEN; OXYGEN; 1-PROPENE, 2-METHYL-

Canada inventory : All components are listed or exempted.

International regulations

International lists : **Australia inventory (AICS)**: All components are listed or exempted.
China inventory (IECSC): All components are listed or exempted.
Japan inventory: Not determined.
Korea inventory: All components are listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): All components are listed or exempted.
Philippines inventory (PICCS): All components are listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Section 15. Regulatory information

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

WHMIS (Canada) : Class A: Compressed gas.

CEPA Toxic substances: None of the components are listed.
Canadian ARET: None of the components are listed.
Canadian NPRI: The following components are listed: Butene (all isomers)
Alberta Designated Substances: None of the components are listed.
Ontario Designated Substances: None of the components are listed.
Quebec Designated Substances: None of the components are listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.

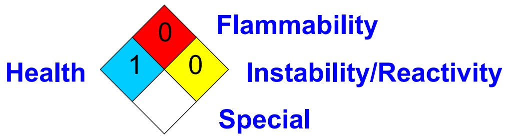
Hazardous Material Information System (U.S.A.)

Health	1
Flammability	0
Physical hazards	0

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)



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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 1/23/2015.

Date of issue/Date of revision : 1/23/2015.

Date of previous issue : No previous validation.

Version : 0.01

Section 16. Other information

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

◤ **Indicates information that has changed from previously issued version.**

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

ASHTA

SAFETY DATA SHEET

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Hydrochloric Acid, 31 – 36.7%

Product Name: Hydrochloric Acid, 31 – 36.7%

Identified Uses: acid etching, steel pickling, oil and gas, ore and mineral, food processing, pharmaceutical, organic chemical synthesis

Company Information:
ASHTA Chemicals Inc.
P.O. Box 858
Ashtabula Ohio 44005
Phone: (440) 997-5221
Fax: (440) 998-0286
24-hour Emergency Phone: CHEMTREC: (800) 424-9300

SECTION 2: HAZARDS IDENTIFICATION

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

GHS label elements, including precautionary statements:

Signal Word: **Danger**

Pictogram(s):

Hazard Statements	
H290	May be corrosive to metals.
H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.
H335	May cause respiratory irritation.
Precautionary Statements	
P234	Keep only in original container.
P261	Avoid breathing dust/ fume/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water. Shower.

P304 + P340 + P310	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/ physician.
P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/ physician.
P363	Wash contaminated clothing before reuse.
P390	Absorb spillage to prevent material damage.
P403 + P233	Store in a well-ventilated place. Keep container with a resistant inner liner.
P405	Store locked up.
P406	Store in corrosive resistant stainless steel container with a resistant inner liner.
P501	Dispose of contents/ container to an approved waste disposal plant.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms:

CHEMICAL NAME:	Hydrochloric acid
TRADE NAME:	Hydrochloric acid, 31 – 36.7%
SYNONYMS:	Muriatic acid, Chlorohydric acid, Hydrogen Chloride
C.A.S:	7647-01-0
EC:	231-595-7
WHMIS:	D2A, E
CHEMICAL FORMULA:	HCl (in aqueous solution)
CHEMICAL FAMILY:	Inorganic Acid

SECTION 4 FIRST AID MEASURES

Description of first aid measures:
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. If breathing is difficult, give humidified air. Give oxygen, but only by a certified physician. Consult a physician.

In case of skin contact
Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Remove contact lenses if present and easy to do. Continue rinsing eyes during transport to medical facility.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth thoroughly with water. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Consult a physician.

SECTION 5 FIRE FIGHTING MEASURES

Flash Point (Method):	Non-combustible.
Extinguishing Media:	Use extinguishing agents compatible with acid and appropriate for the burning material. Use water spray to keep fire-exposed containers cool.
Auto Ignition Temp:	Non-combustible.
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and full protective clothing. In case of fire and/or explosion do not breathe fumes. Use standard firefighting procedures and consider the hazards of other involved materials.
Unusual Fire/Explosion Hazards:	Releases flammable hydrogen gas when reacting with metals.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Environmental Precautions:
Use closed systems when possible. Provide local exhaust ventilation where vapor or mist may be generated. Avoid discharge into drains, water courses or onto the ground.

Containment and Cleaning:
Follow preplanned emergency procedures. Only properly equipped, trained, functional personnel should attempt to contain a leak. All other personnel should be evacuated from the danger area. Using full protective equipment, apply appropriate emergency device or other securement technology to stop the leak if possible.

Small Spill:	Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: neutralize the residue with a dilute solution of sodium carbonate.
Large Spill:	Corrosive liquid. Stop leak if without risk. Do not touch spilled material. Use water spray curtain to knock down vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that vapor is not present at a concentration level above TLV.

SECTION 7: HANDLING AND STORAGE

Precautions to be taken for handling and storage:
Wear appropriate personal protective equipment. Do not get in eyes, on skin, on clothing. Do not breathe mist or vapor. Observe good industrial hygiene practices. Do not empty into drains. Use caution when combining with water; DO NOT add water to acid, ALWAYS add acid to water while stirring to prevent release of heat, steam and fumes. Store in a well-ventilated place. Store away from incompatible materials. Store closed containers in a clean, cool, open or well ventilated area. Keep out of sun.

SECTION 8: EXPOSURE CONTROL/PERSONAL PROTECTION

Principal Component: Hydrochloric Acid
Occupational Exposure Limits:
Regulatory Limits:

Component	OSHA Final PEL TWA	OSHA Final PEL STEL	OSHA Final PEL Ceiling
Hydrochloric Acid Mixture	---	---	5 ppm 7.59 mg/m^3

ACGIH TLV = 5 ppm (7.59 mg/m^3) TWA

NIOSH IDLH = 50 ppm (as HCl, 2010)

Exposure Controls:

Eye Protection:	Tightly fitting safety goggles. Face shield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
Respiratory Protection:	Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).
Other Protection:	Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Ventilation Recommended:	Exhaust ventilation is required to meet PEL limits.
Glove Type Recommended:	Wear neoprene, nitrile, butyl rubber or PVC gloves to prevent exposure.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties:

Appearance	Colorless to light yellow liquid
Odor	Pungent (irritating/strong)
Odor Threshold	0.3ppm (can cause olfactory fatigue)
pH	<1 (in aqueous solution)
Melting point/freezing point	-30°C (-22°F)
Initial boiling point	>100°C (>212°F)
Flash point	Not applicable
Auto-ignition Temp	Not applicable
Evaporation rate	No data available

Decomposition temperature	No data available
Flammability (solid, gas)	Not combustible
Upper/lower flammability or explosive limits	Not combustible
Water solubility	100%
Molecular Weight	36.46
Relative Density (Specific Gravity)	1.16 (32% HCl solution) 1.19 (36.5% HCl solution)
Bulk Density	8.75 lbs/gal (32% HCl solution) 9.83 lbs/gal (36.5% HCl solution)
Vapor Density (air = 1)	1.267 at 20 °C
Vapor Pressure	84 mm Hg @ 20°C
Partition Coefficient: n-octanol/water	No data available

SECTION 10: STABILITY AND REACTIVITY

Stability:	Hydrochloric acid is stable under normal conditions and pressures.
Conditions to avoid:	Incompatible materials, metals, excess heat, bases.
Incompatibility:	Bases, amines, metals, permanganates, (e.g. potassium permanganate), fluorine, metal acetylides, hexalithium disilicide.
Hazardous decomposition products:	Hydrogen chloride, chlorine, hydrogen gas.
Polymerization:	Hazardous polymerization WILL NOT occur.

SECTION 11: TOXICOGICAL INFORMATION

Information on likely routes of exposure:

Inhalation:	Vapors and mist will irritate throat and respiratory system and cause coughing.
Skin contact:	Causes skin burns.
Eye contact:	Causes eye burns.
Ingestion:	Harmful if swallowed. Causes digestive tract burns. Ingestion may produce burns to the lips, oral cavity, upper airway, esophagus and possibly the digestive tract.

Symptoms related to the physical, chemical and toxicological characteristics:
Contact with this material will cause burns to the skin, eyes and mucous membranes. Permanent eye damage including blindness could result.

Information on toxicological effects:

Acute toxicity:	Harmful if swallowed.
Skin corrosion/irritation:	Causes severe skin burns and eye damage.
Serious eye damage/eye Irritation:	Causes serious eye damage.
Respiratory sensitization:	Not available.

Skin sensitization:	No data available.
Germ cell mutagenicity:	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity:	This product is not considered to be a carcinogen by IARC, ACGIH, NTP or OSHA.
Reproductive toxicity:	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure:	May cause respiratory irritation.
Specific target organ toxicity - repeated exposure:	No data available.
Aspiration hazard:	Not available.
Chronic effects:	Prolonged inhalation may be harmful.

Components Species Test Results:
Hydrochloric acid (CAS# 7647-01-0)

Rat - Inhalation LC_{50}:	3124 ppm, (1 hour)
Rabbit - Dermal LD_{50}:	5010 mg/kg

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity:	Because of the low pH of this product, it would be expected produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems.
Aquatic Toxicity:	This material is toxic to fish and aquatic organisms. Most aquatic species do not tolerate pH lower than 5.5 for any extended period.
Fish Toxicity:	Fish LC_{50} Mosquito fish: 282 mg/l, 96 hours Fish LC_{50} Bluegill: 3.6 mg/l, 48 hours
Persistence and degradability:	Not biodegradable. Hydrochloric acid will likely be neutralized to chloride by alkalinity present in natural environment..
Bioaccumulative Potential:	No data available.
Mobility in soil:	Hydrochloric acid will be neutralized by naturally occurring alkalinity. The acid will permeate soil, dissolving some soil material and will then neutralize.
Other adverse effects:	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation

SECTION 13: DISPOSAL CONSIDERATIONS

Collect and reclaim or dispose in sealed containers at a properly licensed waste disposal site. This material , if not neutralized, must be disposed of as hazardous waste. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national or international regulations.

SECTION 14: TRANSPORT INFORMATION

Shipping:

Usual Shipping Containers:	Tank cars, bulk tankers.
Usual Shelf Life:	Indefinite (life of containers).
Storage/Transport Temperatures:	Ambient.

Suitable Storage:

Materials/Coatings:	Teflon, Tygon, Rubber, PVC and polypropylene materials.

D.O.T. Information:

Labeling:	Corrosive
D.O.T. Identification Number	UN 1789
D.O.T. Shipping Name:	Hydrochloric Acid
Hazard Class:	8
Packing Group:	II
Hazard Guide:	157
Placard:	UN 1789

SECTION 15 REGULATORY INFORMATION

SARA 302 Components

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

The following components are subject to reporting levels established by SARA Title III, Section 313:

Hydrochloric Acid	CAS#: 7647-01-0

SARA 311/312 Hazards

Acute health hazard, reactive hazard.

Massachusetts Right To Know Components

Hydrochloric Acid	CAS#: 7647-01-0

Pennsylvania Right To Know Components

Hydrochloric Acid	CAS#: 7647-01-0

New Jersey Right To Know Components

Hydrochloric Acid	CAS#: 7647-01-0

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects or any other reproductive harm.

OSHA PSM TPQ:

CAS# 7647-01-0 is regulated under OSHA PSM ***only*** if anhydrous or >37% HCl.

Toxic Substances Control Act (TSCA):

Hydrochloric Acid	CAS#: 7647-01-0

Comprehensive Environmental Response Compensation Liability Act: (CERCLA)

Hydrochloric Acid	CAS#: 7647-01-0

SECTION 16 OTHER INFORMATION

NFPA Rating:
Health hazard: 3
Fire Hazard: 0
Reactivity Hazard: 1

This information is drawn from recognized sources believed to be reliable. ASHTA Chemicals, Inc. Makes no guarantees or assumes any liability in connection with this information. The user should be aware of changing technology, research, regulations, and analytical procedures that may require changes herein. The above data is supplied upon the condition that persons will evaluate this information and then determine its suitability for their use. Only U.S.A regulations apply to the above.

Version 1.0	For the new GHS SDS Standard	Revision Date: 12/31/2014
Version 1.1	Graphics updated	Revision Date: 3/9/2015
Version 1.2	Title updated	Revision Date: 6/2/2015
Version 1.3	Section 9 changes	Revision Date: 7/30/2015

PRAXAIR®
Making our planet more productive™

Helium, compressed

Safety Data Sheet P-4602

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.

Date of issue: 01/01/1979 Revision date: 10/17/2016 Supersedes: 06/23/2015

SECTION: 1. Product and company identification

1.1. Product identifier

Product form : Substance
Name : Helium, compressed
CAS No : 7440-59-7
Formula : He
Other means of identification : Helium-4, refrigerant gas R-704, LaserStar Helium, Medipure Helium, UltraLift Helium, Helium - Diving Grade

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Industrial use
Medical applications
Diving Gas (Underwater Breathing)

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number : Onsite Emergency: 1-800-645-4633

CHEMTREC, 24hr/day 7days/week
— Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887
(collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-US classification

Compressed gas H280

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS04

Signal word (GHS-US) : WARNING

Hazard statements (GHS-US) : H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
OSHA-H01 - MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION

Precautionary statements (GHS-US) : P202 - Do not handle until all safety precautions have been read and understood
P271 - Use and store only outdoors or in a well-ventilated area
P403 - Use and store only outdoors or in a well-ventilated place
CGA-PG05 - Use a back flow preventive device in the piping
CGA-PG10 - Use only with equipment rated for cylinder pressure
CGA-PG06 - Close valve after each use and when empty
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F)

2.3. Other hazards

Other hazards not contributing to the : Asphyxiant in high concentrations.

classification

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/Information on ingredients

3.1. Substance

Name : Helium, compressed

CAS No : 7440-59-7

Name	Product identifier	%
Helium	(CAS No) 7440-59-7	99.5 - 100

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove to fresh air and keep at rest in a position comfortable for breathing. If not breathing, give artificial respiration. If breathing is difficult, trained personnel should give oxygen. Call a physician.

First-aid measures after skin contact : Adverse effects not expected from this product.

First-aid measures after eye contact : Adverse effects not expected from this product. In case of eye irritation: Rinse immediately with plenty of water. Consult an ophthalmologist if irritation persists.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

No additional information available

4.3. Indication of any immediate medical attention and special treatment needed

None.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Use extinguishing media appropriate for surrounding fire.

5.2. Special hazards arising from the substance or mixture

No additional information available

5.3. Advice for firefighters

Firefighting instructions : Evacuate all personnel from the danger area. Use self-contained breathing apparatus (SCBA) and protective clothing. Immediately cool containers with water from maximum distance. Stop flow of gas if safe to do so, while continuing cooling water spray. Remove ignition sources if safe to do so. Remove containers from area of fire if safe to do so. On-site fire brigades must comply with OSHA 29 CFR 1910.156 and applicable standards under 29 CFR 1910 Subpart L—Fire Protection.

Protection during firefighting : Compressed gas: asphyxiant. Suffocation hazard by lack of oxygen.

Special protective equipment for fire fighters : Use self-contained breathing apparatus. Standard protective clothing and equipment (Self Contained Breathing Apparatus) for fire fighters.

Specific methods : Use fire control measures appropriate for the surrounding fire. Exposure to fire and heat radiation may cause gas containers to rupture. Cool endangered containers with water spray jet from a protected position. Prevent water used in emergency cases from entering sewers and drainage systems

Stop flow of product if safe to do so

Use water spray or fog to knock down fire fumes if possible.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Evacuate area. Ensure adequate air ventilation. Wear self-contained breathing apparatus when entering area unless atmosphere is proven to be safe. Stop leak if safe to do so.

6.1.1. For non-emergency personnel

No additional information available

6.1.2. For emergency responders

No additional information available

6.2. Environmental precautions

Try to stop release.

6.3. Methods and material for containment and cleaning up

No additional information available

6.4. Reference to other sections

See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Wear leather safety gloves and safety shoes when handling cylinders. Protect cylinders from physical damage; do not drag, roll, slide or drop. While moving cylinder, always keep in place removable valve cover. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Never insert an object (e.g, wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Slowly open the valve. If the valve is hard to open, discontinue use and contact your supplier. Close the container valve after each use; keep closed even when empty. Never apply flame or localized heat directly to any part of the container. High temperatures may damage the container and could cause the pressure relief device to fail prematurely, venting the container contents. For other precautions in using this product, see section 16.

Safe use of the product : **The suitability of this product as a component in underwater breathing gas mixtures** is to be determined by or under the supervision of personnel experienced in the use of underwater breathing gas mixtures and familiar with the physiological effects, methods employed, frequency and duration of use, hazards, side effects, and precautions to be taken.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Store in a cool, well-ventilated place. Store and use with adequate ventilation. Store only where temperature will not exceed 125°F (52°C). Firmly secure containers upright to keep them from falling or being knocked over. Install valve protection cap, if provided, firmly in place by hand. Store full and empty containers separately. Use a first-in, first-out inventory system to prevent storing full containers for long periods

OTHER PRECAUTIONS FOR HANDLING, STORAGE, AND USE: When handling product under pressure, use piping and equipment adequately designed to withstand the pressures to be encountered. Never work on a pressurized system. Use a back flow preventive device in the piping. Gases can cause rapid suffocation because of oxygen deficiency; store and use with adequate ventilation. If a leak occurs, close the container valve and blow down the system in a safe and environmentally correct manner in compliance with all international, federal/national, state/provincial, and local laws; then repair the leak. Never place a container where it may become part of an electrical circuit.

7.3. Specific end use(s)

None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Helium, compressed (7440-59-7)	
ACGIH	Not established
USA OSHA	Not established

Helium (7440-59-7)	
ACGIH	Not established
USA OSHA	Not established

8.2. Exposure controls

Appropriate engineering controls	Use a local exhaust system with sufficient flow velocity to maintain an adequate supply of air in the worker's breathing zone. Mechanical (general): General exhaust ventilation may be acceptable if it can maintain an adequate supply of air.
Eye protection	Wear safety glasses with side shields.
Skin and body protection	Wear metatarsal shoes and work gloves for cylinder handling, and protective clothing where needed. Wear appropriate chemical gloves during cylinder changeout or wherever contact with product is possible. Select per OSHA 29 CFR 1910.132, 1910.136, and 1910.138.
Respiratory protection	When workplace conditions warrant respirator use, follow a respiratory protection program that meets OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable). Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure. For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus (SCBA).

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	Gas
Appearance	Colorless gas.
Molecular mass	4 g/mol
Color	Colorless.
Odor	Odorless.
Odor threshold	No data available
pH	Not applicable.
Relative evaporation rate (butyl acetate=1)	No data available
Relative evaporation rate (ether=1)	Not applicable.
Melting point	-272 °C
Freezing point	No data available
Boiling point	-268.93 °C
Flash point	No data available
Critical temperature	-268 °C
Auto-ignition temperature	Not applicable.
Decomposition temperature	No data available
Flammability (solid, gas)	No data available
Vapor pressure	Not applicable.
Critical pressure	230 kPa
Relative vapor density at 20 °C	No data available
Relative density	No data available
Density	0.166 kg/m^3
Relative gas density	0.14
Solubility	Water: 1.5 mg/l
Log Pow	Not applicable.
Log Kow	Not applicable.
Viscosity, kinematic	Not applicable.
Viscosity, dynamic	Not applicable.
Explosive properties	Not applicable.
Oxidizing properties	None.
Explosion limits	No data available

9.2. Other information

Gas group	Compressed gas
Additional information	None

SECTION 10: Stability and reactivity

10.1. Reactivity

No additional information available

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

None.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

None.

10.6. Hazardous decomposition products

None.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity	:	Not classified
Skin corrosion/irritation	:	Not classified pH: Not applicable.
Serious eye damage/irritation	:	Not classified pH: Not applicable.
Respiratory or skin sensitization	:	Not classified
Germ cell mutagenicity	:	Not classified
Carcinogenicity	:	Not classified
Reproductive toxicity	:	Not classified
Specific target organ toxicity (single exposure)	:	Not classified
Specific target organ toxicity (repeated exposure)	:	Not classified
Aspiration hazard	:	Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : No ecological damage caused by this product.

12.2. Persistence and degradability

Helium, compressed (7440-59-7)	
Persistence and degradability	No ecological damage caused by this product.

Helium (7440-59-7)	
Persistence and degradability	No ecological damage caused by this product.

12.3. Bioaccumulative potential

Helium, compressed (7440-59-7)	
Log Pow	Not applicable.
Log Kow	Not applicable.
Bioaccumulative potential	No ecological damage caused by this product.

Helium (7440-59-7)	
Log Pow	Not applicable for inorganic gases.
Log Kow	Not applicable.

