34 BERRY STREET

BROOKLYN, NEW YORK

Remedial Investigation Work Plan

BCP Site #: C224268
AKRF Project Number: 11259

Prepared for:

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CERTIFICATION

I, Marc S. Godick, QEP, certify that I am currently a Qualified Environmental Professional as defined in 6 NYCRR Part 375 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).

Marc S. Godick, LEP		July 9, 2018
Name	Signature	Date

FIGURES

APPENDICES

1.0 INTRODUCTION

This Draft Remedial Investigation Work Plan (RIWP) has been prepared by AKRF, Inc. (AKRF) on behalf of 34 Berry Street, LLC (the Volunteer) for the property located at 34 Berry Street in the Williamsburg neighborhood of Brooklyn, New York (Site). The legal definition of the Site is Brooklyn Borough Tax Block 2289, Lot 14. The site is located on the western side of Berry Street, between North 11th and North 12th Streets, and is comprised of a seven-story residential building and courtyard area, with a basement level parking garage. A Site Location Plan is provided as Figure 1.

34 Berry Street, LLC has applied to enter the Brownfield Cleanup Program (BCP) as a Volunteer. The BCP application included a review of existing environmental conditions that was documented by pre-development investigations, a post-development Closure Report prepared to satisfy "E" designation requirements for the site, supplemental on-site and off-site investigations to delineate known contamination, and operation, monitoring, and maintenance (OM&M) of a light non-aqueous phase liquid (LNAPL) recovery system. OM&M reports prepared for NYSDEC review and approval concluded that there is solvent and petroleum-contamination in groundwater, which appears to be related to historic filling, previously existing underground storage tanks (USTs) and/or historical on-site/off-site industrial operations. This RIWP describes the procedures to be used to further define the nature and extent of the contamination in the on-site petroleum release area, identify sub-slab soil gas and indoor air quality within the occupied spaces of the on-site and off-site buildings, and provide soil and groundwater data relative to the solvent source area.

The data compiled from the Remedial Investigation (RI) will be used to develop a Remedial Action Work Plan (RAWP). All work will be completed in accordance with this RIWP, which includes a Quality Assurance Project Plan (QAPP) (Appendix A) and a Health and Safety Plan and Community Air Monitoring Plan (HASP and CAMP) (Appendix B). The Community Air Monitoring Plan (CAMP) detailed in the HASP will be implemented during all subsurface disturbance activities at the Site, including, but not limited to, soil boring advancement, soil sampling, and backfilling of boreholes.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Description and Surrounding Land Use

The project site consists of a 36,472 square foot, irregularly shaped lot. The lot is occupied by an L-shaped, seven-story residential building that fronts Berry and North 12th Streets, with an open courtyard area located behind the building, in the central portion of the site. A basement level parking garage is located under the building and courtyard, with an entrance ramp located on North 11th Street. A small, street-level valet parking lot is also located on North 11th Street, immediately east of the garage entrance ramp. The site is bounded to the north by North 12th Street, to the east by Berry Street, to the south by North 11th Street and two low-rise residential buildings, and to the west by a warehouse building used by the Brooklyn Brewery. The surrounding neighborhood is primarily residential and commercial in nature, containing apartment buildings, businesses and storage warehouses. A Site Plan is provided as Figure 2.

2.2 Site Geology, Hydrogeology, and Subsurface Characteristics

The surface topography in the surrounding area is generally flat, gradually sloping to the northeast in the vicinity of the site, with an area-wide gradual slope to the northwest towards the East River, which is located approximately 1,100 feet to the northwest. Based on reports compiled by the U.S. Geological Survey (Brooklyn, NY Quadrangle), the property lies at an elevation of approximately 20 feet above the National Geodetic Vertical Datum of 1929 (an approximation of mean sea level).

Shallow subsurface soils encountered during previous on-site investigations completed before redevelopment included urban fill material containing brick, asphalt, and concrete fragments to approximately 6 to 10 feet below grade, underlain by apparent native silty sand and silt. Most of the fill was removed during development to construct the current structure. United States Geological Survey reports indicate that the depth to bedrock at the site is expected to be approximately 100 feet below ground surface.

Based on local topography and previous environmental investigations, the dominant groundwater flow direction at the site is to the north and northeast, with some variations to the northwest. Historically, groundwater has been encountered at depths ranging from approximately 5 to 8 feet below the basement garage floor, which corresponds to approximate depths of approximately 11 to 14 feet below street level. Groundwater in Brooklyn is not used as a potable source. There are no surface water bodies or streams on or immediately adjacent to the Site.

2.3 Site History

Based on a Phase I Environmental Site Assessment (ESA) of the subject property conducted by Langan Engineering and Environmental Services (Langan) in June 2006, the site was occupied by the New York Quinine and Chemical Works from circa 1887 to 1951. Review of historic Sanborn maps from this period indicate that this facility contained various buildings associated with the manufacturer and packaging of quinine, including morphine, caffeine, and ether rooms, an extracting house, steam dry rooms, dissolving and extracting rooms, and a bottling, labeling, and packaging plant. The 1905 Sanborn map also depicts two areas of the facility labeled as "coal oil refining". These locations are subsequently labeled as "storage of oil in tanks" in the 1916 and 1942 Sanborn maps. Sanborn maps from 1965 to 2006 (after decommissioning of the quinine factory) depict a large two-story freight loading facility and warehouse in the western portion of the site, a two-story truck repair facility/warehouse and a four-story unspecified manufacturing facility in the southwestern portion of the site, and a parking lot in the eastern

portion of the site containing two gasoline tanks of unspecified capacity. In 2006, at the time of Langan's Phase I ESA, the on-site buildings contained artist loft residences, a furniture manufacturer warehouse, a garage, a forklift sales and service facility, and an empty warehouse; and the eastern parking lot was used for vehicle parking and storage.