Helium (7440-59-7)	
Bioaccumulative potential	No ecological damage caused by this product.

12.4. Mobility in soil

Helium, compressed (7440-59-7)	
Mobility in soil	No data available.
Ecology - soil	No ecological damage caused by this product.

Helium (7440-59-7)	
Mobility in soil	No data available.
Ecology - soil	No ecological damage caused by this product.

12.5. Other adverse effects

Effect on ozone layer : None

Effect on the global warming : None

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Dispose of contents/container in accordance with local/regional/national/international regulations. Contact supplier for any special requirements.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1046 Helium, compressed, 2.2

UN-No.(DOT) : UN1046

Proper Shipping Name (DOT) : Helium, compressed

Class (DOT) : 2.2 - Class 2.2 - Non-flammable compressed gas 49 CFR 173.115

Hazard labels (DOT) : 2.2 - Non-flammable gas

Additional information

Emergency Response Guide (ERG) Number : 120 (UN1963);121 (UN1046)

Other information : No supplementary information available.

Special transport precautions : Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

Transport by sea

UN-No. (IMDG) : 1046

Proper Shipping Name (IMDG) : HELIUM, COMPRESSED

Class (IMDG) : 2 - Gases

MFAG-No : 121

Air transport

UN-No. (IATA) : 1046

Proper Shipping Name (IATA) : Helium, compressed

Class (IATA) : 2

Civil Aeronautics Law : Gases under pressure/Gases nonflammable nontoxic under pressure

SECTION 15: Regulatory information

15.1. US Federal regulations

Helium, compressed (7440-59-7)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory	
SARA Section 311/312 Hazard Classes	Sudden release of pressure hazard

All components of this product are listed on the Toxic Substances Control Act (TSCA) inventory.

This product or mixture does not contain a toxic chemical or chemicals in excess of the applicable de minimis concentration as specified in 40 CFR §372.38(a) subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

15.2. International regulations

CANADA

Helium, compressed (7440-59-7)
Listed on the Canadian DSL (Domestic Substances List)

Helium (7440-59-7)
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

Helium, compressed (7440-59-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

15.2.2. National regulations

Helium, compressed (7440-59-7)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Listed on INSQ (Mexican National Inventory of Chemical Substances)

15.3. US State regulations

Helium, compressed(7440-59-7)	
U.S. - California - Proposition 65 - Carcinogens List	No
U.S. - California - Proposition 65 - Developmental Toxicity	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Female	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No
State or local regulations	U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

Helium (7440-59-7)				
U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	Non-significant risk level (NSRL)

Helium (7440-59-7)				
No	No	No	No	

Helium (7440-59-7)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Other information : When you mix two or more chemicals, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Before using any plastics, confirm their compatibility with this product

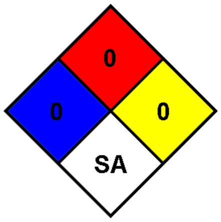
Praxair asks users of this product to study this SDS and become aware of the product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this SDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information

The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Safety Data Sheet. Since the use of this information and the conditions of use are not within the control of Praxair, Inc, it is the user's obligation to determine the conditions of safe use of the product

Praxair SDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current SDSs for these products, contact your Praxair sales representative, local distributor, or supplier, or download from www.praxair.com. If you have questions regarding Praxair SDSs, would like the document number and date of the latest SDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (Phone: 1-800-PRAXAIR/1-800-772-9247; Address: Praxair Call Center, Praxair, Inc, P.O. Box 44, Tonawanda, NY 14151-0044)

PRAXAIR and the Flowing Airstream design are trademarks or registered trademarks of Praxair Technology, Inc. in the United States and/or other countries.

NFPA health hazard : 0 - Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.
NFPA fire hazard : 0 - Materials that will not burn.
NFPA reactivity : 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.
NFPA specific hazard : SA - This denotes gases which are simple asphyxiants.



HMIS III Rating

Health : 0 Minimal Hazard - No significant risk to health
Flammability : 0 Minimal Hazard
Physical : 3 Serious Hazard

MATERIAL SAFETY DATA SHEET

ALCONOX®

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS, Australian WorkSafe, Japanese Industrial Standard JIS Z 7250:2000, and European Union REACH Regulations

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	**ALCONOX®**	
CHEMICAL FAMILY NAME:	Detergent.	
PRODUCT USE:	Critical-cleaning detergent for laboratory, healthcare and industrial applications	
U.N. NUMBER:	Not Applicable	
U.N. DANGEROUS GOODS CLASS:	Non-Regulated Material	
SUPPLIER/MANUFACTURER'S NAME:	Alconox, Inc.	
ADDRESS:	30 Glenn St., Suite 309, White Plains, NY 10603. USA	
EMERGENCY PHONE:	**TOLL-FREE in USA/Canada**	800-255-3924
	International calls	813-248-0585
BUSINESS PHONE:	914-948-4040	
DATE OF PREPARATION:	May 2011	
DATE OF LAST REVISION:	February 2008	

SECTION 2 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: This product is a white granular powder with little or no odor. Exposure can be irritating to eyes, respiratory system and skin. It is a non-flammable solid. The Environmental effects of this product have not been investigated.

US DOT SYMBOLS	CANADA (WHMIS) SYMBOLS	EUROPEAN and (GHS) Hazard Symbols
Non-Regulated		 Signal Word: **Warning!**

EU LABELING AND CLASSIFICATION:

Classification of the substance or mixture according to Regulation (EC) No1272/2008 Annex 1
EC# 205-633-8 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 268-356-1 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 231-838-7 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 231-767-1 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 207-638-8 Index# 011-005-00-2
EC# 205-788-1 This substance is not classified in the Annex I of Directive 67/548/EEC

GHS Hazard Classification(s):

Eye Irritant Category 2A

Hazard Statement(s):

H319: Causes serious eye irritation

Precautionary Statement(s):

P260: Do not breath dust/fume/gas/mist/vapors/spray
P264: Wash hands thoroughly after handling
P271: Use only in well ventilated area.
P280: Wear protective gloves/protective clothing/eye protection/face protection/

Hazard Symbol(s):

[Xi] Irritant

Risk Phrases:
R20: Harmful by inhalation
R36/37/38: Irritating to eyes, respiratory system and skin

Safety Phrases:
S8: Keep container dry
S22: Do not breath dust
S24/25: Avoid contact with skin and eyes

HEALTH HAZARDS OR RISKS FROM EXPOSURE:

ACUTE: Exposure to this product may cause irritation of the eyes, respiratory system and skin. Ingestion may cause gastrointestinal irritation including pain, vomiting or diarrhea.

CHRONIC: This product contains an ingredient which may be corrosive.

TARGET ORGANS: ACUTE: Eye, respiratory System, Skin CHRONIC: None Known

SECTION 3 - COMPOSITION and INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS:	CAS #	EINECS #	ICSC #	WT %	HAZARD CLASSIFICATION; RISK PHRASES
Sodium Bicarbonate	144-55-8	205-633-8	1044	33 - 43%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	268-356-1	Not Listed	10 – 20%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Tripolyphosphate	7758-29-4	231-838-7	1469	5 - 15%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Tetrasodium Pyrophosphate	7722-88-5	231-767-1	1140	5 - 15%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Carbonate	497-19-8	207-638-8	1135	1 - 10%	HAZARD CLASSIFICATION: [Xi] Irritant RISK PHRASES: R36
Sodium Alcohol Sulfate	151-21-3	205-788-1	0502	1 – 5%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Balance of other ingredients are non-hazardous or less than 1% in concentration (or 0.1% for carcinogens, reproductive toxins, or respiratory sensitizers).					

NOTE: ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-2004 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR, EU Directives and the Japanese Industrial Standard *JIS Z 7250: 2000*.

SECTION 4 - FIRST-AID MEASURES

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to health professional with contaminated individual.

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly after handling. Seek medical attention if irritation develops and persists. Remove contaminated clothing. Launder before re-use.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention if breathing dificulty continues.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or MSDS with the victim to the health professional.

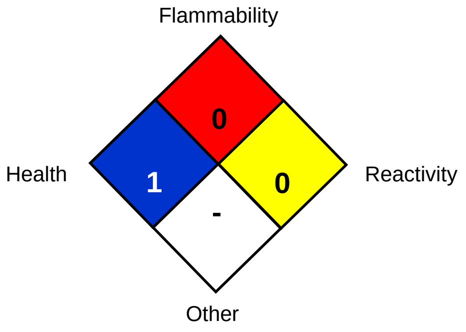
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin, or eye problems may be aggravated by prolonged contact.

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and reduce over-exposure.

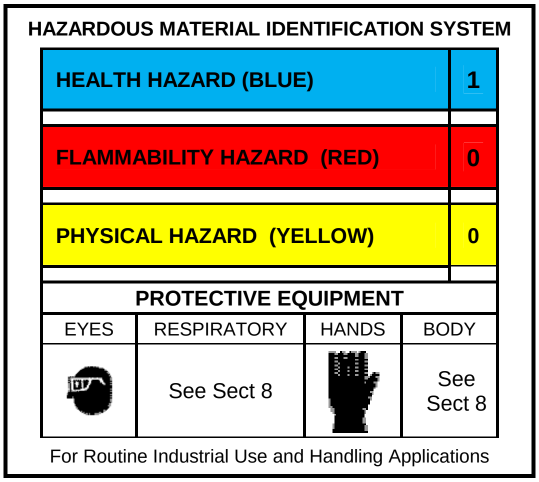
SECTION 5 - FIRE-FIGHTING MEASURES

FLASH POINT:	Not Flammable
AUTOIGNITION TEMPERATURE:	Not Applicable
FLAMMABLE LIMITS (in air by volume, %):	Lower (LEL): NA Upper (UEL): NA
FIRE EXTINGUISHING MATERIALS:	As appropriate for surrounding fire. Carbon dioxide, foam, dry chemical, halon, or water spray.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	This product is non-flammable and has no known explosion hazards.
Explosion Sensitivity to Mechanical Impact:	Not Sensitive.
Explosion Sensitivity to Static Discharge:	Not Sensitive
SPECIAL FIRE-FIGHTING PROCEDURES:	Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

NFPA RATING SYSTEM



HMIS RATING SYSTEM



HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

HEALTH HAZARD (BLUE)	1
FLAMMABILITY HAZARD (RED)	0
PHYSICAL HAZARD (YELLOW)	0

PROTECTIVE EQUIPMENT

EYES	RESPIRATORY	HANDS	BODY
	See Sect 8		See Sect 8

For Routine Industrial Use and Handling Applications

Hazard Scale: **0** = Minimal **1** = Slight **2** = Moderate **3** = Serious **4** = Severe * = Chronic hazard

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SECTION 6 - ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Personnel should be trained for spill response operations.

SPILLS: Contain spill if safe to do so. Prevent entry into drains, sewers, and other waterways. Sweep, shovel or vacuum spilled material and place in an appropriate container for re-use or disposal. Avoid dust generation if possible. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

SECTION 7 - HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Avoid breathing dusts generated by this product. Use in a well-ventilated location. Remove contaminated clothing immediately.

STORAGE AND HANDLING PRACTICES: Containers of this product must be properly labeled. Store containers in a cool, dry location. Keep container tightly closed when not in use. Store away from strong acids or oxidizers.

SECTION 8 - EXPOSURE CONTROLS - PERSONAL PROTECTION

EXPOSURE LIMITS/GUIDELINES:

Chemical Name	CAS#	ACGIH TWA	OSHA TWA	SWA
Sodium Bicarbonate	144-55-8	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Sodium Tripolyphosphate	7758-29-4	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Tetrasodium Pyrophosphate	7722-88-5	5 mg/m³	5 mg/m³	5 mg/m³
Sodium Carbonate	497-19-8	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Sodium Alcohol Sulfate	151-21-3	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust

Currently, International exposure limits are not established for the components of this product. Please check with competent authority in each country for the most recent limits in place.

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation to ensure exposure levels are maintained below the limits provided below. Use local exhaust ventilation to control airborne dust. Ensure eyewash/safety shower stations are available near areas where this product is used.

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Based on test data, exposure limits should not be exceeded under normal use conditions when using Alconox Detergent. Maintain airborne contaminant concentrations below guidelines listed above, if applicable. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Use chemical resistant gloves to prevent skin contact.. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate to prevent contact (e.g. lab coat, overalls). If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

PHYSICAL STATE:	Solid
APPEARANCE & ODOR:	White granular powder with little or no odor.
ODOR THRESHOLD (PPM):	Not Available
VAPOR PRESSURE (mmHg):	Not Applicable
VAPOR DENSITY (AIR=1):	Not Applicable.
BY WEIGHT:	Not Available
EVAPORATION RATE (nBuAc = 1):	Not Applicable.
BOILING POINT (C°):	Not Applicable.
FREEZING POINT (C°):	Not Applicable.
pH:	9.5 (1% aqueous solution)
SPECIFIC GRAVITY 20°C: (WATER =1)	0.85 – 1.1
SOLUBILITY IN WATER (%)	>10% w/w
COEFFICIENT OF WATER/OIL DIST.:	Not Available
VOC:	None
CHEMICAL FAMILY:	Detergent

SECTION 10 - STABILITY and REACTIVITY

STABILITY: Product is stable
DECOMPOSITION PRODUCTS: When heated to decomposition this product produces Oxides of carbon (COx)
MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong acids and strong oxidizing agents.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Contact with incompatible materials and dust generation.

SECTION 11 - TOXICOLOGICAL INFORMATION

TOXICITY DATA: Toxicity data is available for mixture:

CAS# 497-19-8 LD50 Oral (Rat)	4090 mg/kg
CAS# 497-19-8 LD50 Oral (Mouse)	6600 mg/kg
CAS# 497-19-8 LC50 Inhalation (Rat)	2300 mg/m³ 2H
CAS# 497-19-8 LC50 Inhalation (Mouse)	1200 mg/m³ 2H
CAS# 7758-29-4 LD50 Oral (Rat)	3120 mg/kg
CAS# 7758-29-4 LD50 Oral (Mouse)	3100 mg/kg
CAS# 7722-88-5 LD50 Oral (Rat)	4000 mg/kg

SUSPECTED CANCER AGENT: None of the ingredients are found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.
IRRITANCY OF PRODUCT: Contact with this product can be irritating to exposed skin, eyes and respiratory system.
SENSITIZATION OF PRODUCT: This product is not considered a sensitizer.
REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

SECTION 12 - ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

ENVIRONMENTAL STABILITY: No Data available at this time.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on this product’s effects on plants or animals.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on this product’s effects on aquatic life.

SECTION 13 - DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

SECTION 14 - TRANSPORTATION INFORMATION

US DOT; IATA; IMO; ADR:

THIS PRODUCT IS NOT HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.
PROPER SHIPPING NAME: Non-Regulated Material
HAZARD CLASS NUMBER and DESCRIPTION: Not Applicable
UN IDENTIFICATION NUMBER: Not Applicable
PACKING GROUP: Not Applicable.
DOT LABEL(S) REQUIRED: Not Applicable
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): Not Applicable
MARINE POLLUTANT: None of the ingredients are classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B)

U.S. DEPARTMENT OF TRANSPORTATION (DOT) SHIPPING REGULATIONS:
This product is not classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.

TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:
This product is not classified as Dangerous Goods, per regulations of Transport Canada.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA):
This product is not classified as Dangerous Goods, by rules of IATA:

INTERNATIONAL MARITIME ORGANIZATION (IMO) DESIGNATION:
This product is not classified as Dangerous Goods by the International Maritime Organization.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):

SECTION 15 - REGULATORY INFORMATION

UNITED STATES REGULATIONS

SARA REPORTING REQUIREMENTS: This product is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows: None

TSCA: All components in this product are listed on the US Toxic Substances Control Act (TSCA) inventory of chemicals.

SARA 311/312:

Acute Health:	Yes	Chronic Health:	No	Fire:	No	Reactivity:	No

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this product. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): None of the ingredients are on the California Proposition 65 lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: All of the components of this product are on the DSL Inventory

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: No component of this product is on the CEPA First Priorities Substance Lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: This product is categorized as a Controlled Product, Hazard Class D2B as per the Controlled Product Regulations

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

EU LABELING AND CLASSIFICATION:

Classification of the mixture according to Regulation (EC) No1272/2008. See section 2 for details.

AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: All components of this product are listed on the AICS.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

JAPANESE INFORMATION FOR PRODUCT:

JAPANESE MINISTER OF INTERNATIONAL TRADE AND INDUSTRY (MITI) STATUS: The components of this product are not listed as Class I Specified Chemical Substances, Class II Specified Chemical Substances, or Designated Chemical Substances by the Japanese MITI.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac:	Listed
Australian Inventory of Chemical Substances (AICS):	Listed
Korean Existing Chemicals List (ECL):	Listed
Japanese Existing National Inventory of Chemical Substances (ENCS):	Listed
Philippines Inventory if Chemicals and Chemical Substances (PICCS):	Listed
Swiss Giftliste List of Toxic Substances:	Listed
U.S. TSCA:	Listed

SECTION 16 - OTHER INFORMATION

PREPARED BY: Paul Eigbrett Global Safety Management, 10006 Cross Creek Blvd. Suite 440, Tampa, FL 33647

ANNEX:

IDENTIFIED USES OF ALCONOX® AND DIRECTIONS FOR USE

Used to clean: Healthcare instruments, laboratory ware, vacuum equipment, tissue culture ware, personal protective equipment, sampling apparatus, catheters, tubing, pipes, radioactive contaminated articles, optical parts, electronic components, pharmaceutical apparatus, cosmetics manufacturing equipment, metal castings, forgings and stampings, industrial parts, tanks and reactors. Authorized by USDA for use in federally inspected meat and poultry plants. Passes inhibitory residue test for water analysis. FDA certified.

Used to remove: Soil, grit, grime, buffing compound, slime, grease, oils, blood, tissue, salts, deposits, particulates, solvents, chemicals, radioisotopes, radioactive contaminations, silicon oils, mold release agents.

Surfaces cleaned: Corrosion inhibited formulation recommended for glass, metal, stainless steel, porcelain, ceramic, plastic, rubber and fiberglass. Can be used on soft metals such as copper, aluminum, zinc and magnesium if rinsed promptly. Corrosion testing may be advisable.

Cleaning method: Soak, brush, sponge, cloth, ultrasonic, flow through clean-inplace. Will foam—not for spray or machine use.

Directions: Make a fresh 1% solution (2 1/2 Tbsp. per gal., 1 1/4 oz. per gal. or 10 grams per liter) in cold, warm, or hot water. If available use warm water. Use cold water for blood stains. For difficult soils, raise water temperature and use more detergent. Clean by soak, circulate, wipe, or ultrasonic method. Not for spray machines, will foam. For nonabrasive scouring, make paste. Use 2% solution to soak frozen stopcocks. To remove silver tarnish, soak in 1% solution in aluminum container. RINSE THOROUGHLY—preferably with running water. For critical cleaning, do final or all rinsing in distilled, deionized, or purified water. For food contact surfaces, rinse with potable water. Used on a wide range of glass, ceramic, plastic, and metal surfaces. Corrosion testing may be advisable.

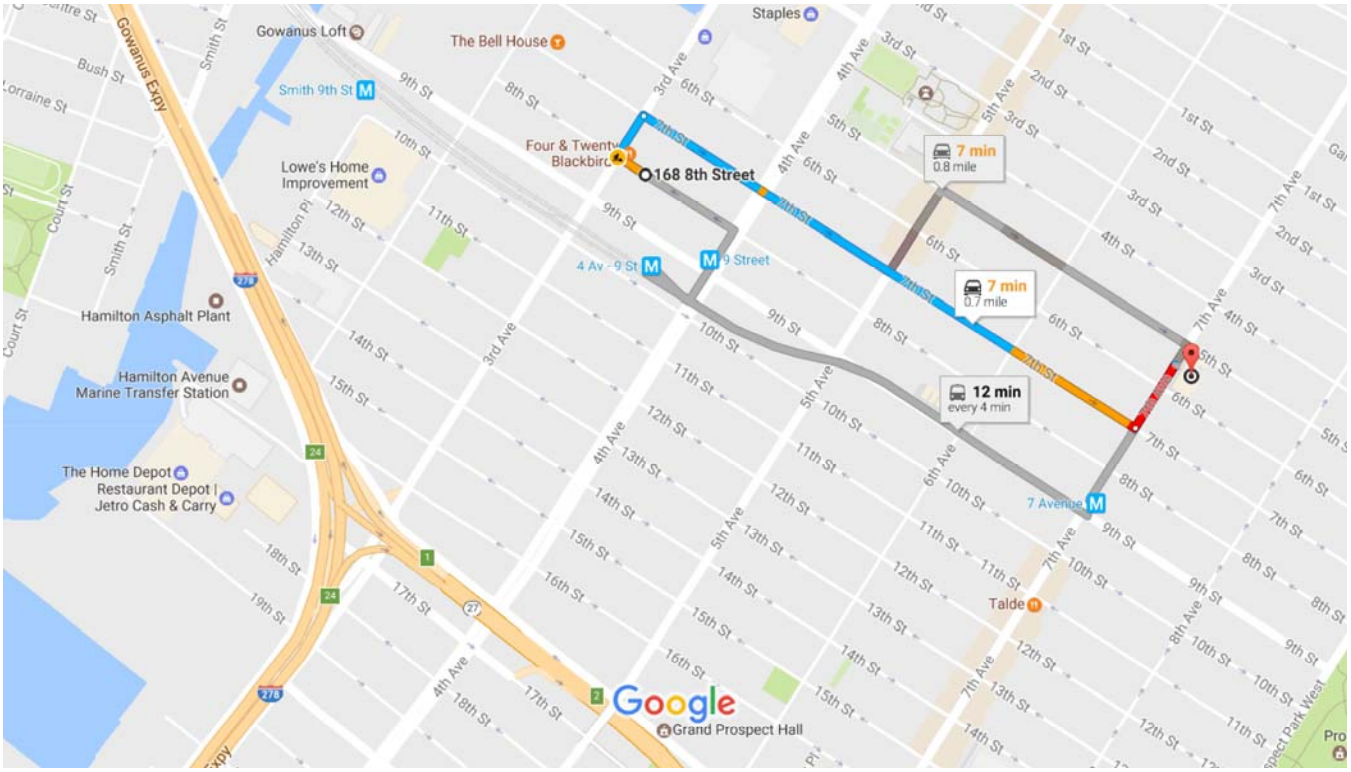
Attachment C

Hospital Route

Google Maps

168 8th St, Brooklyn, NY 11215 to NewYork-Presbyterian Brooklyn Methodist Hospital Faculty Practice

Drive 0.7 mile, 7 min



Map data ©2017 Google 500 ft

168 8th St

Brooklyn, NY 11215

↑ 1. Head northwest on 8th St toward 3rd Ave

177 ft

↱ 2. Turn right at the 1st cross street onto 3rd Ave

262 ft

↱ 3. Turn right at the 1st cross street onto 7th St

0.6 mi

↰ 4. Turn left onto 7th Ave

ⓘ Destination will be on the right

397 ft

NewYork-Presbyterian Brooklyn Methodist Hospital Faculty Practice

263 7th Ave, Brooklyn, NY 11215

Attachment D

Work Care Information

WORKCARE®
Making Health Count

FACT SHEET

EARLY INCIDENT INTERVENTION®

Immediate Access to Medical Advice for Work Related Incidents

(888) 449-7787

INTRODUCTION

WorkCare, Inc. (WorkCare) and TRC have partnered together to promote Incident Intervention®, a resource designed to support company safety goals/targets—while reducing runaway-costs associated with workplace injuries and illnesses.

PURPOSE

Early Incident Intervention provides TRC employees with **IMMEDIATE** telephonic access to WorkCare clinicians at the time of a presumed, non-emergency workplace injury or illness. Clinicians provide expert guidance on the evaluation of symptoms, appropriate first aid, and the need for additional medical evaluation or treatment.

When utilizing this service within the first hour of an incident, known as the "Golden Hour," licensed medical staff can guide the case so that medical evaluation and treatment are rendered appropriately.

> *"…helps the worker traverse the unpredictable terrain of work-related injuries and illness."*

PRINCIPLES OF EARLY INCIDENT INTERVENTION

- Utilizes principles of the "Golden Hour."
- Provides workers immediate clinician support at the time of an incident.
- Focuses on providing the right care, at the right time in the proper setting.

BENEFITS FOR EMPLOYEES

- Instant access to a medically qualified professional for evaluation of symptoms and possible outcomes.
- Professional guidance on appropriate first aid measures and medications.
- Professional advice regarding the need for additional medical evaluation or treatment.

BENEFITS FOR TRC

- Point of contact for emergency and non-emergency medical clinicians.
- Triages the incident to determine risk and urgency, delivering interventions that are consistent with medical guidelines for the specified injury and illness.
- Maintains communication with clinicians to ensure accurate and timely reporting.

The Right Care - The Right Time - The Proper Setting

(888) 449-7787

Attachment E

Job-Safety Analyses (JSA)

Soil Sampling/Well Installation Job Safety Analysis

COMPANY/ PROJECT NAME or ID/ LOCATION (City, State) **168 8th Street, Brooklyn, NY 11215**	DATE PREPARED FOR HASP: 12/11/2015	☐ NEW ☒ REVISED
JSA WORK ACTIVITY (Description): **Soil Borings/Well Installation**	List of Contractor(s) and key work activity:	

SITE SPECIFIC JSA AUTHOR	POSITION / TITLE	DEPT	SIGNATURE
Lindsay O'Hara	**Project Manager**	**ECR**	

TRC HEALTH AND SAFETY MANAGEMENT	POSITION / TITLE	APPROVAL DATE
Wes Lindemuth	**Office Safety Coordinator**	12/11/2015

PERSONAL PROTECTION EQUIPMENT (PPE) QUICK SUMMARY

Required PPE (indicate with "R") vs. Must Have Available On-site (indicate "A")

___R__ REFLECTIVE VEST ___R__HARD HAT ___R___GLOVES: **ANSI Cut Level 4 & 5 Kevlar** ___R__SAFETY GLASSES ______GOGGLES ______FACE SHIELD	__R___ HEARING PROTECTION __R__SAFETY SHOES: Protective Toe _____ 5pt.HARNESS / LANYARD PPE CLOTHING: ____Coveralls ____Tyvek Suit ____Nomex ____Other (specify):	RESPIRATORY PROTECTION: ☒ NA ____½ face Air Purifying Respirator (APR) ___ Cartridge: ☐ P100 ☐ Multigas_ _____Full face ARP; specify cartridge type: _____ Air Supplied Respirator ____SCBA _____Air-line	Additional PPE/Notes: As per defined in the job/site specific Health and Safety Plan (HASP) wear PPE at all times when performing site work.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

¹ JOB TASKS	² POTENTIAL HAZARDS	³ HAZARD CONTROLS (beyond wearing "Required" PPE)
1) Set-up	a. Lack of concentration or focus.	a1. Review all plans (HASP, Work, Utility, Site Plans, etc.), logs, and field notes prior to starting a new task. Identify daily tasks and required personnel actions. a2. Conduct safety tailgate meeting with subcontractor personnel prior to beginning work activities. Explain the site safety hazards and work precautions outlined in the HASP and obtain signatures indicating the HASP was discussed.
	b. Fire and explosion.	b1. No smoking or open flame. Periodically monitor ambient air concentrations with PID/LEL Meters. Shut down job and move personnel and equipment upwind if hydrocarbon concentrations are HASP defined action levels. b2. Deploy 2-20lb ABC Fire extinguishers in accordance site safety officer's direction.
	c. Electric shock/ electrocution.	c1. Have a qualified electrician cut all power connections to the site and remove main breaker from power panel. c2. De-energize all circuits/power sources and follow TRC's Lock-Out, Tag-Out (LOTO) procedures for circuits within 3-feet of boring location or 10-feet' of overhead utilities.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.		
[1] JOB TASKS	**[2] POTENTIAL HAZARDS**	**[3] HAZARD CONTROLS (beyond wearing "Required" PPE)**
1) Cont'd	d. Malfunctioning heavy equipment safety devices.	d1. Inspect drill rig to determine if in good condition. Perform all equipment and safety checks prior to event startup (per operating manual).
	e. Being struck by moving vehicles or equipment onsite.	e1. Always wear safety vest, establish eye contact with operators utilizing flag men wear appropriate. e2. Vehicles shall use reverse beepers or flagmen. e3. Create an exclusion zone at least 10-feet beyond the limits of the boring to limit access to staging/work area using snow fencing, barricades, delineators, cones and/or caution tape. e4. Face the direction of oncoming traffic during work activities when possible.
	f. Bad organization creating confusion and hazard.	f1. Identify staging area with good lateral and vertical access for loading and unloading of trucks.
	g. Unauthorized personnel in exclusion zone.	g1. Use visitor check-in log and allow no-one in exclusion area without proper PPE (as defined on this JSA) and training documentation (e.g., HAZWOPER, other as defined in the HASP).
2) Drilling	a. Contact with subsurface water, gas, electrical, and/or fiber optic lines in the vicinity of drilling locations.	a1. If unknown lines or obstructions are encountered, stop drilling and notify PM. Do not undermine any utilities.
	b. Broken rod.	b1. Do not stand in close proximity of the rods being pushed into the ground. Stand off to the side and wear required PPE.
	c. Distracted driller.	c1. Always communicate with the driller before approaching the operating drill stem.
	d. Slips, trips, and falls.	d1. Spread absorbent to soak up any pools of water that accumulate during drilling. d2. Maintain a clean, unobstructed work area by good housekeeping and placing unused equipment away from work area.
	e. Soil cross contamination.	e1. Ensure downhole sampling equipment is cleaned between samples. e2. Create a clean sample collection area with removable poly sheeting/aluminum foil or other method ensure a clean work surface that is refreshed between each sample.
	f. Cut/pinched fingers or toes; and strained muscles.	f1. See PPE Quick Summary. f2. Use proper lifting techniques and 2-man rule as outlined in TRC's Employee IIPP Handbook and "Back Safety: A User's Guide" training module" handbook, when moving heavy objects (>50 lbs).

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

[1] JOB TASKS	[2] POTENTIAL HAZARDS	[3] HAZARD CONTROLS (beyond wearing "Required" PPE)
2) Cont'd	g. Noise.	g1. All personnel will use hearing protection within work area while heavy machinery is operating at >85 dB.
	h. Flying particles, dust and hazardous substances from clearance activities.	h1. See PPE Quick Summary.
	i. Exposure to impacted soil or groundwater.	i1. Wear latex or nitrile gloves during handling of soil or ground water.
	j. Toxic or explosive atmosphere.	j1. Periodically monitor ambient atmosphere with PID or LEL meter. Shut down job and move personnel and equipment upwind if concentrations are detected above HASP defined action levels.
	k. Opening/handling core sleeves.	k1. Do not attempt to open retrieved core sleeves. Request the driller to open the plastic sleeves using ANSI cut level 5 Kevlar gloves. TRC personnel must have ANSI cut level 4 Kevlar gloves when handling/transporting open core sleeves.
	l. Inclement weather/ lightning.	l1. Monitor forecasted weather prior to and during drilling activities. Hault drilling activities if lightning is observed or anticipated and wait in personal/company vehicle until weather passes or until directed otherwise by the project manager.
	m. Heat illness.	m1. Refer to Activity Performed in Hot Illness Prevention JSA.
	n. Cold illness.	n1. Refer to Activity Performed in Cold Illness Prevention JSA.
3) Boring Completion	a. Bad organization causing cross-contamination of soil, groundwater, or personnel.	a1. Waste management—Identify and delineate soil stockpile area or storage area if soil cuttings/purge water are to be drummed. a2. Blot up puddles of standing water and the work area will be swept.
	b. Moving heavy objects (>50-lbs) and mixing grout/concrete.	b1. Get assistance for moving heavy objects and mixing grout/concrete. Use mechanical aids to move objects or mix grout/concrete.
	c. Opening/closing/ moving drums.	c1. Wear must wear ANSI cut rated 4 or 5 Kevlar gloves during the opening and closing of drums to protect fingers. c2. Use only drum dolly to move drums with soil, hydrated bentonite grout, or concrete or other heavy contents. c3. Empty metal drums could also cause strain or injury if not moved properly. Use caution and appropriate tools (e.g., dolly).
	d. Slips, trips, falls and physical injury during auger removal.	d1. Place all removed rods to side, so as not to become a trip hazard.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.		
[1] JOB TASKS	**[2] POTENTIAL HAZARDS**	**[3] HAZARD CONTROLS (beyond wearing "Required" PPE)**
3) Cont'd	e. Overspray and cross-contamination during rod decontamination.	e1. See PPE Quick Summary. e2. Do not overspray while cleaning rods. Create a "clean zone" with plastic liner for placement of decontaminated rods.
	LOCATION(S) WHERE HAZARD IS TO BE EXPECTED	**[3] HAZARD CONTROLS (beyond wearing "Required" PPE)**
1.	a.	a.
2.	a.	a.
3.	a.	a.

PID—photoionization detector; LEL—lower explosive limit; PPE—Personal Protective Equipment; ANSI—American National Standards Institute

Field Notes:

____

____

LIMITATION: As part of TRC's EHS Policy, a JSA is provided by TRC for its employees. The purpose of a JSA is NOT to identify all hazards associated with a task, but to identify key potential hazards to get TRC and other onsite personnel thinking about other potential safety hazards and mitigating actions for unsafe conditions and behavior during various works. TRC recognizes that JSA's may not cover every conceivable step or hazard that emerges during a job, so we've provided a "Field Change" section below to amend a JSA if required. The JSA does not supersede or replace any local, state or federal permit, regulation, statute or other entities policies and procedures but is simply a tool for enhancing the execution of safe work at a jobsite under TRC's supervision. Similarly, all subcontractors are required to provide their own JSA(s) for their specialty prior to performing any work for TRC or its customers in accordance with TRC's EHS Policy; however, any unsafe condition or hazard not covered in any JSA is ultimately the direct responsibility of the person or entity performing the work.

TRC JOB SAFETY ANALYSIS

(Revised July 2006)

COMPANY/ PROJECT NAME or ID/ LOCATION (City, State) 168 8th Street, Brooklyn, NY 11215	DATE	☐ NEW ☒ REVISED

WORK ACTIVITY (Description):
Groundwater Sampling and Gauging

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Lindsay O’Hara	Project Manager	Wes Lindemuth	Office Safety Coordinator

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (SEE CRITICAL ACTIONS FOR TASK-SPECIFIC REQUIREMENTS)

☒ REFLECTIVE VEST ☒ HARD HAT ☐ LIFELINE / HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION ☒ SAFETY SHOES ProtectiveToe	☒ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING Nomex if LPH detected)	☒ GLOVES ________ ☐ OTHER ________

- **ALWAYS CONDUCT A MENTAL JSA PRIOR TO STARTING WORK; WHEN CHANGING TASKS; AND THROUGHOUT THE DAY.**
- **THROUGHOUT THE DAY - MENTALLY FOCUS UPON EACH NEW TASK, DIFFERENT PROCEDURES, AND SKILL SETS TO BE USED.**

[1]JOB STEPS	[2]POTENTIAL HAZARDS	[3]CRITICAL ACTIONS TO MITIGATE HAZARDS
1. Groundwater Measurements	a. Lack of concentration and unfamiliarity with site	a. Review all plans and logs in field notebook prior to starting a new task. a. Follow cell phone use procedures when working.
	b. Moving vehicles.	b. Always face traffic or moving equipment when working (establish eye contact with drivers). b. Follow work area exclusion Zone Procedures Use “buddy system” when unable to observe traffic of moving equipment (> 50 lbs).
	c. Pinched fingers or toes; and strained muscles.	c. Wear leather gloves when opening barrels & well lids, lifting sharp or heavy equipment. Use proper tools for opening and closing purge water storage barrels. c. Lift heavy objects utilizing leg muscles rather than depending entirely on your back. Get assistance when equipment exceeds 50-lbs.
	d. Lost equipment and damage to well from foreign objects.	d. Fasten equipment raising and lowering ropes or cables to object larger than well diameter. Carry no loose pens or tools in pockets, place well lid fasteners away from well opening.
	e. Fire/Explosions	e. No Smoking or Open Flames while on site. Request anyone smoking to please extinguish cigarettes. Identify location(s) of all emergency shut-off devices.
	f. Electrocution	f. Perform all necessary equipment and safety checks prior to event startup (per operating manual). Check sounding and measurement equipment for shorts, frayed wires, or loose connections.
	g. Contamination	g. Wear nitrile or latex gloves with handling water or soil. Wear Safety glasses with splash guards when handling groundwater. g. Always cap open wells and replace surface covers when finished. Don’t leave any open well unattended.
	h. Slip/trips and falls	h. Maintain good house keeping - place unused equipment out walkways and work areas. Clean-up all spills. h. Use portable steps to mount and dismount sampling vehicle. Place equipment and tools down on truck bed before mounting and dismounting sampling vehicle.
	i. Noise	i. Use hearing protection when working with operating equipment (>75db).
	j. Visitors/spectators	j. Control entry in work area using exclusions zones and check-in log in field notebook.
1. Sample Storage and Well Closure	a. Damage to Samples b. Well Damage	a. Use procedures outlined in TRC’s Groundwater Monitoring and Sampling Procedures. b. Cap and lock sampled well, then securely fasten drive-over cover before moving onto next well to be sampled.

TRC JOB SAFETY ANALYSIS

(Revised July 2006)

[1] Each Job or Operation consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the associated hazards in Column 2

[2] A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress / ergonomics / lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught"

[3] Aligning with the first two columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable and quantified terms. Avoid subjective general statements such as, "be careful" or "use as appropriate".

LIMITATION: As part of TRC's EHS Policy, a JSA is provided by TRC for its employees. The purpose of a JSA is NOT to identify all hazards associated with a task, but to identify some potential hazards to get TRC and other onsite personnel thinking about other potential safety hazards and mitigating actions for unsafe conditions and behavior during various works. TRC recognizes that JSA's may not cover every conceivable step or hazard that emerges during a job, so we've provided a "Field Change" section below to amend a JSA if required. The JSA does not supersede or replace any local, state or federal permit, regulation, statute or other entities policies and procedures but is simply a tool for enhancing the execution of safe work at a jobsite under TRC's supervision. Similarly, all subcontractors are required to provide their own JSA(s) for their specialty prior to performing any work for TRC or its customers in accordance with TRC's EHS Policy; however, any unsafe condition or hazard not covered in any JSA is ultimately the direct responsibility of the person or entity performing the work.

Field Changes:

Attachment F

Daily Pre-Job Safety Briefing Form

Daily Pre-Job Safety Briefing

Project Name: Proposed Pre-Kindergarten K710 | Remedial Investigaiton
Project Number: 287821
Work Location: 168 8th Street, Brooklyn, NY 11215
Date: ______________
Tasks Performed: ______________
Time: __________ AM PM
Client Name: New York City School Construction Authority
Submitted By: ______________

Health and Safety Plan Available Onsite: Yes ☐ No ☐
Health and Safety Plan Location: ______________
Emergency Facility(s): New York Presbyterian Brooklyn Methodist Hospital
Number(s): (718) 780 3000
Physical Address: 506 6th Street, Brooklyn, NY
First Aid/CPR Persons: ______________

For Emergencies Dial 911/For Non-Emergencies Dial WorkCare (888) 449-7787

Personal Protective Equipment Required	Yes	No	Type
Fall Protection	☐	☐	________
body harness, lifelines, barricades, other (specify)			
Eye/Face	☐	☐	________
goggles, face shield, hood, other (specify)			
Respirator	☐	☐	________
SCBA, supplied air, HEPA, dust, other (specify)			
Foot Protection	☐	☐	________
safety toe, EH rated, rubber boots, other (specify)			
Hand Protection	☐	☐	________
leather, cut resistant, chemical, EH, other (specify)			
Head Protection	☐	☐	________
hard hat, helmet, electrical hazard, other (specify)			
Clothing	☐	☐	________
coveralls, welding, sleeves, rain, FR, reflective vest, chemical, other (specify)			
Hearing Protection	☐	☐	________

Procedures/Programs Required	Yes	No
Hot Work	☐	☐
LOTO/Energy Control	☐	☐
Trenching/Excavation	☐	☐
Signs/Barricades	☐	☐
Confined Space	☐	☐
Cranes/Critical Lifts	☐	☐
Line Breaking/Hot Tap	☐	☐
Scaffolds/Aerial Lifts	☐	☐
System Testing/ Grounding	☐	☐
Employee Certification/Training Required		
Crane Operator	☐	☐
Forklift Operator	☐	☐
Mobile Equipment Operator	☐	☐
Competent Person	☐	☐
OSHA 10/30	☐	☐
HAZWOPER	☐	☐
Clearance/Tagging Authority	☐	☐

Additional Considerations

Work Procedures: ☐ Isolation of equipment
☐ Check for potential ☐ Adequate grounding
☐ Vehicle grounds ☐ Working clearances
☐ Dig Safe/CBYD ☐ E-911 Protocol
People: ☐ Worker fatigue ☐ Other work groups
☐ Public safety ☐ Pedestrian control ☐ Experience
☐ Traffic control ☐ Other utilities ☐ Spec. Training
Tools/Equipment: ☐ Adequate cover-up
☐ Live line tools ☐ Portable Grounds
☐ Inspection of tools/equipment
☐ Specialized tools/equipment
☐ Correct tool/equipment for the job
Special Precautions: ☐ Adjacent structures
☐ Condition of structures ☐ Weather conditions
☐ Lighting conditions ☐ Terrain ☐ Water bodies
☐ Spills and leaks ☐ Environmental ☐ Cultural
Other: ______________

If Conditions CHANGE…Stop Work, Review and Revise the Plan!!