All on-site buildings were demolished starting in April 2008, and construction of the existing residential structure started in June 2008. Building construction was completed in early 2009, and the initial temporary certificate of occupancy (TCO) was issued by the NYC Department of Buildings on April 30, 2010, and included approval for occupancy of the cellar level through the 4th floor. A TCO for the cellar level, floors 1 to 7, and the building roof was issued on June 3, 2010 and renewed on September 8, 2010. A final Certificate of Occupancy (CO) was issued in December 2012.

During development, the Site was subject to "E"-designation requirements for hazardous materials as part of the Greenpoint-Williamsburg Rezoning, which included preparation and implementation of a Remedial Action Plan (RAP) to address Soil Management at the Site. A June 2006 Subsurface (Phase II) Investigation Report prepared by Langan concluded that contaminated soil and groundwater are present at the Site. Chlorinated solvent- and petroleum-related volatile organic compounds, polycyclic aromatic hydrocarbons (PAHs), and metals were detected in soil and/or groundwater. Site contamination appeared to be related to historic operations at the Site, placement of urban fil material of unknown origin by prior owners, and the presence of on-site fuel oil storage tanks. The detections revealed evidence of a "spill" requiring reporting to the NYSDEC [Spill No. 07-12424 (the "Spill")].

On March 3, 2010, a Closure Report was prepared and submitted to New York City Mayor's Office of Environmental Remediation (OER) as part of the "E" designation requirements for the Site. Redevelopment of the Site was completed in December 2009, and included the demolition of the existing buildings and the construction of a - seven-story residential building, an open courtyard, and basement level garage. Excavation extended between approximately 10-17 feet below grade throughout the building footprint. The report documented the disposal of 18,676 tons of soil excavated during site redevelopment activities, removal of underground storage tanks, and installation of engineering controls including a vapor barrier, passive sub-slab depressurization system (SSDS), and a site cap. OER issued a Notice of No Objection (NNO) for the Site on April 20, 2010, which indicated that the E-designation requirements had been satisfied. On September 13, 2012, and in accordance with the NNO, a Notice of Satisfaction (NOS) was issued to the Requestor after it entered into a Stipulation Agreement with the NYSDEC regarding appropriate remediation of the open Spill. The Stipulation Agreement specified the required investigations, remediation, and monitoring measures to be implemented with respect to LNAPL that remained in the saturated zone beneath the building slab at the Site in order to achieve case closure with respect to the Spill.

To address the Spill, and under review of NYSDEC, an LNAPL recovery system consisting of four recovery wells was installed at the end of building construction in early 2009. A fifth recovery well was added in April 2012OM&M of the NAPL system and submission of monitoring reports were conducted based upon an agreed upon schedule with NYSDEC. From September 2009 through December 2014, monthly OM&M visits and quarterly groundwater sampling were completed to monitor site conditions and the effectiveness of the NAPL removal system. From January 2014 to the present day, quarterly OM&M visits with semi-annual groundwater sampling were completed. The results of each visit were compiled and reported to NYSDEC for review and approval. The OM&M program documented that the system has been effective in reducing the amount of LNAPL beneath the building. Groundwater sampling

completed as part of site OM&M documented that 1,2-dichloroethane (DCA) was present in groundwater, and the results suggested that the DCA source area was located in the vicinity of the southern (upgradient) property boundary.

In November 2010, AKRF performed an off-site investigation in accordance with an NYSDEC-approved work plan to determine whether potential off-site sources were contributing to petroleum contamination observed at the property. Field evidence of contamination, including slight petroleum-like odors and a visible sheen, was noted below the water table in three soil borings immediately north of the site and one boring located across North 12th Street from the site; with no contamination noted in the other two borings across North 12th Street or in the two borings across Berry Street. Laboratory analytical results for soil were consistent with these field observations, indicating generally higher levels of petroleum-related VOCs in soil samples from borings immediately north of the site, with each detection below NYSDEC Soil Cleanup Objectives (SCOs) that were consistent with site use. LNAPL was not observed in any of the off-site monitoring wells during groundwater sampling activities. Fingerprint analysis of LNAPL samples collected from on-site monitoring wells indicated a product profile consistent with weathered diesel fuel/No. 2 fuel oil, and not an MGP residual which would be associated with the MGP gas holders formerly located on the north side of North 12th Street. These combined field observations and laboratory analytical results indicated that the petroleum-related contamination at the 34 Berry Street site was most likely not originating from an off-site source. .

In April 2013 and July 2016, the Volunteer voluntarily performed additional subsurface investigations to identify the potential DCA source area, provide additional groundwater data associated with the existing chlorinated solvent plume, and to address investigation data gaps for the site. Each phase of additional investigation was completed in accordance with a NYSDEC-approved work plan. The additional investigations did not identify a solvent contamination source area in soil. The groundwater sampling results confirmed that the concentration of petroleum compounds were consistent with previous sampling events, and exceeded the ambient water quality values (AWQVs) in the northeastern portion of the property where the NAPL recovery wells are located. The groundwater results for solvent compounds confirmed that the location of off-site monitoring wells, MW-18 and MW-22, have had concentrations of DCA that were one to two orders of magnitude higher than the remaining concentrations across the site. These results, combined with the established groundwater flow direction, suggested that the DCA source area may be located along the property boundary between 34 Berry and 44 Berry Street, or may originate from the upgradient adjacent 44 Berry Street property.

2.4 Previous Investigations

A CD containing each of the investigation reports described in this section is included as Appendix C.