Daily Pre-Job Safety Briefing

Hazards Associated with the Job (focus on the GEMS)

Gravity	Electrical	Mechanical	Kinetic	Other/Environmental
☐ Falling from a height	☐ Electrical contact	☐ Equipment failure	☐ Traffic	☐ Asbestos/Lead
☐ Falling objects	☐ Induced voltage	☐ Conductor tension	☐ Driving conditions	☐ Animals/Insects
☐ Falling structures	☐ Back-feed	☐ Cable tension	☐ Moving/Shifting loads	☐ Confined space
☐ Climbing obstructions	☐ Flash potential	☐ Loaded springs	☐ Rotating machinery	☐ Excavations
☐ Dangerous trees	☐ Step/Touch potential	☐ Moving parts	☐ Vehicle stability	☐ Heat/Cold
☐ Aerial device operation	☐ Static charge	☐ Crane/Rigging	☐ Heavy equip. operation	☐ Pressurized fluids/gases

List all hazards associated with this task

Signature of Crew Members Present

Barriers to eliminate/control above hazards?

Supervisor Signature

Post Task Safety Analysis

Did any injuries or incidents occur today? If yes, explain.

☐ Yes ☐ No

Was the injury or incident reported the safety department?

☐ Yes ☐ No ☐ N/A

What problems did you have with today's work assignment?

What can we do tomorrow to improve performance?

Attachment G

Incident Reporting Forms

TRC Incident Reporting Guidelines

Incident Response:

1. For life threatening injuries and medical emergencies call 911 or go to the closest emergency room.
2. An injured worker must report an injury to their supervisor immediately.
3. Supervisor is required to complete The TRC Incident Report Form within 24 hours of the reported accident and forward to Bill Russell at Sargent & Associates with a copy to Mike Glenn.

   Bill Russell – Sargent &Associates
   Office: (978) 256-7459; Fax: (978) 256-4941
   bill@sargentandassociates.com

   Mike Glenn, National Safety Director
   Office: (949) 727-7347; Mobile: (949) 697-7418
   mglenn@trcsolutions.com

4. WorkCare can provide assistance in providing first aid advice and directing an injured worker to non-emergency medical care. WorkCare is a service that provides 24/7 access to an Occupational Healthcare physician or clinician.

   WorkCare Incident Intervention
   (888) 449-7787

Return to Work:

1. The injured worker is responsible for providing the Supervisor with a copy of the doctor's note detailing the injury and "return to work" status within 24 hours of the doctor's visit. The supervisor must email or fax the completed TRC Incident Report and Doctor's notes to Sargent & Associates.
2. Sargent & Associates will contact the injured worker and the Supervisor to confirm the facts surrounding the injury.
3. Sargent & Associates will report the injury to the workers' compensation insurance carrier, Zurich.

4. Zurich may contact the injured worker and supervisor to conduct an accident investigation.
5. Sargent & Associates will maintain communication with all parties in order to monitor the medical treatment, and the injured worker’s return to work status. They will act as liaison between the injured worker, TRC, and Zurich.
6. Sargent & Associates will work with TRC's Health & Safety, Human Resources, and/or Supervisors to determine if modified duty work is an option, until the injured worker is able to return to full duty work activities.

Incident Investigation:

1. All incidents that result in injuries that require reporting for OSHA recordkeeping purposes and all high potential first aid and near miss events require an incident investigation.
2. The Supervisor with assistance from the National Safety Director and/or Safety Coordinator, must complete the incident investigation report/contributing cause analysis within 7 days of the incident and must develop a corrective action plan within 14 days of the incident.

TRC Incident Report Form

(To be completed immediately after an Injury, Illness, Incident, Accident or Significant Near Miss by Employee's Supervisor and Employee involved)

Incident Category

☐ Employee Injury/Illness ☐ Near Miss/Loss ☐ Property Damage ☐ Vehicle Accident ☐ Fire ☐ Other: Specify

1	Incident Location:	
2	Site Identification/Project No.:	
3	Site Address:	
4	Date Incident Occurred:	
5	Time Incident Occurred:	
6	Date Incident Reported to Supervisor:	
7	Date Report Completed:	
8	Was WorkCare Contacted? ☐ Yes ☐ No	
9	Client:	

TRC Employee Information

10	Name:		
11	Address:		
12	Employee Phone:		
13	Title or Occupation:		
14	Sector/Practice:		
15	Supervisor Name/Phone:		

TRC Employee Information (to be completed by Worker's Compensation Claims Administrator)

16	Employee Date of Birth:		
17	Employee Social Security Number:		
18	Employee Marital Status:	☐ Married	☐ Single
19	Number of Dependant under the age of 18:		
20	Date of Hire:		
21	Rate of Pay:		Hours per week:

Type of Employee Injury or Illness (To be determined by Safety Director)

22	☐ First Aid Only	20	☐ Extended Time Away From Work (3 days or more)
23	☐ Medical Treatment Only	21	☐ Fatality
24	☐ Restricted Work-case	22	☐ Other (specify):
25	☐ Lost Workday		
26	Estimated Number of Days on Restricted Work:		
27	Estimated Number of Days Away from Work:		

Employee Injury or Illness Description

28 Describe the Injury or Illness:

29 First Aid/Medical Treatment Administered:

30 Name of Doctor's Office, Clinic, or Hospital: Concentra

31 Address and Phone Number:

Incident Description

32 Equipment Involved:

33 Site Description:

34 What task was being performed at time of incident?

35 Describe Incident in Detail :

36 Conditions at time of Incident: (weather, lighting, etc.):

37 Motor Vehicle Accident:

38 TRC Vehicle ID:

39	Year/Make/Model:	
☐ DOT Regulated Vehicle ☐ Towed From Scene ☐ Airbag Deployed ☐ Seatbelt in Use ☐ TRC Fleet ☐ Rental ☐ Personal Vehicle		
40	Other Vehicle License Plate	
41	Other Vehicle Year/Make/Model	
42	Other Vehicle Driver Name	
43	Other Vehicle Year/Make/Model	
44	Other Injured Parties ☐ Yes ☐ No	
43	Description of other injuries:	

Subcontractor Involvement / Description of Incident

44	Subcontractor Involved: ☐ Yes ☐ No
45	Name of Company:
46	Address:
47	Contact Name and Phone Number:
48	Subcontractor Description of Incident:

Witness Involvement / Description of Incident

49	Witnesses to Incident: ☐ Yes ☐ No
50	Name(s) and Address(s):
51	Phone Number(s):
52	Witness Description of Incident:

Personal Protective Equipment (PPE)

53	List PPE required to complete the task: (glasses, gloves, shoes, hard hat, respirator, hearing protection, etc.)
54	Was the employee using the proper PPE at the time of the Incident?

Immediate Corrective Actions

55	Describe the immediate corrective actions taken:		
56	Immediate Supervisor:	Signature:	Date:
57	Employee:	Signature:	Date:

Supervisor’s Post-Incident Review and Recommendations

Safety Violation ☐ Yes ☐ No

58 State the company safety rule, OSHA regulation, or specific training that was violated:

59 Describe the training the employee received to prevent this violation:

#	Root Cause Factors (RCF)
1	Lack of skill or knowledge
2	In the past, did not follow procedures or acceptable practices and no incident occurred (injury, product quality incident, equipment damage, regulatory assessment or production delay)
3	Doing the job according to procedures or acceptable practices takes more time/effort
4	Short-cutting procedures or acceptable practices are positively reinforced or tolerated
5	Lack of or inadequate operational procedures
6	Inadequate communication of expectations regarding procedures or acceptable practices
7	Inadequate tools or equipment (available, operable and safely maintained, proper task and workplace design)
8	External factors

60	Root Cause(s)	Identified Root Cause(s):							
		#1	#2	#3	#4	#5	#6	#7	#8
A		☐	☐	☐	☐	☐	☐	☐	☐
B		☐	☐	☐	☐	☐	☐	☐	☐
C		☐	☐	☐	☐	☐	☐	☐	☐
D		☐	☐	☐	☐	☐	☐	☐	☐
E		☐	☐	☐	☐	☐	☐	☐	☐
F		☐	☐	☐	☐	☐	☐	☐	☐
G		☐	☐	☐	☐	☐	☐	☐	☐
H		☐	☐	☐	☐	☐	☐	☐	☐

61 **Conclusion: Why did the Incident Occur?**

62	Item No.	RCF No.	Recommended Corrective Action(s) How to Prevent Incident from Reoccurring	Responsible Person	Due Date	Completed (date)	Verified/ Validated (date)

Supervisor: ____________________________ Signature: _______________________________ Date: __________

TRC Safety Director: ________________________ Signature: _______________________________ Date:__________

TRC
Results you can rely on

AUTO INCIDENT REPORT

TRC DRIVER INFORMATION:

Driver's Name: ____________________ Driver's Phone: (   ) ____________

Company Name: ____________________ Company Location: ____________________

Supervisor's Name: ____________________ Supervisors Phone: (   ) ____________

Project Name: ____________________ Client Name: ____________________

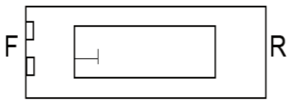
Driver's Date of Birth (MM/DD/YY): ________ Driver's License #: ____________________ State: ________

TRC VEHICLE INFORMATION (V-1):

Year/Make/Model of Vehicle: ____________________

License Plate #: ____________________ Vehicle ID # (VIN): ____________________

Circle Point of Contact:



Was Vehicle Drivable? ☐ Yes ☐ No
Personal: ☐ Yes Rental: ☐ Yes Fleet: ☐ Yes
Rental Company

INCIDENT INFORMATION:

Date of Incident: ________ Time of Incident: ________ A.M. ________ P.M. Photos Taken: ☐ Yes ☐ No

Location of Incident: ____________________ City: ____________

Were The Authorities Contacted? Police: ☐ Yes ☐ No Ambulance: ☐ Yes ☐ No Fire: ☐ Yes ☐ No

Name of Police Dept: ____________ Case #: ____________ Officer Name: ____________

Were Citations Issued? ☐ Yes ☐ No If Yes, To Whom? ____________________

Citation Number: ____________________

Were There Any Witnesses? ☐ Yes ☐ No If Yes, Please Provide Name, Address and Phone Below:

Witness Name: ____________________ Witness Phone: (   ) ____________

Witness Address: ____

Traffic Conditions (i.e., heavy, light): ____________ Weather Conditions (i.e., dry, wet, ice, fog): ________

Was the TRC Driver Injured? ☐ Yes ☐ No Was Medical Treatment Received? ☐ Yes ☐ No

Describe Injuries:

____

Describe Damage to Property Other Than Motor Vehicles (i.e., guardrails, mailboxes, etc.):

____

AUTO INCIDENT REPORT

OTHER DRIVER & VEHICLE INFORMATION (V-2):

Driver's Name: ______________________ Driver's Phone: (   ) ______________

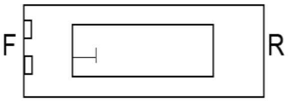
Driver's Address: ____

Owner's Name (If different than driver): ______________ Owner's Phone: (   ) ______________

Owner's Address: ____

Year/Make/Model of Vehicle: ______________ License Plate #: __________ State: ______

Circle Point of Contact:



Was Vehicle Drivable? ☐ Yes ☐ No

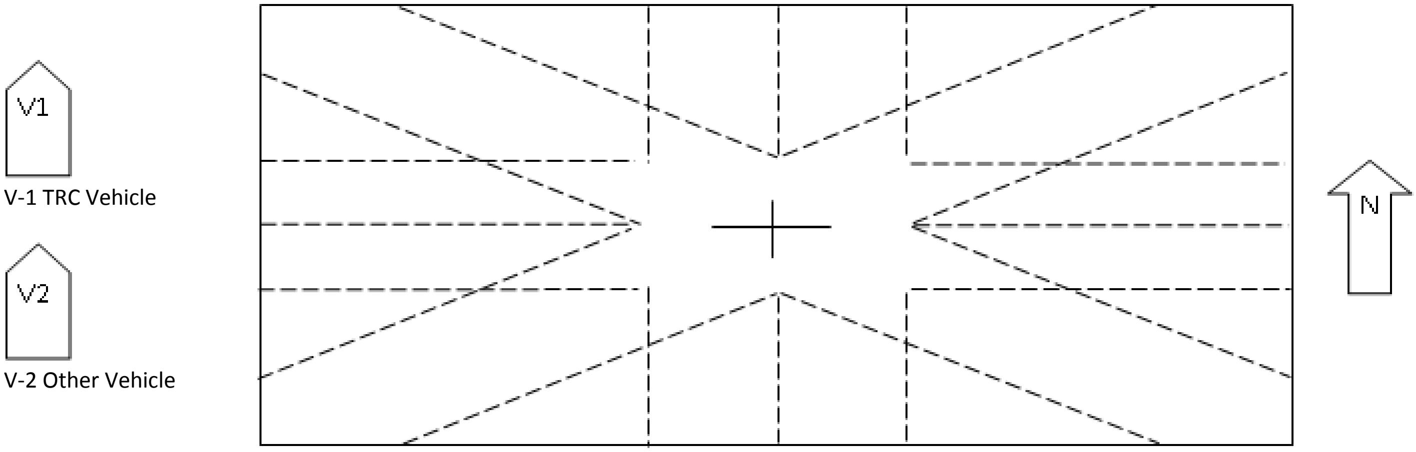
Insurance Company Name: ______________________ Policy Number: ______________________

Insurance Company Phone: (   ) ______________ Number of Passengers in Vehicle: __________

List Persons Injured: ____

Were Any Other Vehicles Involved in Incident? ☐ Yes ☐ No If yes, provide details below:

PLEASE DESCRIBE THE INCIDENT AND COMPLETE THE DIAGRAM BELOW. Be sure to indicate as many details as possible (i.e., How many lanes in each direction; Were there any turn lanes; What kind of traffic controls were there – light, stop sign, yield sign, Positions of vehicles on impact).



Completed By: ______________________ Signature: ______________________

APPENDIX D

Key Personnel Qualifications

DAVID S. GLASS, PE

EDUCATION

M.E., Chemical Engineering, McGill University, 1986
B.A., Chemistry, Colby College, 1983

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

Professional Engineer, New York, 1992
Professional Engineer, New Jersey, 2001
Professional Engineer, Connecticut, 2005

AREAS OF EXPERTISE

Mr. Glass is based in TRC's midtown Manhattan office and manages TRC's Engineering, Construction and Remediation (ECR) Practice in New York State. Mr. Glass has dedicated his career to providing environmental engineering, investigation, design, construction, compliance, and permitting services primarily to municipal agencies in New York State. He has managed and brought to successful completion many large, complex projects in New York City and throughout New York State. Mr. Glass has extensive management and technical experience in the following areas:

- Remedial Investigation and Design
- Remedial Construction Management/Inspection
- Remedial Systems Monitoring, Operation and Maintenance
- Underground and Aboveground Storage Tank Management
- Soil Vapor Intrusion Investigation and Mitigation
- Environmental Regulatory Compliance
- Landfill Investigation and Closure

REPRESENTATIVE EXPERIENCE (Descriptions marked with an asterisk (*) undertaken within past three years)

New York City School Construction Authority Environmental Consulting/Hazardous Material Services Contract*

Mr. Glass serves as Principal-in-Charge for TRC's environmental consulting hazardous materials services contract with the New York City School Construction Authority (NYCSCA). TRC has provided a broad range of services to the NYCSCA under four consecutive on-call contracts, including environmental site assessment and remedial design and construction phase services, and remedial program implementation, operation, maintenance and monitoring services. TRC has successfully completed over 400 assignments for NYCSCA since 2006.

The Port Authority of NY & NJ – Expert Professional Environmental Engineering Services*

Mr. Glass serves as Principal-in-Charge for TRC's Expert Professional Environmental Engineering services contract with the Port Authority. Since 2011 under two consecutive term contracts, TRC has provided remedial investigation, design, construction inspection, closure and remedial systems operations, maintenance and monitoring services to the Port Authority in connection with sites in New York and New Jersey. Mr. Glass's responsibilities include review of proposals, quality control of work products, and monitoring TRC progress and effort with respect to schedule and budget. Among the projects assigned by Port Authority to TRC that Mr. Glass has served in a quality control role are: Goethals Bridge Replacement Project (Site Assessments/Investigations), Port Ivory – Howland Hook Marine Terminal (Voluntary Cleanup Program Closure/Remediation), and JFK Airport Bulk and Satellite Fuel Farms (Petroleum Spill Remediation Systems Optimization/Design).

MTA Long Island Rail Road (LIRR) General Engineering Consultants (GEC) Environmental Engineering Contract*

Mr. Glass serves as Principal-in-Charge for TRC's GEC contract for environmental engineering services with the MTA Long Island Rail Road. In this capacity Mr. Glass has supervised services provided to LIRR in connection with a remedial investigation of the Morris Park Yard, design and construction of a petroleum remediation system at the Morris Park Yard, and remedial investigations of petroleum spills at the West Side Storage Yard on the west side of Manhattan and at the Richmond Hill Yard in Queens.

NYSDEC Superfund Standby Contract*

Mr. Glass serves as Principal-in-Charge for services currently provided by TRC to NYSDEC under a Superfund Standby (on-call engineering services) Contract. Additionally, between 1996 and 2005, under consecutive Superfund Standby Contracts, Mr. Glass managed environmental design, construction phase and site management services provided to the NYSDEC. Under the multi-site "on-call" contracts with NYSDEC Mr. Glass has been responsible for preparation of work plans, remedial investigations, feasibility studies, interim remedial measures (IRMs), pre-design investigation reports, engineering design reports, design drawings and specifications, and engineering cost estimates for remediation of "State Superfund" sites throughout New York State.

CSX Transportation, Inc.*

Mr. Glass serves as Principal-in-Charge for services provided by TRC to CSX. In this capacity Mr. Glass has supervised engineering assessments of the potential impacts of proposed environmental dredging on CSX rail bridges which span the Buffalo River, in Buffalo, New York, and Onondaga Creek and Ninemile Creek in Syracuse, NY; provided third party review and oversight in connection with complicated remediation of chlorinated solvents in soil and groundwater using in-situ thermal remediation and groundwater extraction and reinjection at Beacon Yards in Boston; and managed the environmental due diligence, remediation and environmental permitting for a new intermodal rail terminal in Pittsburgh.

Queens West Development - Stage 2 Site Remedial Action - Long Island City, NY In connection with an approximately $1.5 billion development on the East River, Mr. Glass supervised the preparation of the Remedial Investigation (RI) Work Plan, RI Report, Remedial Work Plan, Final Engineering Report, and Site Management Plan, and supervised remediation of Operable Units (OUs) 3 and 4 of the Queens West Development – Stage 2 Site, an approximately 9-acre parcel which is the location of a former Standard Oil Company refinery. In December 2010 NYSDEC issued Certificates of Completion for both OUs 3 and 4 under the New York State Brownfield Cleanup Program (BCP). Mr. Glass also managed the design of active sub-slab depressurization systems for several high-rise residential buildings at the site.

NJDEP Remedial Design Services Contract

Between 2001 and 2004, under a remedial design services contract, Mr. Glass managed predesign investigation and design services provided to the NJDEP. Under the multi-site "on-call" contract with NJDEP Mr. Glass supervised preparation of work plans, pre-design investigation reports, engineering design reports, design drawings and specifications, and engineering cost estimates for abandoned landfills, a truck fueling facility site, a former electronics manufacturing site, a bulk chemical storage terminal, an oil storage terminal, and a former metal fabricator site.

Avis Budget Group, Inc. - New York, New Jersey, Connecticut and Massachusetts*

Mr. Glass serves as Principal-in-Charge for TRC's national environmental engineering services contract with the Avis Budget Group, Inc. TRC has provided a broad range of services to the Avis Budget Group since 2006, including environmental arbitration-related, site assessment, petroleum spill closure, and remedial design and construction phase services at several sites in New York, New Jersey, Connecticut and Massachusetts, including properties operated by Avis Budget in Manhattan, and at JFK, LaGuardia, Newark and Logan airports.