2.4.1 Phase I ESA, Langan, June 15, 2006

A Phase I ESA of the subject property was conducted in June 2006 by Langan to identify Recognized Environmental Conditions (RECs) that could affect site redevelopment of the site. The ESA identified the following RECs:

- Historic use of the site as a chemical (quinine factory) from at least 1887 to 1951;
- Historic uses of the adjacent and surrounding properties, including an iron foundry, various manufacturing operations, and an MGP;

- On-site equipment repair and maintenance associated with a fork-lift company, including an associated solvent tub, stockpiles of batteries, waste oil drums, and an acetylene tank for welding;
- A 2,000 gallon UST documented in the building located southwest-adjacent to the site; and
- Two vent stacks observed on the sidewalk across North 12th Street from the site.

Based on these findings, Langan recommended a Phase II Environmental Site Investigation to determine whether soil and groundwater at the site were affected by the identified RECs.

2.4.2 Phase II Environmental Site Investigation (ESI), Langan, June 27, 2006

Langan performed a subsurface investigation to determine whether the RECs identified during their Phase I ESA affected subsurface conditions at the Site. The Phase II ESI included advancing six (6) soil borings (five on the project site, and one in the basement of an adjacent building at 111 North 11th Street), and collection of soil and groundwater samples from each boring. In addition, a groundwater sample was collected from an observation well installed during a geotechnical survey conducted by Langan. Soil samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs); groundwater samples were analyzed for VOCs, SVOCs, and metals. Historic fill material was observed in all soil borings to depths of approximately 6 to 10 feet below grade, and petroleum-like odors were observed in three borings advanced in the northern portion of the site, along North 12th Street (EB-1, EB-2, and EB-3) at approximately 6 to 12 feet below grade. SVOCs were detected at concentrations exceeding the Technical and Administrative Guidance Memorandum (TAGM) Recommended Soil Cleanup Objectives (RSCOs) in effect at that time in two of the soil samples collected for laboratory analysis [EB-1b (2-2.5) and EB-3 (1-2)] and metals were detected above TAGM RSCOs in all soil borings. No VOCs or PCBs were detected in any of the soil samples collected. VOCs and SVOCs were detected above NYSDEC Class GA Ambient Water Quality Values (AWQVs) in groundwater samples collected from two of the soil borings (EB-1 and EB-2), and metals were detected above the AWQVs in groundwater samples from all of the soil borings. Based on the findings of the Phase II ESI, Langan concluded that soil and groundwater conditions in the northern portion of the site (generally along North 12th Street) were indicative of petroleum contamination requiring spill reporting to the NYSDEC. Langan indicated that the soil and groundwater results for the remainder of the site were characteristic of a typical urban fill site in New York City.

2.4.3 Environmental Subsurface Investigation Report, Landmark, April 2007

Landmark conducted a "remedial investigation" of the site to further delineate the petroleum contamination identified during Langan's June 2006 Phase I ESA. The investigation consisted of the advancement of 16 soil borings, including a total of 10 borings in the loading dock and factory bay areas of the on-site warehouse building (LDA-1 through LDA-6 and FBA-1 through FBA-4); and 6 borings in the parking lot area (EB-1 through EB-6). One to two grab soil samples were collected from each boring and analyzed for VOCs, SVOCs, and metals; two grab soil samples (from FBA-3 and FBA-4) were analyzed for total petroleum hydrocarbons (TPH) and PCBs; and one

composite and two grab soil samples were analyzed for leachable VOCs, SVOCs, metals, pesticides, and herbicides by the Toxicity Characteristic Leaching Procedure (TCLP). In addition, one groundwater sample (GW-1) was collected from the northwestern portion of the site and analyzed for VOCs and SVOCs.

The VOC 2-butanone was detected in one soil sample (EB-1) at a concentration exceeding the TAGM RSCO; however, the presence of this compound was attributed to laboratory contamination, not on-site conditions. All other VOC concentrations in the soil samples were below their respective TAGM RSCOs. Individual SVOCs were detected at concentrations exceeding their respective TAGM RSCOs in eight of the soil borings. The highest total SVOC concentration [62.9 parts per million (ppm)] was detected at 6 feet below grade in soil boring FBA-3, located in the northwestern portion of the site. Metals were detected at concentrations above their respective TAGM RSCOs in each of the six soil borings advanced within the open parking lot area, while all metals concentrations in soil samples from the loading dock and freight bay areas were below TAGM RSCOs. Gasoline range TPH were detected in the samples collected from borings FBA-3 and FBA-4, at concentrations of 1,460 to 3,080 ppm, respectively; no PCBs were detected in these samples. All contaminant concentrations in the samples analyzed by TCLP were below their respective hazardous waste thresholds. Several SVOCs, including 2-methylnaphthalene, benzo(a)pyrene, fluorene, and phenanthrene, were detected in the groundwater samples at concentrations exceeding their respective AWQVs. VOCs detected in groundwater were below their respective AWQVs.

Landmark concluded that, based on visual observations, PID screening, and laboratory analytical results, petroleum-contaminated soil is present in an approximately 11,350 square foot area in the northern portion of the site, near North 12th Street to depths of approximately 9 feet below grade. Landmark estimated that approximately 3,800 cubic yards of contaminated soil would need to be excavated from this area to remediate the site. In addition, Landmark recommended that any historic fill material excavated during proposed site redevelopment be properly disposed at a permitted disposal facility.

2.4.4 Remedial Action Plan and Construction Health and Safety Plan, Landmark, February 2008

Remedial Action Plan

A RAP presented measures for: handling, stockpiling, transportation, and disposal of excavated soil and fill material during construction; proper groundwater pre-treatment if dewatering was performed; and the implementation of vapor control for the future building. Excavated soil, excluding segregated petroleum-contaminated soil or hazardous waste, would be removed from the site or reused as fill on-site, as necessary for construction. Petroleum contaminated and any hazardous waste soil would be disposed of off-site in accordance with applicable federal, state, and local regulations.