Environmental Compliance, Design and Construction Services – Danbury, CT*

Mr. Glass serves as Principal-in-Charge for TRC's environmental engineering contract with the City of Danbury, CT. TRC has provided a broad range of services to the City since 2005, including air quality management services in connection with the closed Danbury Landfill and Public Works Complex; optimization of the landfill gas control system and enclosed landfill gas flare; city-wide compliance surveys of underground storage tanks; preparation of storm water pollution prevention plans for the City's Public Works Complex and Water Pollution Control Plant; preparation of Spill Prevention, Control and Countermeasure (SPCC) Plans for the City's Public Works Complex and Police Department Headquarters and related training and compliance assistance; design and construction inspection services for the removal and replacement of gasoline and diesel fuel storage tank systems and dispensers at the Fire Department headquarters; design and construction inspection services for a new vehicle fueling facility at the Public Works Complex which includes a 10,000-gallon aboveground diesel fuel tank, an 8,000-gallon aboveground gasoline tank, and overhead canopy with recessed lighting; and, design services for removal and replacement of fuel oil storage tanks at the City Airport, City Hall, and two City Public Schools.

Stewart EFI Facility - VCP Site No. V00691, Yonkers, NY

Mr. Glass served as Principal-in-Charge and supervised the services provided by TRC which resulted in reaching closure under the New York State Voluntary Cleanup Program (VCP) for the former Stewart EFI Facility. Under Mr. Glass's supervision TRC designed and oversaw construction of a sub-slab depressurization system (SSDS) at the former 100,000-square foot metal stamping and electroplating facility in Yonkers, New York, performed remedial design investigations, prepared an RI and Remedial Alternatives Analysis report, and coordinated with NYSDEC and NYSDOH for closure.

ExxonMobil Bayway Refinery - Linden, NJ

Mr. Glass supervised the design of the hydraulic control system for the Sludge Lagoon Operable Unit (SLOU) at the Bayway Refinery in Linden, NJ. The hydraulic control system includes 21 dual pump extraction wells, thousands of feet of buried piping, and sophisticated instrumentation and controls. The dual pump extraction wells were designed to automatically extract separately groundwater (for hydraulic control) and oil in the SLOU.

48th Avenue, LLC – Long Island City, New York

Mr. Glass represented the seller (48th Avenue, LLC) in connection with five contiguous parcels (formerly occupied by an industrial facility) in Long Island City adjacent to the East River. A significant amount of the purchase price of the properties was being held in escrow by the buyer (Toll Brothers, Inc.) pending a determination of the cost of environmental remediation prior to construction of a low rise residential development. Toll Brothers and their environmental consultant claimed the full amount in escrow was required for remediation. Mr. Glass analyzed the claim and related documentation, determined that actual costs of development attributable to environmental conditions were insignificant, and successfully argued for release of the full amount in escrow.

Consolidated Edison Company of New York, First Avenue Properties – New York, NY In connection with the Final Engineering Report, Mr. Glass served as the Engineer of Record for the decommissioning, demolition, and remediation of the 7-acre Waterside Steam Generating Station site located in Midtown Manhattan. Key components of the work included the asbestos abatement of the circa-1900 steam and electric generating station, the removal of a 255,000 gallon fuel oil underground storage tank, decommissioning and removal of acid and caustic tanks, demolition of three 200-foot high steel and brick smokestacks, demolition of six eight-story high boilers, sealing of twelve-foot diameter cooling water tunnels, remedial investigations, excavation and disposal of 20,000 tons of contaminated soil, and sheeting and shoring to protect adjacent roadways and public right-of-ways.

KeySpan Corporation Cable Fluid Release Site - Sands Point, NY

Mr. Glass managed the pre-design investigation, design and construction phase services for the ground water extraction and treatment system to contain and remediate the release of dielectric cable fluid from a high voltage underground electric utility-owned cable. Mr. Glass was responsible for design of the dual phase extraction well, solids filters, carbon adsorption system, instrumentation and controls, treatment system building, utilities, on-site treated water recharge system (dry well network), site access road, site drainage structures and landscaping.

Consolidated Edison Former MGP Plant - New York, NY
Mr. Glass supervised preparation of the Remedial Work Plan for the Consolidated Edison West 42nd Street former Manufactured Gas Plant Site. The RWP was prepared in accordance with the terms of a Voluntary Cleanup Agreement (VCA) with the NYSDEC. The remedial plan developed for the site was designed to meet the requirements of the NYSDEC for cleanup of the former MGP site, as well as allow for the planned future use of the site: construction of a high rise residential building.

Former Textiles Processing Facility, Soil and Groundwater Remediation Services – Moonachie, NJ
Mr. Glass managed services provided for remediation of tetrachloroethene contaminated soil and groundwater, including dense non-aqueous phase liquid (DNAPL), at a former textiles processing facility in Moonachie, New Jersey. Remedial design included selective building demolition, deep excavation, water-tight sheeting, and in-situ chemical oxidation.

Brookhaven National Laboratory, Sediment Remediation Services – Upton, NY
Mr. Glass managed preparation of the conceptual design drawings for remediation of contaminated sediment in the Peconic River at Brookhaven National Laboratory in Upton, New York. Mr. Glass also served as project manager for closure of the hazardous waste and mixed waste storage facility at Brookhaven National Laboratory (BNL), a Department of Energy (DOE) operated facility. Responsibilities included oversight of decontamination of four hazardous waste storage buildings and two mixed waste storage units, post-closure sampling and preparation of the final closure certification report.

Bergen County Overpeck Park Site, Wetland and Landfill Closure Services – Leonia, NJ
Mr. Glass was manager for stream bank stabilization, wetland restoration and landfill cover repair and closure of the over 400-acre Bergen County Department of Parks Overpeck County Park site (Leonia, New Jersey). The project included redevelopment of the landfill property for passive and active recreation.

Southhold Landfill, Landfill Closure Services – Southhold, NY
Mr. Glass managed engineering services for the closure of a 34-acre municipal solid waste landfill in Southhold, New York. His responsibilities included preparation of the final landfill closure plan, plans and specifications, and a cost estimate for construction of the landfill capping system as well as supervising construction inspection services.

Fishers Island Landfill, Landfill Closure Services – Fishers Island, NY
Mr. Glass managed engineering services for the closure of a 10-acre landfill located in Fishers Island, New York. His responsibilities included preparation of the final landfill closure plan, and plans and specifications for closure of the landfill.

Captain's Cove Landfill, Landfill Remediation Services – Glen Cove, NY
Mr. Glass managed engineering services for remediation of the Captain's Cove landfill located in Glen Cove, New York (New York State Superfund Site Registry No. 1-30-032). His

responsibilities included preparation of plans and specifications for reclamation of the landfill, backfill, grading and drainage, and supervising construction inspection services.

City of Paterson Sewer System Overflow Study – Paterson, NJ

Mr. Glass managed services provided to the City of Paterson, New Jersey, for a combined sewer system overflow study. His responsibilities included supervising mapping of the combined sewer system, cleaning and televising sewers, flow monitoring, and modeling to identify sources of inflow and infiltration and minimize combined system overflows to surface water.

SPECIALIZED TRAINING

- 40-Hour OSHA Health and Safety Training

PROFESSIONAL AFFILIATIONS

- American Chemical Society
- American Institute of Chemical Engineers

JENNIFER L. MIRANDA

EDUCATION

M.S., Environmental and Occupational Health Science, Hunter College, 2002
National Institute of Environmental and Occupational Health Fellow, 2002
B.S., Anthropology and Human Biology, Co-major Human and Natural Ecology, Emory University, 1998

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

Certified Asbestos Inspector, New York State Department of Labor

AREAS OF EXPERTISE

Ms. Miranda has program management and technical experience in the following areas:

- Management and Quality Control of Complex Projects
- Environmental Due Diligence Assessments
- Remedial Investigation
- Environmental Remediation and Alternatives Analysis
- Environmental Compliance Audits
- Brownfields Initiatives
- Remedial Construction Management
- Pre-Demolition Regulated Building Materials Surveys
- Environmental Health and Safety
- Underground Storage Tank Management

Ms. Jennifer Miranda has over 18 years of experience and has assumed progressively increasing responsibility in environmental consulting, due diligence and remedial construction management throughout her career. Ms. Miranda serves as Principal Environmental Scientist/Office Practice Leader in TRC's New York City office, in the Engineering, Construction and Remediation (ECR) Practice, and among her responsibilities are office-wide quality control. Ms. Miranda's experience includes extensive environmental due diligence assessment, field investigation supervision, work plan and report preparation, cost estimating, remedial construction management, project management and program management. Ms. Miranda has served in the capacity of project manager and quality control officer for many large, complex and diverse environmental projects in New York City.

Ms. Miranda is currently responsible for all aspects of quality assurance and control for the environmental due diligence practice in TRC's NYC ECR (environmental due diligence and remediation) group. Ms. Miranda performs comprehensive reviews of the NYC office's work products and certifies work product quality standards have been met. Ms. Miranda is detail oriented and technically proficient in all areas of environmental due diligence in support of property transactions in New York City. Ms. Miranda excels at implementing project controls across large project teams and across her practice by using methodical and reproducible approaches (training, templates, forms, multi-tier reviews, etc.). Ms. Miranda has been responsible for the quality of over one hundred Phase I Environmental Site Assessments (ESAs) and due diligence assignments. She has reviewed and been the Principal-in-Charge of design and implementation of over 50 Phase II Environmental Site Investigations (ESIs)/Remedial Investigations (RIs). Ms. Miranda has prepared numerous hazardous materials chapters for City and State Environmental Assessments and Impact Statements including large scale linear projects such as the Cross Harbor Freight Tunnel and Second Avenue Subway. Ms. Miranda is thoroughly familiar with local regulations and was a founding board member of the New York City Brownfield Partnership, which supports the New York City Mayor’s Office of Environmental Remediation (MOER).

REPRESENTATIVE EXPERIENCE

New York City School Construction Authority – New York, NY

Under consecutive on-call hazardous materials services contracts with the New York City School Construction Authority, Ms. Miranda has served as the technical project lead for due diligence and remediation assignments. Responsibilities have included quality assurance for project deliverables, supervising the preparation of Phase I ESA reports, management of the preparation of Phase II ESI reports, and focused regulatory agency database and prior report reviews for leased properties (over 50 leased New York City public school properties). Recently, Ms. Miranda has provided key technical review and guidance during preparation of Phase I ESA and Phase II ESI reports for challenging proposed Public School sites (K667, K671, K710, and R840), two of which are being considered for the Brownfield Cleanup Program (K671 and K710). Ms. Miranda’s expertise in the Brownfield Cleanup Program has been integral during the preliminary application phases for each of these sites.

The Port Authority of NY & NJ, Port Ivory Voluntary Cleanup Program Sites - VCP Site Nos. V00615, V00674, and V00675 - Staten Island, NY

Ms. Miranda assessed the regulatory status of three VCP Sites. The three Sites encompass approximately 123-acres in the Port Ivory area of Staten Island, New York. Ms. Miranda performed a file review, site visit and prepared summaries and “road map to closure” charts for presentation to the NYSDEC case manager. Ms. Miranda presented the strategy at a meeting with the NYSDEC to achieve site closure/release and covenant not to sue for each Site. NYSDEC has approved closure of two of the sites under the VCP and the Remedial Action Work Plan for the third site has been approved by the NYSDEC.

New York City Department of Parks and Recreation – New York, NY

Under TRC’s on-call Citywide Consultant Environmental Services contract with the New York City Department of Parks and Recreation, Ms. Miranda serves as program manager. Responsibilities have included coordination, management and quality assurance for projects including supplemental soil investigations in coordination with USEPA, NYSDEC and NYCDOH, design of a 50-acre capping remedy for the Redhook Ballfields under a Consent Order with the USEPA, landfill maintenance and monitoring, and regulatory compliance for the Former Bayside Fuel Oil Depot.

Ms. Miranda has provided consulting services to maintain compliance for the Former Bayside Fuel Oil Depot. The Parks Department has long-term development plans for a large waterfront park near Bushwick Inlet. In the interim, prior to large scale remediation and reconstruction as a Park, the former fuel oil terminal fuel storage and transmission systems, stormwater management systems and underlying Manufactured Gas Plant (MGP) impacts must be addressed to maintain compliance. Ms. Miranda oversaw the records review, preparation of Major Oil Storage Facility (MOSF) license Site Assessment Proposal (i.e., MOSF closure plan), preparation of the State Pollutant Discharge Elimination System (SPDES) stormwater collection and treatment system Closure Plan, and regulatory interaction with multiple parties within the NYSDEC.

New York City Economic Development Corporation – On-Call Environmental Consulting Services Contract – New York, NY

Ms. Miranda is the Principal-in-Charge for TRC's on-call environmental services contract with the New York City Economic Development Corporation (NYCEDC). Under Ms. Miranda's management, TRC has provided the following services to the NYCEDC: supplemental investigation work plans; lead investigation and dust removal; remedial oversight and management of a PCB release; asbestos surveys; in-situ soil characterization and specifications for reuse and disposal; semi-annual groundwater monitoring; annual inspections and periodic review reporting for NYSDEC VCP Site V00228, St. George Ball Park, Staten Island; remedial oversight and preparation of the site management plan and final engineering report for NYSDEC Environmental Restoration Site B000312, Bush Terminal Landfill Piers 1-4, Brooklyn; and indoor air quality monitoring and microbial sampling.

Under previous on-call contracts, Ms. Miranda managed numerous environmental site assessments and site investigations for NYCEDC. Ms. Miranda managed the large-scale Island-wide investigation of Governors Island in Upper New York Bay. Governors Island is the site of historic military and US Coast Guard operations.

Industrial and Manufacturing Due Diligence, Permitting Reviews and Compliance Audits, Variety of Facilities - New York and New Jersey

Ms. Miranda has been responsible for numerous Phase I ESAs, material compliance audits, and permitting reviews associated with a variety of industrial and manufacturing facilities including proposed solar installations on landfills, fossil fuel power plants, oil and gas transmission facilities, former pharmaceutical facilities, skin care products manufacturing facilities, an air freight warehouse and high-rise commercial buildings. Ms. Miranda has expertise in identifying significant environmental risks during the due diligence process.

For example, Ms. Miranda served as the senior reviewer/quality control officer for a Phase I ESA and Limited Environmental Regulatory Review for Sundial (a manufacturer of natural and organic skin products). The assessment encompassed four separate facilities in Amityville, NY, with the objective of identifying environmental liabilities in excess of $50K. The purpose of the assessment was to quantify environmental liabilities in support of obtaining approval from a financial lending institution for proposed expansion of the facilities.

Recently, Ms. Miranda served as the senior reviewer for a large and complex Phase I ESA and hazardous materials chapter for an Environmental Assessment Statement (EAS) for the Rockville Centre Power Plant, which has operated since 1898. The assessment was performed to identify environmental issues which may impact a proposed Microgrid project and to identify potential mitigation measures for any issues identified. The Microgrid project consists of retiring several units, adding a new unit, ancillary upgrades to plant systems and installation of solar panels in multiple locations.

Stewart EFI Facility - VCP Site No. V00691 - Yonkers, NY
Ms. Miranda served as Project Manager for the regulatory closure of a former 100,000-square foot metal stamping and electroplating facility site in Yonkers, New York (NYSDEC VCP Site No. V00691). Ms. Miranda served as the primary contact with the NYSDEC Project Manager, managed the work plan preparation and implementation of the Supplemental Investigation, and preparation of the Remedial Investigation Report, Remedial Alternatives Report and the Site Management Plan. A release and covenant not to sue letter was issued by the NYSDEC for the site as a result of Ms. Miranda's efforts.

Sequa – Former Chromalloy Facility – New York State Superfund Site No. 344039 - West Nyack, NY
Ms. Miranda served as Project Manager for the regulatory closure of the former metal coating facility in West Nyack, New York. The Site is undergoing remediation under the New York State Inactive Hazardous Waste Disposal Site Remedial Program, administered by NYSDEC. Ms. Miranda served as the primary contact with the NYSDEC Project Manager and managed the preparation of the Interim Site Management Plan. Maintenance and monitoring of an existing remediation system, under Ms. Miranda's supervision, is ongoing.

Spectra Energy – Natural Gas Pipeline Project - Linden, NJ to New York, NY
Ms. Miranda served as Project Manager for the construction dewatering permitting in support of the installation of the new 20.3 mile natural gas pipeline in Staten Island and Manhattan. Ms. Miranda prepared permit applications which included treatment of dewatering fluids and discharge at ten temporary outfalls to wetlands and surface water bodies, obtained necessary permits and approvals, and administered the preparation of reports and termination of construction dewatering permits.

Queens West Development – Stage 2 Site – Long Island City, NY

Ms. Miranda served as the Project Manager for the over $60 million remediation of the Queens West Development – Stage 2 Site, the site of a former oil refinery in Long Island City. In addition to the presence of several historic abandoned underground storage tank systems, buried on the site was an extensive network of historic refinery piping. The Site was contaminated with petroleum-related VOCs and SVOCs, and metals, in several instances present in soil at concentrations above TCLP regulatory limits, and a large LNAPL plume. In connection with Operable Units 3 and 4 (OUs 3 and 4) (NYSDEC BCP Site Nos. C241095 and C241096), which consist of over 9 acres adjacent to the East River developed with a public school, park, and residential/commercial towers, Ms. Miranda was responsible for the preparation of the Remedial Investigation (RI) Work Plan, RI Report, Remedial Action Work Plan, Final Engineering Reports and Site Management Plans as well as Odor and Vapor Control and Enhanced Community Air Monitoring Plans. Ms. Miranda was also responsible for supervising implementation of the work plans. The RI included advancement and sampling of over 100 soil borings, installation and sampling of a monitoring well network, soil gas sampling within the footprints of the planned buildings, sediment and surface water sampling in the East River to determine potential site impacts, locating and characterizing buried historic refinery remnants, a tidal influence study, a human health risk assessment and fish and wildlife impact analysis. Implementation of the remedial action work plan, supervised by Ms. Miranda, included high vacuum extraction of thousands of gallons of LNAPL, pre-excavation waste characterization and re-use sampling (over 250 borings and thousands of samples were collected for analysis), excavation of over 100,000 tons of contaminated soil under negative pressure enclosures (i.e., tents) and off-site disposal of excavated material, and post-remediation soil, groundwater and soil gas sampling. Ms. Miranda was responsible for financial management, investigation and construction phase field coordination and management, health and safety program management, daily and monthly reporting to the NYSDEC, community outreach program implementation and subcontractor procurement and management. Ms. Miranda served as a primary point of contact for nearby residents during the site remediation, presented at public meetings, prepared fact sheets for distribution to the public, and served as a primary point of contact with the NYSDEC and NYSDOH in connection with responding to local citizens' concerns. In addition, Ms. Miranda managed implementation of a chemical oxidation pilot test on the site, including preparation of a NYSDEC-approved pilot test work plan. In December 2010 NYSDEC issued the final Certificates of Completion for Operable Units 3 and 4 under the BCP.

National Grid - Engineering and Consulting Services for Abatement, Decommissioning, and Demolition: Glenwood Power Station - Glenwood Landing, NY and Far Rockaway Power Station, Far Rockaway, Queens, NY

Ms. Miranda served as Project Manager for engineering and consulting services for abatement, decommissioning and demolition of two of National Grid's oldest power plants in New York City and Long Island. The Far Rockaway and Glenwood power stations ceased operation in July 2012. TRC has provided

National Grid the following services under Ms. Miranda's management: asbestos/regulated materials surveys; structural evaluations; Phase I ESAs; preparation of subsurface investigation work plans; permitting; preparation of specifications and drawings for abatement, decommissioning and demolition; preparation of engineer's cost estimates and schedules; and preparation of bid documents. Ms. Miranda also served as project manager for bid phase services and the construction phase services for the decommissioning and demolition projects.

New York Power Authority (NYPA) - Engineering Services during Decommissioning: Charles Poletti Power Plant – Astoria, NY
Ms. Miranda served as the Project Manager for engineering services for the decommissioning of the Charles Poletti Power Plant. The Charles Poletti Power Plant was a steam-electric 885 megawatt facility capable of firing natural gas and fuel oil. NYPA ceased operations at Poletti in January 2010. In June 2010, TRC was contracted to provide engineering services for the decommissioning of the Charles Poletti Power Plant. Decommissioning services provided to NYPA by TRC under Ms. Miranda's management included an asbestos/regulated materials survey; coordination and oversight of asset recovery; pre-demolition structural assessment of adjoining buildings and cooling water intake and discharge structures; preparation of specifications and drawings for abatement, decommissioning, and demolition; and, preparation of an engineer's cost estimate and bid documents. In addition, Ms. Miranda managed bid phase services for the decommissioning and demolition project. Ms. Miranda also managed design services for temporary winterization of the Poletti Plant and for the relocation of electrical connections and procurement of a New Electric Fire Water Pump System. Ms. Miranda also served as the project manager during the construction phase which has included the following services: submittal review, construction engineering services, asbestos-abatement project monitoring and environmental and health and safety inspection services.