The design for the vapor barrier consisted of Grace Preprufe® 300 waterproofing membrane applied to the underside of the foundation. The design also included a 6-inch thick layer of gravel placed below the vapor barrier. Any penetrations through the foundation would be sealed with Grace Bituthene® liquid membrane. The vapor barrier would serve to mitigate the potential vapors from entering the building from the subsurface and would also serve as a structural waterproofing system to prevent moisture from infiltrating through the foundation. In addition, the basement level of the proposed building would be used for vehicle parking and would contain a separate active

ventilation system to prevent build-up of vehicle emissions. Since the underground portion of the building would be actively ventilated, the potential for vapor intrusion would be further reduced.

An air monitoring program was specified during disturbance of historic fill and contaminated soil to avoid or minimize exposure of the field personnel and the public to potential environmental hazards during soil disturbance activities. Proposed dust control measures included a dedicated on-site water truck, tarp covers for haul trucks, stabilized construction entrances, wash stations, and minimizing the speed of on-site vehicles. Proposed vapor/odor control measures included: limiting the area of open excavation; shrouding open excavations with tarps; using foams to cover exposed soils; and/or using chemical odorants in spray or misting systems.

The RAP also included contingency plans in the event that unknown USTs and/or areas of contaminated soil were encountered during soil excavation activities. Any USTs or areas of contaminated soil uncovered during the site development would be addressed in accordance with accepted industry standards and applicable federal, state, and local regulatory agency requirements.

Construction Health and Safety Plan

The CHASP assigned responsibilities, established personnel protection standards, mandatory safety practices and procedures and air monitoring requirements, and outlined contingency measures for unknown conditions that could arise during the remediation work associated with excavation and foundation work at the site. The CHASP was intended to minimize health and safety risks resulting from the known and potential presence of hazardous materials on the site.

The NYCDEP approved the RAP and CHASP and issued a Notice to Proceed on April 3, 2008.

2.4.5 Supplemental Remedial Investigation Report, Landmark, March 2008

After the Spill was reported to the NYSDEC on February 26, 2008 due to the petroleum contamination observed during the previous investigations, and based on a request in a March 14, 2008 letter from NYSDEC, Landmark conducted a supplemental remedial investigation to further characterize subsurface conditions at the site. The investigation included advancing eleven (11) Geoprobe soil borings (EB-1 through EB-11) with continuous macro-core sampling to groundwater and collecting one soil sample from the most contaminated interval in each boring to be analyzed for VOCs and SVOCs. Landmark indicated that field screening identified slightly stained soil in one boring located near the southern site boundary along North 11th Street and four borings located along the western perimeter of the site, adjacent to the Brooklyn Brewery building. The stained soil was observed in discontinuous seams at depths ranging from 2 to 12 feet below grade. Individual SVOCs were detected in six of the borings (EB-6 through EB-11) at concentrations exceeding their respective TAGM RSCOs. All VOC concentrations were below their respective TAGM RSCOs. Based on these results, Landmark refined the extent of petroleum-contaminated soil to an approximately 16,000 square foot area located along the northern and western portions of the site. Based on these results, Landmark indicated that all soil excavated from within the proposed development footprint to accommodate the building foundation and basement parking garage, including the delineated petroleum-contaminated soil, would be removed in

accordance with applicable regulations and that endpoint samples would be collected from the bottom of the excavation in accordance with NYSDEC guidance. In response to NYSDEC concerns regarding soil vapor intrusion, Landmark indicated that the basement parking garage would include a separate ventilation system and a sub-slab vapor barrier.

2.4.6 Soil Corrective Action and Remedial Subsurface Investigation, Impact Environmental Restoration, Inc. (Impact), September 2008

This report was prepared by Impact and submitted to NYSDEC and NYCDEP to document the excavation and off-site disposal of petroleum-contaminated soil from the site. Soil removal operations, which were conducted between May 15 and August 1, 2008, included the excavation of approximately 18,977 tons of soil under the entire building footprint, with off-site disposal at four different disposal facilities. Waste characterization samples were collected prior to and during the soil excavation activities to gain acceptance of the material at the designated facilities. Following soil removal, the bottom of the excavation was field screened for evidence of contamination and 34 post-excavation grab samples were collected at depths of approximately 10 to 14 feet below grade. The samples were collected across a grid pattern on approximately 20-foot centers and analyzed for VOCs and SVOCs. Impact reported that soil at the bottom of the excavation generally consisted of coarse sand containing some cobbles, and did not exhibit evidence of contamination or elevated PID readings; however, a reddish brown petroleum product was noted on the surface of the groundwater in the northern portion of the site, along North 12th Street. Analytical results for the endpoint samples indicated that four of the samples contained VOCs or SVOCs slightly exceeding the TAGM 4046 RSCOs. Based on these results, Impact recommended installing six, 4-inch diameter monitoring wells screened across the water table to monitor and recover LNAPL observed on the water table in the northern portion of the site.

The NYSDEC issued a November 19, 2008 letter indicating that, based on the data in Impact's report, no additional soil would need to be removed from the site; however, continued LNAPL monitoring and recovery would be required.

2.4.7 Soil Remedial Action Plan Addendum, Landmark, April 2009

An addendum to the RAP was prepared by Landmark to specify measures for addressing the LNAPL that was observed on the groundwater surface at the site following soil removal operations. The presumed source of the LNAPL was twelve USTs that were uncovered and removed during soil excavation for the building foundation. The proposed remediation measures consisted of operation and maintenance of an LNAPL recovery system and periodic groundwater monitoring in observation wells installed around the system. The proposed system included pumping of LNAPL/groundwater from three recovery wells, with treatment of the extracted fluids using an oil/water separator, air stripper, particulate filter, and two granular activated carbon (GAC) units in series prior to being discharged to the NYCDEP sewer system. The RAP addendum specified an OM&M schedule and periodic reporting to the NYSDEC. A May 5, 2009 letter from Landmark to NYSDEC provided supplementary pump test and LNAPL gauging data to support the LNAPL recovery system design.

2.4.8 Remedial Closure Report, AKRF, March 2010

The Closure Report was prepared to document disposal, monitoring, and other remedial activities undertaken during construction activities at Block 2289, Lot 14 in accordance

with the NYCDEP-approved RAP and CHASP. The information contained in the report was intended to satisfy the NYCDEP and NYCOER E-designation for Hazardous Materials requirements.

The excavated fill material was disposed of off-site in accordance with applicable regulatory requirements. Engineering controls consisted of a vapor barrier and a site cap. A passive SSDS had been designed for the on-site building, and installation was scheduled to be completed later that month. Based on the completion of the work specified in the RAP and CHASP, AKRF recommended that the NYCOER issue an NNO for the project site upon receipt of an addendum documenting SSDS installation. OER issued a NNO in April 2010, and issued the NOS in September 2012.

2.4.9 Closure Report Addendum, AKRF, April 9, 2010

The Closure Report Addendum was prepared to document additional remedial activities conducted subsequent to the March 2010 Closure Report, including installation of a passive SSDS and paving of a small area in the western portion of the site.

The passive SSDS was installed by retrofitting the newly constructed building as an added safeguard against possible soil vapor intrusion. The system included four branches of 6-inch diameter perforated piping installed within an 18-inch layer of gravel, which was integrated with the 6-inch gravel layer previously installed under the entire slab during building construction. The 6-inch perforated piping transitioned to 4-inch diameter solid cast iron piping below the slab, which was connected to 4-inch diameter solid PVC aboveground risers. The aboveground risers connected to a single 4-inch diameter discharge line mounted in the southeastern corner of the parking garage. The riser vents to the atmosphere through a 4-inch diameter cast iron stack with a wind-driven turbine terminating above the roof of the parking garage stairway enclosure, located on the western side of a street-level courtyard.

On March 26, 2010, Tectonic, Inc. of Staten Island, New York installed 6-inch thick concrete pavement in an approximately 20-foot by 50-foot area in the southeastern corner of the site not underlain by the building slab. Following installation, the pavement was covered with a layer of mulch. This pavement was installed to complete the final site cap described in the March 2010 Closure Report.

2.4.10 Off-Site Investigation Report, AKRF, November 24, 2010

The Off-Site Investigation Report documented results from investigation of subsurface conditions north- and east-adjacent of the subject site. The Off-Site Investigation was conducted to determine whether potential off-site sources were contributing to petroleum contamination observed at the property during site redevelopment and subsequent remediation activities. Field evidence of contamination, including slight petroleum-like odors and a visible sheen, was noted below the water table in three soil borings immediately north of the site and one boring located across North 12th Street from the site; with no contamination noted in the other two borings across North 12th Street or in the two borings across Berry Street. Laboratory analytical results for soil were consistent with these field observations, indicating generally higher levels petroleum-related VOCs in soil samples from borings immediately north of the site. LNAPL was not observed in any of the off-site monitoring wells during groundwater sampling activities or the tidal survey. Petroleum-related VOCs and/or SVOCs exceeding their respective AWQVs were detected in groundwater from MW-9 and MW-10 located immediately north of the

site, and MW-12 and MW-13, located across North 12th Street, with naphthalene concentrations of 37 to 79 parts per billion (ppb) reported in MW-13. However, the concentrations were all below 100 pbb and were not indicative of the presence of NAPL. Fingerprint analysis of LNAPL samples collected from on-site monitoring wells indicated a product profile consistent with weathered diesel fuel/No. 2 fuel oil, and not consistent with residual associated with the MGP gas holders formerly located on the north side of North 12th Street. These combined field observations and laboratory analytical results indicate that the petroleum-related contamination at the 34 Berry Street site was not likely originating from on off-site source (to the north). Based on the finding of the off-site investigation, AKRF recommended evaluating modifications to the on-site LNAPL recovery system to help enhance free product recovery rates and incorporating off-site monitoring wells into the monthly fluid level gauging program to better evaluate groundwater flow direction and verify absence of LNAPL north and east of the site.

2.4.11 OM&M Status Report (May 1 to June 30, 2013), AKRF, July 25, 2013

AKRF prepared the Quarterly Monitoring Report OM&M of a LNAPL recovery system at the subject site for three quarterly events over the period of May 1, 2013 through June 30, 2013. Additional activities during the reporting period included completion of an additional Off-Site Investigation (OSI) in June 2013. The OSI was completed in accordance with a work plan that was reviewed and approved by NYSDEC. The investigation included the drilling of soil borings and installation of monitoring wells at three upgradient locations (MW-17 through MW-19) to determine whether upgradient properties were contributing to site contamination.

Groundwater was encountered in the soil borings at approximately 10 to 11 feet below grade. No field evidence of contamination (e.g., sheens, odors, or elevated PID readings) was noted in the soil borings. Subsurface soils identified in the samplers generally consisted of miscellaneous fill (sand and gravel, with some organic material) extending to the bottom of each boring.

The soil sampling results did not identify a soil contamination source area. 1,2-DCA was detected in sample MW-18S at a concentration of 0.013 milligrams per kilogram (mg/kg), which was below the NYSDEC Part 375 Unrestricted Use Soil Cleanup Objective (UUSCO) of 0.02 mg/kg. No other VOCs detected in the soil samples. SVOCs were not detected in the soil samples. Groundwater sampling from the remaining on-site wells and off-site wells showed that petroleum-related VOCs and/or SVOCs exceeding their respective AWQVs were detected in groundwater from on-site wells MW-3, MW-6, MW-7, and MW-16, and from off-site well MW-18. Off-site monitoring well MW-18, which is upgradient of on-site monitoring well MW-4 and located in the sidewalk bordering the 34 Berry Street and 44 Berry Street properties, contained 1,2-DCA, 1,2-DCP, and TCE at concentrations higher than in on-site MW-4. The groundwater sampling results for MW-18 suggested a potential off-site source for the 1,2-DCA detections.