Ms. Miranda also served as the project manager for characterization of sediment in support of upland disposal of material dredged from the former cooling water discharge canal as part of the decommissioning. The decommissioning activities included the removal of the sheet pile wall which forms the Cooling Water Discharge Canal in the East River. Excess sediment deposits within the Cooling Water Discharge Canal were dredged in accordance with the Joint Application for Permit to the NYSDEC and the US Army Corps of Engineers (USACE). Ms. Miranda managed the preparation and implementation of a Field Sampling Plan (FSP) to characterize the material to be dredged for upland disposal. The FSP was prepared to meet the requirements of the NYSDEC Dredge Team and the New Jersey Department of Environmental Protection (NJDEP) Office of Dredging & Sediment Technology. Because of the limited boat access, a vibracore operator and crane were subcontracted to obtain the sediment samples from land. Global positioning system (GPS) readings were taken at the sample locations. A Sediment Sampling and Analysis Report was prepared and approved by the NYSDEC and NJDEP. Ms. Miranda worked with sediment disposal outlets in the region to gain acceptance of the material which was transported via barge, stabilized and ultimately disposed of at an upland facility.

Consolidated Edison Hudson Avenue Generating Station – Brooklyn, NY
The 12-acre Consolidated Edison Hudson Avenue Generating Station is the site of an active electric and steam generating plant that has been used as a generating station for over 80 years. Consolidated Edison was considering installing new steam boilers to replace the existing steam boilers at the Hudson Avenue Generating Station. As part of re-development of the Hudson Avenue Generating Station, Ms. Miranda supervised the Phase I ESAs, Hazardous Materials Pre-Demolition Assessments (for all existing on-site structures), preparation and implementation of the Phase II ESI Work Plan and preparation of the Phase II ESI Report.

Second Avenue Subway - New York, NY
In connection with the environmental assessment of the Second Avenue Subway Route in Manhattan, Ms. Miranda prepared the Hazardous Materials chapter of the Environmental Impact Statement for the proposed transportation project. Ms. Miranda also performed the Phase I ESA using a Global Information System data sorting process to create a comprehensive database. The database was then mapped using State Plane Coordinates and summarized in the Environmental Impact Statement.

Long Island City – Environmental Assessment – Queens, NY
Ms. Miranda performed a Phase I ESA of a portion of Long Island City being considered for rezoning. Based on the results of the Phase I ESA restrictive declarations or E-designations were assigned to a number of lots by the New York City Department of Environmental Protection arising from environmental concerns. This site consisted of an entire block of buildings with a history of manufacturing and commercial uses.

Cross Harbor Freight Movement Project – NY and NJ
Ms. Miranda prepared the Hazardous Materials chapter of the Environmental Impact Statement (EIS) for the proposed transportation project. Ms. Miranda prepared the Phase I ESA using a Global Information System (GIS) data sorting process to create a comprehensive database. The proposed study area included 10 rail yards and approximately 25 miles of track running through New Jersey, Staten Island, Brooklyn, and Queens. The data was categorized by potential to require additional investigation and entered into a GIS database. The GIS database was then mapped using State Plane Coordinates. The resulting maps and tables were summarized in an EIS chapter and the impacts of these sites were analyzed.

Columbia University Master Plan – New York, NY
Ms. Miranda provided support for the Columbia University Master Planning process for the Manhattanville campus, a 17-acre area in Harlem. The expansion included an arts complex, research space and residence halls to supplement the

university's main campus in Morningside Heights. The study area had been historically used for commercial, manufacturing and industrial uses over the past 90 years. Ms. Miranda performed a nine-block survey of hazardous materials and prepared a large-scale demolition and remediation cost estimate for the purpose of long term planning.

Corporate Health and Safety Program Manager
Ms. Miranda assisted with implementation of the corporate Health and Safety Program. Ms. Miranda prepared updates to the corporate health and safety plan that included such topics as personnel protective clothing, air monitoring, site control procedures, medical surveillance program, respiratory protection program, hearing conservation, assessment of biological hazards, hazard communications, and emergency response. Ms. Miranda updated medical surveillance and incident record-keeping practices and implemented a right-to-know program. In addition, in her role as an assistant to the corporate health and safety director, Ms. Miranda conducted annual 8-hour health and safety-training classes, prepared site-specific environmental and construction phase health and safety plans, and supervised implementation of health and safety activities during hazardous waste operations.

Ringold Street Site Investigation – Trenton, NJ
Working with the Department of Housing and Development of the City of Trenton and the New Jersey Department of Environmental Protection, Ms. Miranda prepared a Remedial Investigation Work Plan and a Remedial Investigation Report for a 2-acre Brownfield site. Ms. Miranda conducted the site investigation at this former gasoline station to delineate the extent of subsurface contaminants and prepared a limited remedial feasibility study. Remedial actions to address PAHs and heavy metals detected at the site included hot spot removal and capping.

Superfund Technical Assessment and Response Team – Atlanta, GA
Ms. Miranda prepared CERCLA Hazardous Ranking Scoring Strategies, conducted CERCLA Site Investigations and oversaw USEPA Emergency Response and Removals. As a member of the USEPA Hurricane Response Team, Ms. Miranda conducted oversight of emergency operation tasks and participated in helicopter over-flights of hazardous materials storage and treatment facilities following Hurricane Floyd’s landfall in North Carolina.

SPECIALIZED TRAINING

- OSHA 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Training
- OSHA 8-Hour Supervisor HAZWOPER Training
- NYC Mayor’s Office of Environmental Remediation (OER) Turbo-Training, Gold Certified, 2016
- Practical Applications in Hydrogeology, Rutgers University
- USEPA’s All Appropriate Inquiry Rule, National Brownfields Association
- USEPA Region 4 Standard Operating Procedures for Field Sampling

- Hazard Ranking System Training Course

PROFESSIONAL AFFILIATIONS

- 2008-2009 Founding Board Member, 2008-2016 Brownfield Awards Committee Member, New York City Partnership of Brownfield Practitioners http://www.brownfieldnyc.org/

LINDSAY O’HARA, CHMM

EDUCATION

B.A., Environmental Studies, Union College, 2007

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

Certified Hazardous Materials Manager, February 2015

AREAS OF EXPERTISE

Ms. O’Hara possesses ten years of environmental consulting experience, primarily in connection with projects in New York City, encompassing:

- Project Management
- Environmental Site Assessments, Investigations and Audits
- Soil and Groundwater Investigation and Remediation
- Indoor Air Quality Assessments
- Ambient and Community Air Monitoring
- Remedial Activity Oversight and Management
- Hazardous Materials Building Inspections
- Regulatory Compliance

Ms. O’Hara’s experience includes: Project management, comprehensive due diligence investigations and assessments, polychlorinated biphenyls (PCB) soil investigations and remediation, hazardous materials building assessments, remediation oversight, LNAPL remediation systems installation oversight and operation, groundwater monitoring well sampling, monitoring well/product gauging and LNAPL extraction, monitoring well installation oversight, soil sampling, development and implementation of community air monitoring plans (CAMP), and fuel release investigations. Ms. O’Hara serves as a Project Manager based in TRC’s Milford, Connecticut office.

REPRESENTATIVE EXPERIENCE

New York City School Construction Authority

Ms. O’Hara serves as a project manager (Contract Title: Associate Environmental Scientist) performing site assessments in support of new construction and renovations of New York City public schools. Responsibilities include Phase I Environmental Site Assessments, Phase II Environmental Site Investigations, Indoor Air Quality Investigations, and Outdoor Air Assessments. Ms. O’Hara’s responsibilities have included all aspects of preparation of reports and all elements of field investigations, subcontractor supervision, and report preparation associated with completion of due diligence assessments. In this capacity, Ms. O’Hara has been the primary author of over 50 Phase I ESAs for the NYCSCA. Additionally, Ms. O’Hara is the current TRC lead for the Universal Pre-Kindergarten due diligence investigations in the borough of Queens.

Ms. O'Hara also served as Project Manager for tasks relating to investigations and remediation of polychlorinated biphenyl (PCB) contaminated soil at various New York City schools under an Asbestos, Lead, Mold & PCB Environmental Consulting Services Contract. Ms. O'Hara's project management responsibilities include daily communication and project coordination with NYCSCA and their contractors, supervision of field staff, and review of all work products including daily summary reports, laboratory results for excavation activities, Surface Soil Investigation Reports, PCB Soil Remediation Reports, and United States Environmental Protection Agency (EPA) Notification Letters.

The Port Authority of New York and New Jersey - Howland Hook Marine Terminal – Port Ivory Facility – Staten Island, New York

Ms. O'Hara serves as Project Manager for environmental tasks associated with three Voluntary Cleanup Program (VCP) Sites at the Howland Hook Marine Terminal (HHMT) – Port Ivory Facility (VCP Site No. V00615-2 (Site 1), VCP Site No. V00674-2 (Site 2) and VCP Site No. V00675-2 (Site 3)). The approximately 123.75-acre HHMT-Port Ivory Site was formerly owned by Proctor and Gamble (P&G). P&G reclaimed the Site from marshland and improved the Site from 1906 to 1907. As a result of P&G's industrial land use from approximately 1908 to 1990, soil and groundwater were impacted by metals and organic compounds. Ms. O'Hara was responsible for remedial construction oversight during implementation of the Interim Remedial Work Plan for Site 3 which included excavation of petroleum-contaminated soil, the collection of post-excavation soil samples, post-excavation soil sampling, implementation of the CAMP, bi-weekly gauging activities including product removal, Site inspections, and annual landfill inspections. Additionally, Ms. O'Hara assisted the Port Authority's legal department by filing the required deed restrictions for Sites 1 and 2. Ms. O'Hara assumed responsibilities in connection with preparation of several reports for this Site, including the final Site Management Plans for Sites 1 and 2, the Final Engineering Reports for Sites 1 and 2, the Periodic Review Reports for Sites 1 and 2, the Interim Remedial Measure Work Plan and Remedial Action Work Plan for Site 3, Landfill Monitoring Summary Reports, and monthly progress reports.

NYSDEC, State Superfund-Related Projects – New York

Ms. O'Hara assists in the management of site characterizations, remedial investigations, and feasibility studies for sites throughout New York State. Responsibilities include the preparation of work plans, project execution, client interaction, and report preparation.

United States Postal Service – New York

Ms. O'Hara serves as Project Manager for tasks relating to environmental due diligence and indoor air quality investigations for USPS sites throughout New York State. Ms. O'Hara's responsibilities have included management of field staff and report preparation associated with completion of Phase I ESAs and Phase II ESIs.

The Port Authority of New York and New Jersey – Red Hook Container Terminal - Brooklyn, New York
Ms. O’Hara served as Project Manager for closure and removal of four 4,000-gallon underground storage tanks at the Red Hook Container Terminal in Brooklyn. Responsibilities included management of soil and groundwater sampling, contractor oversight, communication with NYSDEC Project Managers, and preparation of a UST Closure Report and a Remedial Action Work Plan to address the residual petroleum impacts to soil and groundwater. Additionally, Ms. O’Hara manages the remediation at this property, which includes the implementation of focused vacuum truck extraction and sulfate injection events, groundwater monitoring and analytical groundwater data management and review.

National Grid – Long Island, New York
Ms. O’Hara served as Senior Project Scientist for tasks relating to comprehensive environmental due diligence investigations for two Power Stations in Long Island, New York. Ms. O’Hara completed Phase I ESAs for an approximately 64-acre active electric generating station (the Port Jefferson Power Station) in Port Jefferson, New York and an approximately 127-acre active electric generating station (the E.F. Barrett Power Station) in the Town of Hempstead, New York. Ms. O’Hara completed the Site inspections at each facility and authored both reports.

Civic Builders – New York City
Ms. O’Hara serves as Project Manager for tasks relating to environmental due diligence, subsurface investigations, remediation design, and construction inspection services for Civic Builders, a developer of new charter schools in New York City. Ms. O’Hara has been responsible for preparation of Phase I ESA reports, Phase II ESI reports, Remedial Action Plans, and Construction Health and Safety Plans for proposed school sites, and has obtained required environmental approvals for charter school construction from the New York City Department of Environmental Protection, New York City Housing Authority, and New York City School Construction Authority. Additionally, Ms. O’Hara has managed environmental design and construction inspection services for new charter school construction.

AIMCO – New York City
Ms. O’Hara serves as Project Manager for an environmental services task order contract with a nationwide investor in multi-family housing. Ms. O’Hara’s responsibilities include management and performance of environmental due diligence investigations, water quality testing, and radon sampling.

Queens West Development – Stage 2 Site - Long Island City, NY
Ms. O’Hara served as project scientist for environmental tasks for the remediation of Operable Units (OUs) 3 and 4 of the Queens West Development – Stage 2 Site (NYSDEC BCP Site Nos. C241095 and C241096) in Long Island City, Queens, NY. The site is an approximately nine-acre parcel which is the location of a former oil

refinery. Prior use of the property resulted in metals and petroleum-related contamination in soil and groundwater, including an approximately one-acre LNAPL plume. Ms. O'Hara was responsible for in-place waste characterization sampling, remedial construction oversight, installation of over 50 soil borings and collection and characterization of soil samples, supervision of the installation of over 50 groundwater monitoring wells, weekly LNAPL vacuum extraction oversight, monitoring well development, groundwater sampling, implementation of the CAMP, oversight of utility clearance utilizing ground penetrating radar (GPR), and all related reporting. Ms. O'Hara assumed project scientist responsibilities in connection with preparation of several reports for this Site, including the In-Situ Chemical Oxidation Pilot Test Report, a Post-Remediation Sampling Report, the Final Engineering Reports for OUs 3 and 4, and a Remedial Action Work Plan amendment.

Consolidated Edison Company of New York, Inc., Newtown Substation - Long Island City, NY
In support of the development by Consolidated Edison of the Newtown Substation site in New York, Ms. O'Hara collected and characterized soil samples for delineation purposes and in-situ waste characterization profiling to support a "load and go" scenario for future soil excavation and off-site transportation and disposal. Following the field work and in accordance with the regulatory agency-approved Remedial Action Work Plan (RAWP), Ms. O'Hara provided contractor oversight of three chemical oxidation injection events each consisting of 81 injection locations on-site to address residual petroleum impacts in the soil and groundwater. In addition, Ms. O'Hara performed low-flow groundwater sampling and managed the CAMP, monitoring well decommissioning, soil excavation activities, and construction of the groundwater remediation system. Following the implementation of the RAWP, Ms. O'Hara prepared the Final Engineering Report.

Consolidated Edison Company of New York Inc., Rainey Substation - Long Island City, NY
Ms. O'Hara provided environmental consulting services consisting of remediation oversight of excavation, post-excavation soil and groundwater sampling, and well pumping and gauging. Additionally, Ms. O'Hara coordinated subcontractor agreements for analytical testing. Upon completion of post-excavation sampling events and Site restoration, Ms. O'Hara prepared the Remedial Action Report.

Consolidated Edison Various Spill Sites - Queens, Manhattan, Staten Island, Westchester County, NY
Ms. O'Hara provided various environmental services to the Consolidated Edison Transmission Operations Department in support of spill investigations. Ms. O'Hara performed soil and groundwater sampling and report preparation in support of spill closure activities.

Consolidated Edison Hudson Avenue Generating Station - Brooklyn, NY
Ms. O'Hara served as project scientist for the preparation and implementation of a hazardous material inventory assessment. In the field, Ms. O'Hara recorded the description, location, and condition of regulated and hazardous building materials in support of proposed demolition. In addition, Ms. O'Hara collected samples of potentially hazardous materials, including paint chips, window caulking, liquid chemicals, solid chemicals, and dusts/residues, for laboratory analysis.

SPECIALIZED TRAINING

- OSHA 40-Hour HAZWOPER Training and 8-hour Refresher
- OSHA 10-Hour Construction Safety Training
- First Aid / CPR Certified

WES LINDEMUTH, CHMM, CSP

EDUCATION

B.S., Environmental Science, Kutztown University, December 2004

PROFESSIONAL REGISTRATION/CERTIFICATIONS

IHMM – Certified Hazardous Materials Manager – CHMM (No. 15661), May 2011
BCSP – Certified Safety Professional – CSP (No. CSP-30429), September 2015
NYSDEC – Erosion and Sediment Control Training (No. 45T-012014-31), January 2014

AREAS OF EXPERTISE

Mr. Lindemuth has experience in the following general areas:

- Project Management
- Environmental Assessment and Audit
- Remedial Investigation
- Remedial Construction Inspection and Management
- Underground Storage Tank Investigation and Management
- Environmental Health and Safety
- Hazardous Materials Building Inspections
- Indoor Air Quality Investigations
- Vapor Intrusion Assessments

Mr. Wes Lindemuth serves as a Senior Project Manager based in TRC's New York City office and has over 11 years of environmental consulting experience. Mr. Lindemuth has assumed progressively increasing responsibilities in environmental consulting. His experience includes project scoping, budgeting, management, implementation of site assessments and investigations, reporting, health and safety management and close out of large scale environmental projects as well as supervising and directing project staff.

Mr. Lindemuth has performed, reviewed and managed staff in connection with over 500 Phase I Environmental Site Assessments (ESAs) and 40 Phase II Environmental Site Investigations (ESIs) for residential, commercial, industrial, manufacturing and other properties throughout his career.

REPRESENTATIVE EXPERIENCE (Descriptions marked with an asterisk (*) undertaken within past three years)

NYC School Construction Authority – New York, NY (2015 – Present)*

Mr. Lindemuth serves as in-house consultant staff for the IEH Division and provides technical oversight, performs quality control reviews, and assist with coordination and management of the Local Law 12 (LL12) reporting program. Mr. Lindemuth provides oversight and reviews of the reporting documentation provided by several prime environmental consulting firms which are contracted to provide environmental due diligence, remedial design and remedial construction phase services to the SCA. Mr. Lindemuth is responsible for review of LL12 reporting checklists, contextualized summaries and review of associated Phase I Environmental Site Assessments reports, Phase II Environmental Site Investigation reports, indoor air quality survey reports, remedial investigation reports, construction inspection reports, water disinfection reports, and evaluations of excavated material disposal plans for consistency with LL12 reporting checklists and contextualized summaries. Mr. Lindemuth is also responsible for the submission of notifications of “exceedances” of applicable regulatory criteria to the New York City Department of Education.

NYC School Construction Authority – New York, NY (2006 – 2012)
Mr. Lindemuth served as a Project Manager (Contract Title: Junior Environmental Scientist) providing consulting services in connection with proposed new construction, alteration, and leased sites to assess the suitability of the sites for use as public school facilities. Responsibilities included management of 25 Phase I ESAs, 15 Phase II ESIs, five Vapor Intrusion and Indoor Air Quality Investigations, four PCB remediation projects, three underground storage tank (UST) closures, four petroleum spill investigations, four Product Safety reviews, review of two excavated material disposal plans (EMDPs), preparation of state pollutant discharge elimination system (SPDES) permit applications, Long Island well permit applications, a chemical bulk storage tank closure plan, and assisted with obtaining New York City (NYC) Department of Environmental Protection (DEP) sewer use permits. Responsibilities included all aspects of scope of work and cost estimate preparation, client consultation, staff supervision, subcontractor supervision and work plan implementation, emergency response, and report writing including development of conclusions and recommendations.

ProSource Technologies LLC – NYS Smart Home Buyout Program*
Mr. Lindemuth served as a Project Manager providing consulting services in connection with pre-acquisition due diligence for Hurricane Sandy-impacted residential and commercial properties located throughout New York. Responsibilities included the management of the completion of nearly 400 Phase I ESAs, 1,045 Tier II Forms, 12 Phase II ESIs and implementation of Stormwater Pollution Prevention Plan (SWPPP) inspections. Responsibilities also included all aspects of scope of work and cost estimate preparation, attending client meetings, staff supervision, subcontractor supervision, work plan implementation, and report preparation.

The City of New York Department of Parks and Recreation – New York City*
Mr. Lindemuth serves as a Senior Project Manager providing consulting services in connection with the construction and reconstruction of park buildings and facilities in New York City. Responsibilities include investigation, remediation and reconstruction of several ballfields under the direction of the USEPA located within the 57-acre Red Hook Recreation Area. Responsibilities include all aspects of scope of work and cost estimate

preparation, client consultation, staff supervision, subcontractor supervision and work plan preparation and implementation, and report writing including development of conclusions and recommendations.

Brookfield Office Properties – Manhattan West, New York, NY*
Mr. Lindemuth served as a Project Manager responsible for managing the performance of environmental services in connection with the construction of a 69-story commercial tower at the Manhattan West redevelopment project enrolled in the New York City Office of Environmental Remediation (OER) Voluntary Cleanup Program (VCP). Services included interface with the OER and coordination from enrollment through completion of the VCP, performance of a soil vapor investigation, preparation of a Hazardous Materials Remedial Action Work Plan (RAWP), a Noise Remedial Action Plan (RAP) and an Air Quality RAP required as part of the VCP. Environmental services also included remediation oversight in connection with soil characterization sampling and excavation and off-site disposal of historic fill and hazardous waste. In addition, responsibilities included the management of a third party monitoring consultant in connection with lead abatement activities of the Dyer Avenue Bridge including interface with Port Authority and review of the abatement contractor lead compliance program and health and safety plan (HASP). The Site received a Notice to Proceed from OER in May 2015.

Vornado Realty Trust – New York City*
Mr. Lindemuth served as Project Manager responsible for the continuous performance of due diligence and environmental investigation services associated with acquisition, financial lending and redevelopment of over 25 properties located in NYC. Responsible for managing the performance of property inspections, remediation cost estimates, Phase I ESAs, Phase II ESIs and coordination with NYC OER in connection with Site redevelopment including Site investigations, preparation of Remedial Action Work Plans, and Remedial Action Reports.

Two Trees Management Company – 60 Water Street, Brooklyn, NY*
Mr. Lindemuth served as a Project Manager responsible for the implementation of a Remedial Action Work Plan in connection with the redevelopment of the 46,000-squarefoot NYC OER VCP site. Responsibilities included staff supervision during the oversight of the excavation and off-site disposal of approximately 33,000-cubic yards of historic fill and soil from the site, daily reporting to the NYC OER, collection of post-excavation endpoint soil samples, oversight of the removal of underground storage tanks, performance of inspections in connection with the installation of a passive sub-slab venting system, and preparation of a Remedial Action Report. The site received a notice of satisfaction from OER in December 2014.

Two Trees Management Company – Domino Sugar Project, Brooklyn, NY* Mr. Lindemuth served as a Project Manager providing consulting services in connection with the large scale, mixed-use development project to redevelop the 11.1 acre plot of land the former Domino Sugar Refinery currently resides on. Responsibilities included managing the development of several construction measure plans including dust control, noise control, soil erosion and sediment control, pest management, and air emission reduction measures. Responsible for implementing a groundwater monitoring program to comply with the NYSDEC regulations in connection with two 250,000-gallon No. 6 fuel oil underground storage tanks. In addition, managed and supervised staff during the performance of weekly inspections and submission of a monthly compliance report to the NYC Department of City Planning.

SL Green Realty Corporation – Due Diligence - New York City*

Mr. Lindemuth served as a Project Manager responsible for the performance of due diligence and environmental investigation services associated with acquisition, financial lending and redevelopment of over 25 properties located in NYC. Services provided include performance of property inspections, remediation cost estimates, Phase I ESAs, Phase II ESIs and one property enrolled in the New York State Brownfield Cleanup Program.

BCRE – New York City*

Mr. Lindemuth served as Project Manager responsible for managing the performance of OER related services associated with the redevelopment of two properties in NYC. Responsibilities included all aspects of the required coordination with OER including staff supervision during the preparation of Notices of No Objection, Site Investigation Work Plans, performance of Site Investigations, preparation of Site Investigation Reports and Remedial Action Work Plans.

Artimus - 310 West 118th Street, Harlem, NY*

Mr. Lindemuth served as a Project Manager responsible for closure of a NYSDEC spill case and satisfaction of the OER reporting in connection with the redevelopment of an EDesignation site which involved the removal of two underground storage tanks, excavation and off-site disposal of petroleum contaminated soil and historic fill, inspection of the installation of a vapor barrier, and preparation and approval of a OER Remedial Closure Report.

HINES – 1 Vanderbilt, New York, NY*

Mr. Lindemuth served as a Project Manager responsible for managing the performance of environmental services associated with the demolition of four buildings located adjacent to and west of Grand Central Station to allow construction of a 64-story commercial building. Responsibilities included supervising staff during the performance of a Site Investigation and associated reporting to the NYC DEP and OER.

Gardiner and Theobald – Brooklyn Botanical Garden, Brooklyn, NY*

Mr. Lindemuth served as a Project Manager responsible for providing environmental consulting services in connection with the implementation of enhancements at the Brooklyn Botanical Garden. Responsible for implementation of a soil investigation program and reporting associated with the NYC DEP City Environmental Quality Review

(CEQR) review process. Prepared a Construction Health and Safety Plan for use in connection with construction activities.

Breeze Demolition Inc. – JFK International Airport, Queens, NY*
Mr. Lindemuth served as a Project Manager responsible for managing the preparation of work plans associated with the demolition of Hangers 3, 4 and 5 located at the JFK Airport. Responsibilities included preparation of a Fire Safety Plan, Dewatering Plan and Soil Erosion and Sediment Control Plan for submittal for review and approval by the Port Authority.

New York Families for Autistic Children – Queens, NY
Mr. Lindemuth served as an Associate Project Manager providing environmental consulting services to the New York Families for Autistic Children (NYFAC) in connection with acquisition of a CEQR property located in Queens, New York. Services included the review of prior reports and regulatory correspondence (e.g., conditional negative declaration), performance of an Indoor Air Quality Survey, cleanout of two drywells, and a vapor intrusion survey. Responsibilities included all client coordination, proposal preparation, report preparation, and invoicing.

Spectra Energy – NY/NJ Expansion
Mr. Lindemuth served as an Associate Project Manager in connection with the construction of a natural gas pipeline from New Jersey to New York. The project consisted of the construction of approximately 20.3 miles of multi-diameter pipeline, associated pipeline support facilities, and six new metering and regulating stations. Mr. Lindemuth supervised a team of ten environmental inspectors performing oversight of construction activities including excavation and off-site disposal of non-hazardous and hazardous soil, treatment of groundwater prior to discharge to the ground surface or surface water body, spill reporting and cleanup, stormwater erosion and control inspection, worker health and safety oversight, and compliance with the Federal Energy Regulation Commission (FERC)-approved work plans. Responsibilities included team supervision, team health and safety oversight, review and distribution of daily reports, soil disposal management and tracking, and responding to client requests associated with construction operations.

Turner Construction Company – MSK/CUNY Project, New York, NY*
Mr. Lindemuth served as a Project Manager responsible for providing environmental risk management in connection with the redevelopment of a former department of sanitation property into a Memorial Sloan Kettering Cancer Center and City University of New York Campus. Responsibilities included subcontractor submittal review, staff supervision during soil and bedrock excavation oversight, manifest and hauler tracking, UST removal oversight, air and noise monitoring, and health and safety oversight.

AIMCO, West Harlem Portfolio – Manhattan, NY
Mr. Lindemuth served as a Senior Project Scientist responsible for performing preacquisition due diligence surveys for 95 apartment buildings located throughout the

Harlem neighborhood in Manhattan, New York for AIMCO, a real estate investment trust company. Responsibilities included preparation of Phase I ESA reports for each property as well as radon sampling and implementing several Phase II ESIs. Performed construction oversight for remediation projects including oversight of the removal of an underground storage tank system and oversight of in-situ chemical oxidation for groundwater remediation for AIMCO.

GDF SUEZ, Astoria Energy Power Plant – Queens, NY

Mr. Lindemuth served as an Article X Environmental Inspector working on behalf of Suez Energy (owner) in connection with the construction phase of a state-of-the-art Power Generating Facility in Astoria, NY. Article X Environmental Inspector responsibilities included verifying all construction activities and environmental measures were performed in compliance with the certificate conditions, as well as all federal, state and local statutes, ordinances, rules and regulations. Responsibilities also included client coordination, oversight of hazardous and non-hazardous waste tracking and disposal, SWPPP inspection, and health and safety compliance.

Queens West Development Corporation – Queens, NY

Mr. Lindemuth served as the Site Construction Manager in connection with the remediation of a nine acre designated Brownfield (NYSDEC BCP Site Nos. C241095 and C241096) site in Long Island City, Queens, NY. Supervised a team of four environmental professionals during the excavation of approximately 100,000 tons of soil under negative pressure enclosures (tents), removal of Light Non Aqueous Phase Liquid (LNAPL) via high vacuum extraction and implementation of an in-situ chemical oxidation pilot test using direct injection methods and a five foot diameter soil mixing/injection tool, postexcavation (end point) soil sampling, post-remediation groundwater well construction and sampling and soil vapor sampling. Supervised supplemental remediation activities including excavation of approximately 10,000 cubic yards of “grossly contaminated” soil below a lower permeability “peat” layer and the water table. Responsibilities included staff supervision and management of daily reporting to NYSDEC Region 2, oversight of excavation, dewatering, management of separate phase product, off-site transportation and disposal of excavated material, post-excavation sampling, procurement of clean soil backfill, backfilling of excavations and implementation of the site SWPPP, community air monitoring program, and health and safety oversight. A certificate of completion was issued by NYSDEC in December 2010.

DHL Express USA – Due Diligence, Texas*

Mr. Lindemuth served as a Project Manager in connection with the performance of due diligence activities associated with the evaluation of several commercial properties located in Texas. Responsibilities included managing and supervising staff during the performance of Phase I ESAs and preparation of recommendations in connection with potential environmental risk.

NYC Economic Development Corporation – New York City

Mr. Lindemuth served as an Assistant Project Manager in connection with seven Phase I ESAs, four Phase II ESIs, one hazardous material building inspection, an UST closure and two in-situ soil characterizations. Responsibilities included all aspects of preparation of Phase I ESA reports, all elements of Phase II ESI field investigations, confined space entry associated with the inspection of an underground storage tank vault, and preparation of two winning proposals for in-situ soil characterization. Additionally, responsible for the field inspection services in connection with the initial preparation of the Bush Terminal Landfill for development into a park. Responsibilities included inspection of dynamic compaction activities on the landfill, storm water management, soil gas sampling, and installation of groundwater monitoring well network.

National Grid, Rockaway Park Former Manufactured Gas Plant (MGP) Site, – Queens, NY

Mr. Lindemuth periodically served as the Site Health and Safety Manager in connection with the remediation of the 9.8-acre National Grid Rockaway Park Former Manufactured Gas Plant (MGP) Site located in Queens, NY. The remedial activities performed included the excavation of over 150,000 tons of contaminated soil under negative pressure enclosures (tents) for off-site disposal. Responsible for providing daily health and safety briefings (tool box talks), performing real time air monitoring in the exclusion zone, implementing the necessary personal protective equipment (PPE) level, performing daily and weekly Health and Safety Inspections, and ensuring all site workers were in full compliance with the approved Site Specific HASP.

Stewart EFI – Yonkers, NY

Mr. Lindemuth served as a Senior Project Scientist and field team leader in connection with the Site Investigation, Remedial Investigation and Remedial Alternative Analysis of NYSDEC VCP Site No. V00691-3 located in Yonkers, New York. The Site consisted of over four acres developed with two parking lots, a residential structure, and a 200,000 square foot industrial building formerly utilized for metal parts manufacturing from 1942 until 2008, when manufacturing operations ceased. Field team leader responsibilities included staff supervision and management of mapping of on-site floor drains and piping, oversight of a geophysical survey, and implementation of a soil and groundwater investigation program. Responsible for report preparation including formulating conclusions and recommendations, subcontractor coordination, laboratory analytical results review and comparison to applicable regulatory criteria, and coordination with the client and NYSDEC. TRC's client received a release and covenant not to sue letter from the NYSDEC in October 2011.

Con Edison Inc. – New York City, NY

Mr. Lindemuth served as a Senior Project Scientist for several subsurface investigations and hazardous materials building inspections at Consolidated Edison properties in New York. Served as a Project Scientist in connection with six hazardous material building inspections and two Phase II ESIs for Consolidated Edison properties. Responsibilities included implementation of Phase II ESI field programs and inspections of former substations to identify hazardous materials and characterize building materials prior to planned demolitions.

Pennsylvania Department of Environmental Protection, Wilkes-Barre, Harrisburg, Williamsport, PA – Engineering, Scientific & Technical Intern **SPECIALIZED TRAINING**

- 4-Hour NYSDEC Erosion and Sediment Control Training, January 2014
- 8-Hour OSHA HAZWOPER Supervisor, August 2015
- 8-Hour OSHA HAZWOPER Refresher, March 2016
- 10-Hour OSHA Construction Safety Training, August 2015
- 30-Hour OSHA Construction Safety Training, September 2010
- 40-Hour OSHA HAZWOPER, August 2004
- Transportation Worker Identification Credential (TWIC)
- Secure Worker Access Credential (SWAC)

DANIEL A. SCHMIDT, PE, LEED BD+C

EDUCATION

MBA, Business Administration, University of Delaware, 2008
B.S., Environmental Engineering, University of Delaware, 2006

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

Professional Engineer, New York, 2014
Leadership in Energy and Environmental Design (LEED) Accredited Professional Building Design + Construction
NYSDEC – Erosion and Sediment Control Training (SWT #: 0045T)

AREAS OF EXPERTISE

Mr. Schmidt has experience in the following general areas:

- Remedial Design
- Remediation Construction Inspection
- Vapor Intrusion Mitigation System Design
- Groundwater and Soil Remediation
- Underground Storage Tank Testing, Removal and Closure
- Aboveground and Underground Storage Tank Design
- Environmental Site Assessment
- Indoor Air Quality Investigations

Mr. Schmidt is based in TRC's NYC office and has 8 years of environmental consulting experience and has assumed progressively increasing responsibility in environmental engineering.

REPRESENTATIVE EXPERIENCE

New York City School Construction Authority (NYCSCA)

Under consecutive on-call environmental consulting/hazardous materials services contract with the New York City School Construction Authority (NYCSCA), Mr. Schmidt has served as project engineer for the design and construction of vapor intrusion mitigation systems for numerous New York City public schools. In connection with construction, Mr. Schmidt's responsibilities have included submittal review and performing inspections at critical milestones including: completion of construction of gas permeable aggregate layer, completion of construction of sub-slab depressurization pits and piping, pressure testing of piping, and completion of construction of suction fans and instrumentation. As a construction inspector, Mr. Schmidt has also been responsible for preparing inspection reports and performing sub-slab pressure field testing to verify performance of SSDSs. Mr. Schmidt has also served as an environmental engineer for the design of vapor intrusion mitigation systems for existing school construction. Specific tasks included specification writing, drawing preparation and coordination with the project architects and engineers. Additionally, Mr. Schmidt has performed numerous site assessments, indoor air quality surveys, and site investigations in connection with proposed new construction, alteration, addition and leasing of New York City Schools. Responsibilities have also included management of subsurface investigations, indoor air quality sampling, and outdoor air assessments. Also under Mr. Schmidt has served as project engineer for remediation projects. Specifically, Mr. Schmidt has prepared specifications for removal of underground storage tanks and contaminated soil and performed inspections during excavation of hazardous and petroleum contaminated soil and underground storage tank removals.

Port Authority of NY & NJ: Bulk Fuel Farm and Satellite Fuel Farm Remediation Systems, JFK Airport, Queens, NY

Mr. Schmidt served as a project engineer for engineering and design services in support of upgrades of two dual phase extraction systems at JFK Airport. Mr. Schmidt was responsible for specifying pumps, piping, bag filters, a vacuum blower, air stripper, liquid vapor separator, oil water separator, and process instrumentation; an engineer’s cost estimates; and preparation of bid documents.

Public Schools and Buildings Fuel Tank Systems Removal and Replacements, Danbury, Connecticut

Mr. Schmidt prepared detailed drawings and specifications for public bidding for removal of petroleum storage tanks, piping, and associated fuel system components in connection with replacement of heating fuel storage systems at two City Schools and the Municipal Airport. Mr. Schmidt also served as the project engineer for design of the new aboveground storage tank fuel oil systems at the two City schools and Airport. The drawings and specifications contained detailed requirements for excavation and removal of fueling system components and petroleum contaminated soil and groundwater. In addition, Mr. Schmidt prepared an application for the building department permit and an application for approval for work in a flood zone and adjacent to watercourses. Mr. Schmidt also prepared a detailed engineering cost estimate for the work and provided engineering services during construction.

Engineering and Consulting Services for Abatement, Decommissioning, and Demolition: E.F. Barrett Power Station, Island Park, NY and Port Jefferson Power Station, Port Jefferson, NY

Mr. Schmidt served as the project engineer for engineering and consulting services in support of abatement, decommissioning, demolition and remediation of the E.F. Barrett Power Station located in the Village of Island Park, Nassau County, New York and the Port Jefferson Power Station located in the Village of Port Jefferson, Suffolk County, New York. Mr. Schmidt assisted in providing National Grid the following services: topographic surveys; asbestos and regulated materials surveys; structural evaluations; Phase I Environmental Site Assessments; drawings and specifications for abatement, decommissioning and demolition; engineer's cost estimates and schedules; and preparation of bid documents.

Former Clean Zone Dry Cleaners – NYSDEC Site No. 3-60-050 – Yonkers, NY
Mr. Schmidt served as the project engineer for the vapor intrusion mitigation design for an existing and occupied former dry cleaners in Yonkers, NY. Work included design of improvements to an existing sub-slab depressurization system (SSDS) and overseeing construction of the SSDS improvements. For this work, Mr. Schmidt corresponded and coordinated with the client, the landowner, and the tenants. Mr. Schmidt worked closely with the landowner's consultant to develop a remedial design that satisfied the requirements for the site and NYSDEC.

Golden Horseshoe Shopping Center, Scarsdale, NY
Mr. Schmidt served as project engineer for maintenance, annual inspections and assessments of the existing SSDS system. Mr. Schmidt's responsibilities, included performing sub-slab pressure field testing to verify performance of SSDSs, preparing and implementing a work plan to terminate SSDS operations, performing annual inspections of the SSDS, and preparing summary reports for submittal to the NYSDEC.

Stewart EFI Facility - VCP Site No. V00691, Yonkers, NY
Mr. Schmidt served as project engineer for design and construction phase services for the SSDS at a former 100,000-square foot metal stamping and electroplating facility in Yonkers, New York. Mr. Schmidt's responsibilities included oversight of a pilot test, conducting site inspections during construction of the full-scale SSDS, pressure field testing during startup of the SSDS, and conducting indoor air sampling to demonstrate improved indoor air quality as a result of the active SSDS. Mr. Schmidt was also responsible for preparation of final as-built drawings for submittal to NYSDEC. Mr. Schmidt also performed annual inspections of the SSDS system and prepared summary reports for submittal to the NYSDEC.

Berean Apartments and Community Facility, Brooklyn, NY
Mr. Schmidt served as project engineer for design and construction phase services for the SSDS at a 19,000-square foot apartment building in Brooklyn, New York. Mr. Schmidt's responsibilities included preparing detailed drawings and specifications for the SSDS, oversight of a pilot test, conducting site inspections during construction of the full-scale SSDS, and pressure field testing during startup of the SSDS. Mr. Schmidt was also responsible for preparation of the Remedial Closure Report for submittal to the New York City Department of Environmental Protection (NYCDEP).

Fire Department Headquarters, Airport and City Hall Fuel Tank Systems Removal and Replacements, Danbury, Connecticut

Mr. Schmidt prepared detailed drawings and specifications for public bidding for removal of petroleum storage tanks, piping, dispensers and associated fuel system components and petroleum contaminated soil and groundwater in connection with replacement of vehicle fueling systems at the Fire Department Headquarters and Municipal Airport and replacement of a diesel fuel storage system for an emergency generator at City Hall. Mr. Schmidt also served as the project engineer for design of the new vehicle fueling facilities at Fire Department Headquarters and Airport, and the new UST and piping at City Hall. The drawings and specifications contained detailed requirements for excavation and removal of fueling system components and petroleum contaminated soil and groundwater. In addition, Mr. Schmidt prepared an application for the building department permit and applications for approvals for work in flood zones and adjacent to watercourses. Mr. Schmidt also prepared a detailed engineering cost estimate for the work and provided engineering services during construction.