2.4.12 OM&M Monitoring Report (February 1 to October 31, 2016), AKRF, February 6, 2017

AKRF prepared the Quarterly Monitoring Report documenting OM&M of a NAPL recovery system at the subject site for three quarterly events over the period of February 1, 2016 through October 26, 2016 (three consecutive quarters). Additional activities during the reporting period included completion of a Supplemental Subsurface

Investigation (SSI) in April 2013. The SSI was completed in accordance with a work plan that was reviewed and approved by NYSDEC. The SSI included drilling and sampling of six soil borings, installation of three additional interior on-site monitoring wells (MW-22, MW-23, and MW-24), and two additional off-site monitoring wells (MW-20 and MW-21). The new wells were incorporated into the groundwater sampling program. MW-20 through MW-24 and soil boring SB-25 were completed to identify the potential source area and provide additional groundwater data associated with the existing 1,2-DCA plume. MW-24 was added to the investigation to provide soil and water quality data at the northwestern property boundary, which was a data gap for the site.

Visible staining, petroleum-like odors, and elevated PID readings were observed in soil borings MW-23 at 7 to 10 feet below basement grade (bbg) and MW-24 at 5 to 9 feet bbg. PID readings peaked at 30.4 parts per million (ppm) at MW-23 (8 feet bbg) and 153 ppm at MW-24 (8 feet bbg). No field evidence of contamination (e.g., sheens, odors, or elevated PID readings) was noted in the remaining soil borings.

The soil sampling results compiled during the June 2016 SSI indicated that low level VOC detections for solvent compounds were well below their respective UUSCOs and did not indicate the presence of a source area for the chlorinated solvent plume. The petroleum VOCs detected in on-site soil samples were below their respective UUSCO and were consistent with the known contamination in the Spill area. The groundwater sampling results confirmed that the concentration of petroleum compounds were consistent with previous sampling events, and exceeded the AWQVs in the northeastern portion of the property where the NAPL recovery wells are located. The groundwater results for solvent compounds confirmed that the location of MW-18 and MW-22 have had concentrations of 1,2-DCA that were one to two orders of magnitude higher than the remaining concentrations across the site. These results, combined with the established groundwater flow direction, suggested that the 1,2-DCA source area may be located along the property boundary between 34 Berry and 44 Berry Street, or may originate from the upgradient-adjacent 44 Berry Street property.

3.0 FIELD PROGRAM

The RI field program will focus on collecting soil, groundwater, sub-slab soil gas and indoor air data to further determine the nature and extent of Site contamination and to assist with determining the appropriate remedial action.

3.1 Field Program Summary

The field sampling scope of work consists of: the installation of a permanent 4-inch replacement NAPL recovery well (MW-3R) adjacent to the MW-3 location, the advancement of five soil borings, four of which will include the installation of a permanent monitoring well (SB/MW-26 through SB/MW-29, and SB-30), the collection of soil and groundwater samples from the soil borings, existing monitoring wells, and newly installed monitoring wells for laboratory analysis, and the installation of five temporary sub-slab soil gas probes (SG/IA-1 through SG/IA-5) with the collection of soil gas and indoor air samples. The proposed sample locations are shown on Figure 3. The following sections describe the methods that will be used to complete the scope of work.

The rationale for the proposed sample locations is as follows:

Boring/Well/ Point ID	Location	Rationale
MW-3R (on-site)	Adjacent to existing recovery well MW-3, located in the northern portion of the Site	To replace compromised recovery well MW-3, located within the petroleum release area.
SG/IA-1 to SG/IA-3 (on-site)	34 Berry Street – on-site building	To evaluate sub-slab soil gas and indoor air quality within the on-site building.
SG/IA-4 and SG/IA-5 (off-site)	44 Berry Street – south/southeast-adjacent off-site building	To evaluate sub-slab soil gas and indoor air quality within the off-site building.
SB/MW-26 (on-site)	Northwestern control point near Site property boundary, west of identified petroleum release area	To further assess and delineate the nature and extent of the on-site petroleum release area.
SB/MW-27 to SB/MW-29, and SB-30 (off-site)	44 Berry Street – south/southeast-adjacent off-site building	To provide soil and groundwater data relative to the 1,2- DCA source area.

The CAMP and HASP will be implemented during all subsurface disturbance activities included in the field program to be performed at the Site and off-site. The CAMP includes additional contingencies, such as ventilation measures, to address work being completed within occupied structures. The HASP and CAMP are included as Appendix B.

3.2 On-Site LNAPL Recovery Well Replacement

During recent site operations and maintenance inspections, AKRF discovered that on-site recovery well MW-3 has been compromised and requires complete replacement. The replacement recovery well MW-3R will be advanced with limited access hollow stem auger technology. A target depth of approximately 13 feet below basement grade will be used for MW-3R. The first attempt will include 6.25 inch inside diameter augers to install a 4-inch PVC replacement well. If the target depth is not reachable, a second attempt will include 4.25 inch inside diameter augers to install a 2-inch PVC well. If necessary, additional attempts will be made from multiple locations adjacent to existing MW-3. For the 2-inch or 4-inch PVC

recovery/monitoring well, Morie sand will be backfill to a depth of 2 feet above the screen. A bentonite seal will be placed above the sand for each well, and the remaining borehole area will be filled with bentonite grout. The well will be completed using a flush to grade locking gate box, and will be equipped with a total fluids diaphragm pump with a maximum pumping rate of approximately 5 gallons per minute. The new well pump will be tied into the existing NAPL system. All drill cuttings and any other investigation derived waste will be containerized in 55-gallon drums and handled in accordance with Section 3.9.