Public Buildings, Danbury, Connecticut

Mr. Schmidt performed initial compliance inspections and prepared separate Spill Prevention, Control and Countermeasure (SPCC) Plans for the City's Police Department Headquarters, Fire Engine Co. No. 26, Ellsworth Avenue School, and Beaver Brook Pumping Station in accordance with the requirements of the federal regulations. Mr. Schmidt identified deficiencies that needed to be addressed in order to comply with USEPA Oil Pollution Prevention Regulations. Mr. Schmidt performed follow-up inspections of the facilities to confirm deficiencies had been addressed and corrected.

Avis Budget Group, Inc., New York, NY

Mr. Schmidt served as a project engineer for underground storage tank and petroleum spill case closures in New York City. His responsibilities have included site investigation, oversight of tank closures and removals, and closure report preparation.

ExxonMobil Bayonne Terminal, Bayonne, NJ

Mr. Schmidt served as project engineer in the design of a fuel oil remediation system demolition and replacement. Responsibilities included analyzing the existing remediation system in order to improve the fuel oil recovery rate, specifying pipeline materials and preparing a cost estimate.

AIMCO Fuel Tank Systems Removal & Replacements, Baltimore and Westminster, Maryland

Mr. Schmidt served as project engineer for design phase services, including environmental and civil engineering design services for removal and replacement of tanks and equipment at two AIMCO-owned properties. Mr. Schmidt's responsibilities also included oversight of the removal of underground storage tanks and installation of new underground diesel storage tank systems.

Barclays Capital, Inc., New York, NY

Mr. Schmidt served as a project engineer for the initial compliance inspections of two office buildings located in New York City and prepared SPCC Plans. Deficiencies in the current facilities that needed to be addressed in order to comply with USEPA Oil Pollution Prevention Regulations were identified by Mr. Schmidt. Mr. Schmidt completed NYSDEC Petroleum Bulk Storage Tank applications and performed follow-up inspections of the properties to confirm deficiencies had been addressed and corrected.

Columbia University, New York, NY

Mr. Schmidt provided oversight for cleaning and closure of two (2) 10,000-gallon underground storage tanks (USTs) at Columbia University. The USTs were closed in place under Mr. Schmidt's supervision, as part of a fuel oil storage facility conversion project.

Ferry Point Park, Bronx, NY

Mr. Schmidt served as a project engineer for design of the environmental controls for conversion of the closed Ferry Point Park landfill in the Bronx into a golf course and community park. Mr. Schmidt's responsibilities included serving as project engineer for design of the landfill gas extraction well and piping network for the 200+ acre site.

ExxonMobil Bayway Refinery, Linden, NJ

In connection with design of a hydraulic control system for the sludge lagoon operable unit at the ExxonMobil Bayway refinery in Linden, NJ, Mr. Schmidt was responsible for preparing profiles for thousands of feet of groundwater extraction system piping. Mr. Schmidt evaluated bend radii for the HDPE piping, and using AutoCAD prepared drawings for piping below the frost line, at appropriate and uniform slopes and shallow enough to facilitate trenching for installation.

SPECIALIZED TRAINING

- 40-Hour OSHA Health and Safety Training
- 8-Hour OSHA Health and Safety Refresher
- 10-Hour OSHA Construction Safety Training
- DOT HazMat Transporter Training

- 8-Hour OSHA Supervisor Training
- 30-Hour Construction Safety Training
- Asbestos Awareness Health and Safety Training
- First Aid/CPR Certification

SANJAY SHARMA, CPG

EDUCATION

M.S., Environmental & Waste Management, SUNY, Stony Brook, NY, USA, 2005

M.S., Material Science and Engineering, SUNY, Stony Brook, NY, USA, 2005

M.S., Mineral Exploration, Indian School of Mines, India, 1977

M.S., Geology, University of Jabalpur, India, 1976

B.S., Geology, University of Jabalpur, India, 1974

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

- Certified Professional Geologist (AIPG – CPG # 10982)
- Professional Geologist (State of Alaska - P.G. License No. 565)

AREAS OF EXPERTISE

- Reviewed construction submittals;
- Performed site assessments utilizing Geoprobe, Air Rotary, Hollow-Stem Auger, and Mud Rotary, Sonic drilling techniques;
- Performed multimedia sampling including vapor intrusion assessments;
- Performed groundwater investigations including installation and development of monitoring wells;
- Performed quarterly groundwater and landfill gas sampling for various landfill sites;
- Performed environmental inspections, Phase II ESIs, UST closures, and emergency response;
- Scheduled and coordinated field activities; and
- Provided field training to new team members.

REPRESENTATIVE EXPERIENCE

Mr. Sharma is a Certified Professional Geologist (CPG) with the American Institute of Professional Geologists and a registered Professional Geologist (PG) in the state of Alaska. Mr. Sharma has more than 7 years of professional experience as a geologist in the environmental consulting field and more than two decades of diverse professional experience as an exploration geologist.

Mr. Sharma has been a “key team member” for several consecutive environmental consulting contracts with the New York School Construction Authority (NYCSCA) and the New York State Department of Environmental Conservation (NYSDEC). Mr. Sharma’s environmental consulting work has primarily focused on the assessment and remediation of contaminated soil, soil vapor, and groundwater. In addition, he has performed environmental inspection services at numerous construction sites. His responsibilities and work experience have also included: Phase I Environmental Site Assessments (Phase I ESAs); Phase II Environmental Site Investigations (ESIs); underground storage tank (UST) closures; multimedia environmental compliance; vapor intrusion assessments; low-flow groundwater sampling; implementation of remedial action work plans; sub slab depressurization system (SSDS) inspections; implementation of projects under the New York State Brownfield Cleanup Program; and remediation system installations and decommissioning. Mr. Sharma’s work has also included proposals, report writing, review of project submittals, health & safety coordination, employee training, and client and regulatory interaction.

Mr. Sharma is also an experienced exploration geologist with over 22 years of experience with the Department of Atomic Energy (DAE), India. In DAE his responsibilities ranged from conducting the exploratory drilling programs (Deepest boring with diamond core drilling of 1175 meters) for uranium exploration, radioactive waste management programs, geotechnical investigations for mine development, and environmental surveys.

RELEVANT EXPERIENCE

New York City School Construction Authority (SCA) Projects

- Performed oversight during ongoing remediation work at Brownfield Cleanup Program sites;
- Performed investigation and remediation oversight at a Manufacturing Gas Plant (MGP) site;
- Performed Phase II ESIs, tank closures, and emergency response at NYCSCA construction sites and active schools;
- Performed oversight of hydraulic lift closures;
- Performed inspection services during contaminated soil excavation and loading in accordance with Excavated Material Disposal Plans (EMDPs);

- Prepared and executed ORC injection Plan; Performed inspection services during SSDS installations;
- Implemented Community Air Monitoring Programs during remediation activities;
- Performed oversight during the installation of an air sparge and soil vapor extraction system at a chlorinated solvent contaminated site;
- Tabulation and correlation of laboratory data relative to New York State regulatory criteria and guidance values; and
- Performed groundwater permeability and step-draw down tests, groundwater flow direction calculations, and studies on groundwater tidal fluctuations by setting up “Level Troll 700” devices and utilizing “Win-Situ 5.4.2.5” software.

Class 2 Inactive Hazardous Waste Site- Bulova Corporation, Sag Harbor, NY:

Performed subsurface investigations including soil, groundwater, and vapor sampling for the delineation of subsurface chlorinated solvents at the site.

Voluntary Cleanup Program Site- Bulova Corporation, Jackson Heights, NY:

Performed remedial investigation to assess the extent of chlorinated impacts to soil, soil gas, and groundwater at the site. Investigations also included vapor intrusion studies at on-site and off-site buildings. Performed “Acid Treatment” of injection and extraction wells for a bio-stimulation injection/recirculation system.

The Port Authority of New York & New Jersey - JFK Airport

- Prepared Soil Management Plan;
- Performed multimedia sampling; and
- Performed inspection services during ongoing remediation work.

Consolidated Edison Company of New York, Inc. (Con Edison)

- Prepared site specific Health & Safety Plans and project specifications;
- Performed UST investigations;
- Performed assessment of ongoing remediation systems, plume delineations, and performed groundwater investigations by installation and developing the monitoring wells;
- Synthesized, tabulated and interpreted laboratory data obtained from the groundwater sampling at 17 sites in New York City and Westchester County; and

- Writing of quarterly groundwater monitoring and gauging reports for submission to the NYSDEC.

SPECIALIZED TRAINING

- OSHA 8 Hour HAZWOPER Refresher, 2012
- OSHA 10 Hour Construction Safety and Health, 2012
- Confined Space Supervisor Training, 2007
- OSHA 8-Hour HAZWOPER Supervisor Training, 2006
- OSHA 40-Hour HAZWOPER Training, 2005

PROFESSIONAL AFFILICATIONS

- Geological Society of London - Fellow
- Geological Society of India - Life Fellow
- Geological Society of America - Member

ELIZABETH A. DENLY

EDUCATION

B.A., Chemistry, University of New Hampshire, 1987

PROFESSIONAL REGISTRATIONS /CERTIFICATIONS

Licensed Site Professional Association, Massachusetts, Associate Member
American Chemical Society (ACS)
American Society for Quality (ASQ)

AREAS OF EXPERTISE

Ms. Denly has 28 years of experience in:

- Quality Assurance/Quality Control
- Data Validation
- Laboratory Audits
- Gas Chromatography: Field and Laboratory Analyses
- Gas Chromatography/Mass Spectrometry: Field and Laboratory Analyses

Quality Assurance/Quality Control

As a QA chemist at TRC, Ms. Denly is responsible for providing QA/QC oversight in support of a variety of environmental investigations including contaminant ambient air monitoring, human health and ecological risk assessments, riskbased soil cleanups, remediation programs, and delineation. Ms. Denly has provided this oversight under different regulatory programs, including MassDEP, NYSDEC, NJDEP, and USEPA Region I, Region II, Region III, and Region V. In this role, she has been responsible for the preparation of the project-specific QAPP, coordination with the laboratory, selection of the appropriate analytical methodologies to achieve the desired state or regulatory standards, oversight and performance of the data validation process, and determination of the usability of the data in comparison to the overall project objectives.

In addition, Ms. Denly serves as TRC's Remediation and Building Science Practices Quality Assurance & Chemistry Systems Manager, responsible for the creation and implementation of the Sector's Quality Management Plan and Standard Operating Procedures (SOPs) for field sampling and documentation protocols. Ms. Denly also leads Quality Coordinator networks in the Remediation and Building Science Practices which are responsible for the development and communication of quality initiatives within the organization. Among the quality initiatives that have been implemented or created under Ms. Denly's leadership include the following:

- Procedures for Peer Review of Deliverables

- Tracking of Peer Review Documentation via monthly random audits
- Project Planning Checklist tool
- Analytical Data Review Checklist and Training
- Practice Self-Assessments with follow-up Corrective Actions
- Biweekly Quality Messaging
- Technical Editing Guidelines
- Publication of Quality Lessons Learned reports

Data Validation

Ms. Denly provides oversight and senior review on data validation performed for a variety of analytical parameters. She performs data validation for organic parameters including VOCs, SVOCs, Pesticides, PCB Aroclors, PCB homologues/congeners, Dioxins, specialty analyses including GC/MS/SIM and various air analyses. Validation and reporting guidelines utilized include USEPA National Functional Guidelines, USEPA Regions I through V, and NYSDEC DUSRs. Ms. Denly developed internal protocols for the validation of the MassDEP EPH/VPH methodologies.

With respect to references, serving as an in-house quality control and chemistry expert, Ms. Denly does not have extensive direct client contact.

REPRESENTATIVE EXPERIENCE (Descriptions marked with an asterisk (*) undertaken within past three years) New York City School Construction Authority*

Ms. Denly has provided quality assurance management for a variety of SCA programs, including PCB air monitoring, site investigations, and sub-slab soil vapor and indoor air investigations. In this role, Ms. Denly is responsible for reviewing field team documentation, providing oversight of the analytical laboratory, data validation, and preparation of DUSRs. She is responsible for frequent communication with the laboratories to ensure proper receipt of samples, proper utilization of project-specific analytical protocols in order to achieve necessary project action levels, and to monitor the overall performance of the laboratories.

Brownfields Programs – Various Locations*

Ms. Denly serves as the Project Quality Assurance Manager on TRC's Brownfields programs within USEPA Regions 1 and 3. In this role, she is responsible for maintaining and updating the USEPA-approved generic Brownfields QAPPs. She provides final review of site-specific QAPP addenda prepared for the individual Brownfields sites and assists in the determination of required analytical methodologies necessary to achieve specific project objectives. Ms. Denly is the point of contact for the field team and the laboratory during the investigations for issues related to the ultimate usability of the analytical data. She reviews the chains-of-custody as samples are received by the laboratory to ensure the requirements for sample collection in the sitespecific QAPP addenda are followed and samples are properly logged into the laboratory. Final review of the analytical data is performed by Ms. Denly and a data usability assessment is generated for each investigation.

Vieques Island, Environmental Cleanup Oversight, Vieques, Puerto Rico* Ms. Denly provides technical and regulatory compliance oversight to the Commonwealth of Puerto Rico and the Puerto Rico Environmental Quality Board (EQB) regarding the investigation, assessment, and remediation of contamination on Vieques Island by the U.S. Navy in support of the property's transfer to the Commonwealth of Puerto Rico. Ms. Denly conducts technical and regulatory reviews pertaining to analytical methods and QA/QC issues of the documents prepared by Navy subcontractors including draft and final submissions of work plans, field sampling plans, investigation results, technical memoranda, feasibility studies, and remedial designs.

Massachusetts Department of Environmental Protection – MA*

Ms. Denly is currently providing assistance to MassDEP to determine whether the regulated community is correctly implementing analytical methodologies at MassDEP sites; this includes providing training for all MassDEP auditors. Ms. Denly is also assisting MassDEP in the development of a protocol for the analysis of volatile petroleum hydrocarbons (VPH) by GC/MS. Previously, Ms. Denly has assisted MassDEP in the review/evaluation of data packages for EPH/VPH analyses from laboratories selected by MassDEP as part of a Data Audit project to ensure compliance with the methods and CAM. She provided consultation to MassDEP for revisions to the MassDEP's innovative EPH/VPH analytical methods used to measure petroleum hydrocarbon concentrations in soil and groundwater. Ms. Denly served as a member of the Data Quality Enhancement Work Group led by MassDEP and assisted in the development of a policy for achieving consistency of data reported under the MCP. Ms. Denly was responsible for generating the framework for QC parameters on organic analyses typically utilized under the MCP, method-specific performance standards for these QC parameters, minimum reporting requirements for the laboratories for each method, and a list of what laboratories need to keep on file for potential audits by the MassDEP.

Mattiace Petrochemical Superfund Site – Glen Cove, NY*

Ms. Denly prepared the QAPP for the Long Term Remedial Action under TRC's Exit Strategy® program using USEPA Region II guidance. She provides QA oversight to the field team. Ms. Denly also performs data validation of data generated for demonstration of achievement of cleanup objectives. Ms. Denly is responsible for performing assessment of data to determine overall usability.

USEPA Region I Superfund RAC*

Ms. Denly serves as lead chemist for a variety of Superfund programs under the USEPA Region I Remedial Action Contract (RAC). Her responsibilities have included ongoing development of analytical specifications for laboratories to achieve specific project objectives and development of QAPPs following the requirements of USEPA Region I QAPP guidelines. She performs data validation and/or senior review of data validation for a variety of analytical methodologies utilizing USEPA Region I validation guidelines. Ms. Denly generates data usability assessments and/or split sample comparison reports in accordance with USEPA Region I guidance, when required. She interacts with USEPA Region I chemists in the selection of analytical methodologies and project objectives. Ms. Denly provides QA oversight of PRPs' validation reports, sampling and analysis plans, and QAPPs. She is also responsible for providing QA oversight to field teams, performing daily reviews of COCs and traffic reports, and acting as the main liaison between the field team and USEPA.

FAA, Region II – Atlantic City, NJ

Ms. Denly assisted in the preparation of QA protocols for the Supplemental RI and Ecological Risk Assessment Work Plan. She was also responsible for providing QA support to the field team. Ms. Denly interfaced with laboratories to ensure achievement of risk-based standards and performed data validation and/or oversight for all data generated. Ms. Denly provided oversight for all validation performed on the Remedial Investigation data.

Queens West Development – Stage 2 Site – Long Island City, NY

Ms. Denly prepared the QAPP for the NYSDEC Voluntary Cleanup Program under TRC's Exit Strategy® program. She provided QA oversight to the field team. Ms. Denly performed data validation for the program. She was responsible for performing assessment of data to determine overall usability. Ms. Denly provided daily support to the project team on chemistry, laboratory, and QA issues. She was responsible for ensuring project objectives were achieved by the laboratory and for oversight of laboratory QA issues.

Consolidated Edison First Avenue Properties – New York, NY

Ms. Denly prepared a QAPP for Supplemental Soil Investigation and Voluntary Cleanup of four sites under TRC's Exit Strategy® program. The First Avenue Properties Site is the site of a former Consolidated Edison Power Plant located in midtown Manhattan between East 38th Street and East 40th Street. Ms. Delny provided QA oversight to field team during site remediation. Ms. Denly performed data validation of select data points used for decision-making and was responsible for performing assessment of data to determine overall usability for various Remedial Work Plans.

130 Liberty Street – New York, NY
Ms. Denly developed the QAPP for the extensive ambient air monitoring program and waste management program under USEPA Region II oversight. Ms. Denly provided oversight of six analytical laboratories and was responsible for coordination and performance of data validation for asbestos, metals, dioxins/furans, PAHs, PCBs, and silica ambient air data as well as TCLP and metals waste characterization data. Ms. Denly communicated frequently with the laboratories to ensure proper receipt of samples, proper utilization of projectspecific analytical protocols and to monitor the overall performance of the laboratories. Responsible for the oversight and performance of field and laboratory audits. Reviewed all data prior to web-site posting and submission to USEPA.

PUBLICATIONS AND PRESENTATIONS

Denly, E., "*LOQ, LOD, DL, RL, QL, SQL, MDL, PQL: What the "L"?*" Presented at Thirty-first Annual International Conference on Soils, Sediments, Waters, and Energy, Amherst, MA. 2015.

Denly, E. Chapnick, S., "*Is Presumptive Certainty Generating Usable Data for Massachusetts Contingency Plan (MCP) Decisions?*" Paper presented at Twentieth Annual Conference on Contaminated Soils, Sediments and Waters, Amherst, MA. 2004.

Denly, E., Hoyt, M., Anastas, N., Fitzgerald, J., Hutcheson, M., McGrath, T., "*Massachusetts VPH Method Validation for Indoor Air Samples*". Poster presented at Thirteenth Annual Conference on Contaminated Soils, Amherst, MA. 1998.

Denly, E. Hopper, D., *"Field Chemistry for PAHs and VOCs Applied to a RiskBased Soil Cleanup at a Landfill"*, Paper presented at Fifth International Symposium on Field Analytical Methods for Hazardous Wastes and Toxic Chemicals, Las Vegas, NV. 1997.

Denly, E., Hoyt, M., Camp, W.H., Naughton, G., *"Method Validation Study for Field Screening of Dielectric Fluids in Soils"*, Paper presented at Twelfth Annual Conference on Contaminated Soils, Amherst, MA. 1997.

Denly, E., Wang, H., *"Preparation of Tedlar Bag Whole Air Standards with a SUMMA Canister for Field VOC Analysis"*, Poster presented at Fourth International Symposium on Field Screening Methods for Hazardous Waste and Toxic Chemicals, February 22-24, 1995, Las Vegas, NV.

SPECIALIZED TRAINING

- Data Evaluation for Vapor Intrusion Studies, 9/07

- Sediment Toxicity Testing: Methods to Achieve Strong Data Sets and Interpret Results, 6/07
- Assessing the Vapor Intrusion Pathway at Contaminated Sites, NHDES Waste Management Division, 4/05
- Perchlorate Webinar, USEPA, 2/05
- Improved Project Communication: Within and Outside of the Project Team, ASCE Continuing Education Program, 12/15/04
- Communicating with Tact and Skill for Managers and Supervisors, Rockhurst University Continuing Education Center, 2004
- Training Session for USACE-NAE/USEPA Region I Regional Implementation Manual, 10/7/04
- Training for Non-Trainers, USEPA, 9/04
- Overview of Statistical Data Quality Assessment, USEPA, 9/04
- Assessing Quality Systems, USEPA, 9/04
- Understanding and Evaluating Data Quality Assessments, USEPA, 9/28/04
- PowerPoint 2000 – Level 1, New Horizons Computer Learning Centers, 12/03
- USEPA Forms II Lite Training Course, 9/23/03