3.3 Sub-Slab Soil Gas and Indoor Air Sampling

Temporary sub-slab soil gas points will be installed at each of the on-site and off-site SG/IA sampling locations shown on Figure 1. The on-site SG/IA sampling locations are located in the basement level that includes a parking garage, utility and maintenance rooms, tenant storage, and a staff lounge. The off-site SG/IA sampling locations at 44 Berry Street are located in the basement level that includes a commercial bar, utility rooms, and a gym. There are no residential units in the basement of the 34 or 44 Berry Street building, and there are no common hallways that connect to overlying residential units. Proposed location SG/IA-5 is shown at two potential locations (Plan A and Plan B) and will be confirmed based on access. Since residential occupancies are the primary use of the building, 24-hour sampling durations have been selected for the soil vapor and indoor air samples to allow for a thorough evaluation of indoor air conditions.

A hammer drill with a concrete core attachment will be used to create an access hole in the foundation slab. A temporary sampling point (consisting of tubing and a screened implant connected to an expendable drive point) will be placed inside drilling rods and advance to approximately 8 inches below the floor slab using limited access (pneumatic hammer or slide hammer) equipment. The rods will then be retracted and a sand pack will be placed around the temporary sampling point. Hydrated bentonite will be used to seal the gap between the foundation slab and the tubing. One indoor air sample will be collected simultaneously at each sub-slab soil gas sampling location.

In addition, an outdoor (ambient) air sample will be collected for quality assurance/quality control (QA/QC) purposes. Samples will be collected using six-liter stainless steel Summa canisters. A flow meter will be affixed to each Summa canister and calibrated for sample collection over a 24-hour period of time. All Summa canisters will be analyzed by a NYSDOH-certified laboratory for VOCs by Environmental protection Agency (EPA) Method TO-15. Sub-slab soil gas sampling will be in accordance with the October 2006 New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York.

3.4 Soil Sampling

A limited access direct-push drill rig will be used to advance the soil boring at SB-26. Off-site access at the 44 Berry street site is unknown at this time. For the purpose of this scope, limited access direct push technology will be proposed to advance SB-27 through SB-30. The proposed soil boring locations are shown on Figure 3. Soil borings SB-27 and SB-29 will utilize the core holes drilled for the soil gas sampling points, and an additional core hole will be drilled in the floor slab for SB-28 and SB-30. Proposed location SG/-28 is shown at two potential locations (Plan A and Plan B) and will be confirmed based on access.

Soil samples will be collected continuously until refusal or to a depth of 15 feet below the basement level, whichever is shallower. Soil cores will be collected using stainless steel macrocore piston rod samplers fitted with an internal acetate liner. Soil samples will be inspected

by AKRF field personnel for evidence of contamination (e.g., odors, staining), screened for the presence of volatile organics with a photoionization detector (PID) equipped with a 10.6 electron volt (eV) lamp, and logged using the modified Burmister soil classification system. AKRF field personnel will record and document subsurface conditions. The PID will be calibrated in accordance with manufacturer's recommendations prior to sampling.

One soil sample will be collected from each soil boring from the interval that exhibits the most evidence (i.e., PID readings, odors, staining) of contamination. In the absence of contamination, the sample will be collected from the groundwater interface. Additional samples would be collected for laboratory analysis if field observations (odor and/or staining) and PID readings indicate it is necessary. All sampling equipment (e.g., drilling rods and casing, macro core samplers and probe rods) will be either dedicated or decontaminated between sampling locations.

Soil samples slated for laboratory analysis will be labeled and placed in laboratory-supplied containers and shipped to the laboratory via courier with appropriate chain of custody documentation in accordance with appropriate EPA protocols to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory. The sample(s) collected from on-site soil boring SB-26 will be analyzed for target compound list (TCL) VOCs by EPA Method 8260 and TCL SVOCs by EPA Method 8270. The samples collected from off-site soil borings SB-27 through SB-30 will be analyzed for TCL VOCs by EPA Method 8260. The laboratory report will be prepared using Category B deliverables. A standard turnaround time will be requested from the laboratory.

After the soil boring drilling is complete, soil borings not designated for installation of monitoring wells will be filled with hydrated bentonite and patched with to match existing surface conditions. Each soil boring location will be surveyed by a licensed surveyor and incorporated into the existing site map. All investigation derived waste (IDW) associated with drilling soil borings will be managed as described in Section 3.9.

3.5 Monitoring Well Installation and Well Development

At MW-26, the first attempt for well installation will include the advancement augers via the direct push unit for the purpose of installing a 2-inch PVC well. If the augers are limited due to shallow refusal, a 3-inch macrocore tube will be used to install a 1-inch monitoring well with a pre-packed screen. The off-site wells will include well installation with the 1-inch PVC pre-packed well materials. The wells will be installed with 10 feet of well screen to a depth of 8 feet into the water table, estimated to range from 13 to 15 feet below basement grade. Morie sand will be backfill around MW-3R (and MW-26 if a two-inch well is installed) to a depth of 2 feet above the screen. A bentonite seal will be placed above the sand pack for each well, and the remaining borehole are will be filled with bentonite grout. Each monitoring well will be completed using locking gate boxes, flush with grade, and will be developed by pumping until clear, if practicable. The location of each new will be surveyed by a licensed surveyor and incorporated into the existing site map.

3.6 Groundwater Sampling

Groundwater samples will be collected from existing and newly installed monitoring wells a minimum of one week following development.

Prior to sampling, the depth to water will be measured in each existing on-site and off-site well with a multi-phase interface meter to determine whether NAPL is present. Groundwater samples will be collected from each well where NAPL is not present using low-flow sampling techniques. Since each on-site NAPL recovery well requires purging with a peristaltic pump, the 1-inch wells

have a limited diameter for access, and a peristaltic has been used for all previous sampling events, AKRF recommends purging each well with a peristaltic pump for consistency. The initial groundwater sampling will include analysis for emerging contaminants [1,4-dioxane and polyfluoroalkyl substances (PFAs)], and sample collection will be conducted in accordance with the prevailing NYSDEC protocols. The QAPP included in Appendix A includes detailed protocols that will be followed for emerging contaminant sample collection, including acceptable materials for equipment and personal protective equipment.

The purge water will be monitored for turbidity and water quality indicators (i.e., pH, dissolved oxygen, oxidation-reduction potential, temperature, and specific conductivity) with measurements collected approximately every five minutes. The criteria for stabilization will be three successive readings within ±10% for pH, temperature, and specific conductivity.

Groundwater samples slated for laboratory analysis will be placed in laboratory-supplied containers and shipped in accordance with appropriate EPA protocols to a NYSDOH ELAP-certified laboratory. Each sample will be analyzed for TCL VOCs by EPA Method 8260, TCL SVOCs by EPA Method 8270, 1,4-dioxane by EPA Method 8270D – selective ion monitoring (SIM), and the standard list of 21 per- and PFAS compounds by EPA Method 537. The laboratory report will be prepared using Category B deliverables. A standard turnaround time will be requested from the laboratory.

3.7 Quality Assurance / Quality Control (QA/QC)

Additional analysis will be included for quality control measures, as required by the Category B sampling techniques. The QA/QC samples for soil and groundwater will include one field blank, one trip blank, one MS/MSD, and one blind duplicate sample at a frequency of one sample per 20 field samples per media. The field blank, blind duplicate, and MS/MSD samples will be analyzed for TCL VOCs by EPA Method 8260 and TCL SVOCs by EPA Method 8270, where applicable, using Category B deliverables. Additional QA/QC analysis for the groundwater samples include 1,4-dioxane by EPA Method 8270D – selective ion monitoring (SIM), and the standard list of 21 perfluorooctanioc acid(PFOA)- and PFAS) compounds by EPA Method 537. One laboratory-prepared trip blank will be submitted for analysis of VOCs to determine the potential for cross-contamination. The QA/QC samples for sub-slab soil gas and/or indoor air will include one field duplicate and an outdoor (ambient) air sample analyzed for VOCs by EPA Method TO-15. The QAPP describes the QA/QC protocols and procedures that will be followed during implementation of the RIWP. The QAPP is included as Appendix A. The data will be reviewed by a third-party validator and a Data Usability Summary Report (DUSR) will be prepared to document the usability and validity of the data.

3.8 Decontamination Procedures

All non-dedicated sampling equipment (e.g., submersible/peristaltic pumps and oil/water interface probe) will be decontaminated between sampling locations using the following procedure:

1. Scrub equipment with a bristle brush using a tap water/Simple Green® solution.
2. Rinse with tap water.
3. Scrub again with a bristle brush using a tap water/Simple Green® solution.
4. Rinse with tap water.
5. Rinse with distilled water.

6. Air-dry the equipment.

3.9 Management of Investigation-Derived Waste (IDW)

Soil cuttings will be containerized in properly labeled Department of Transportation (DOT)-approved 55-gallon drums for future off-site disposal at a permitted facility. The drums will be sealed at the end of each work day and labeled with the date, the well or boring number(s), the type of waste (i.e., drill cuttings, decontamination fluids, or purge water) and the name of an AKRF point-of-contact. All drums will be labeled "pending analysis" until laboratory data is available. All IDW will be disposed of or treated according to applicable local, state, and federal regulations. All boreholes will be filled with bentonite chips (hydrated) and concrete capping. Disposable sampling equipment, including spoons, gloves, bags, paper towels, etc. that come in contact with environmental media will be double bagged and disposed of as municipal trash in a facility trash dumpster as non-hazardous refuse.

Purge water generated during well development, equipment decontamination and low flow sampling will be managed on-site by transferring the liquids to the on-site oil/water separator, which is a component of the operating fluid recovery system, located within the cellar-level maintenance room.

4.0 REPORTING REQUIREMENTS

4.1 Remedial Investigation Report (RIR)

Upon completion of all field work and receipt of laboratory analytical results, a RIR will be prepared that will: document field activities; present field and laboratory data; evaluate exposure pathways in an exposure assessment; and discuss conclusions and recommendations drawn from the results of the investigation.

4.1.1 Description of Field Activities

This section of the RIR will describe the field methods used to characterize the Site conditions, including: sampling techniques; field screening equipment; drilling and excavation equipment; recovery and monitoring well installation procedures; and management of IDW.

4.1.2 Soil Boring Assessment

The RIR will include a section that presents field and laboratory data for soil results. The section will include a description of soil characteristics and figures will be provided that illustrate soil boring locations. Field and laboratory analytical results will be presented in the body of the report, summarized in tables and figures, and the detected concentrations will be compared to regulatory standards and/or guidance values. Soil boring logs and laboratory analytical reports will be provided as attachments.

4.1.3 Groundwater Assessment

The RIR will include a section that presents field and laboratory data from the groundwater sampling. The section will include a description of groundwater characteristics and figures will be provided that illustrate recovery and monitoring well locations. Field and laboratory analytical results will be presented and compared with regulatory standards and/or guidance values. Low-flow groundwater sampling logs and laboratory analytical reports will be provided as attachments.

4.1.4 Sub-Slab Soil Gas and Indoor Air Assessment

The RIR will include a section that presents field and laboratory data from the sub-slab soil gas and indoor air sampling. The section will include a description of sub-slab soil gas and indoor air characteristics and figures will be provided that illustrate their locations. Field and laboratory analytical results will be presented and compared with regulatory standards and/or guidance values. Sub-slab soil gas and indoor air sampling logs and laboratory analytical reports will be provided as attachments.

4.1.5 Qualitative Human Health Exposure Assessment

A Qualitative Human Health Exposure Assessment will be performed in accordance with DER-10 Section 3.3. The assessment will be included in the RIR.

5.0 SCHEDULE OF WORK

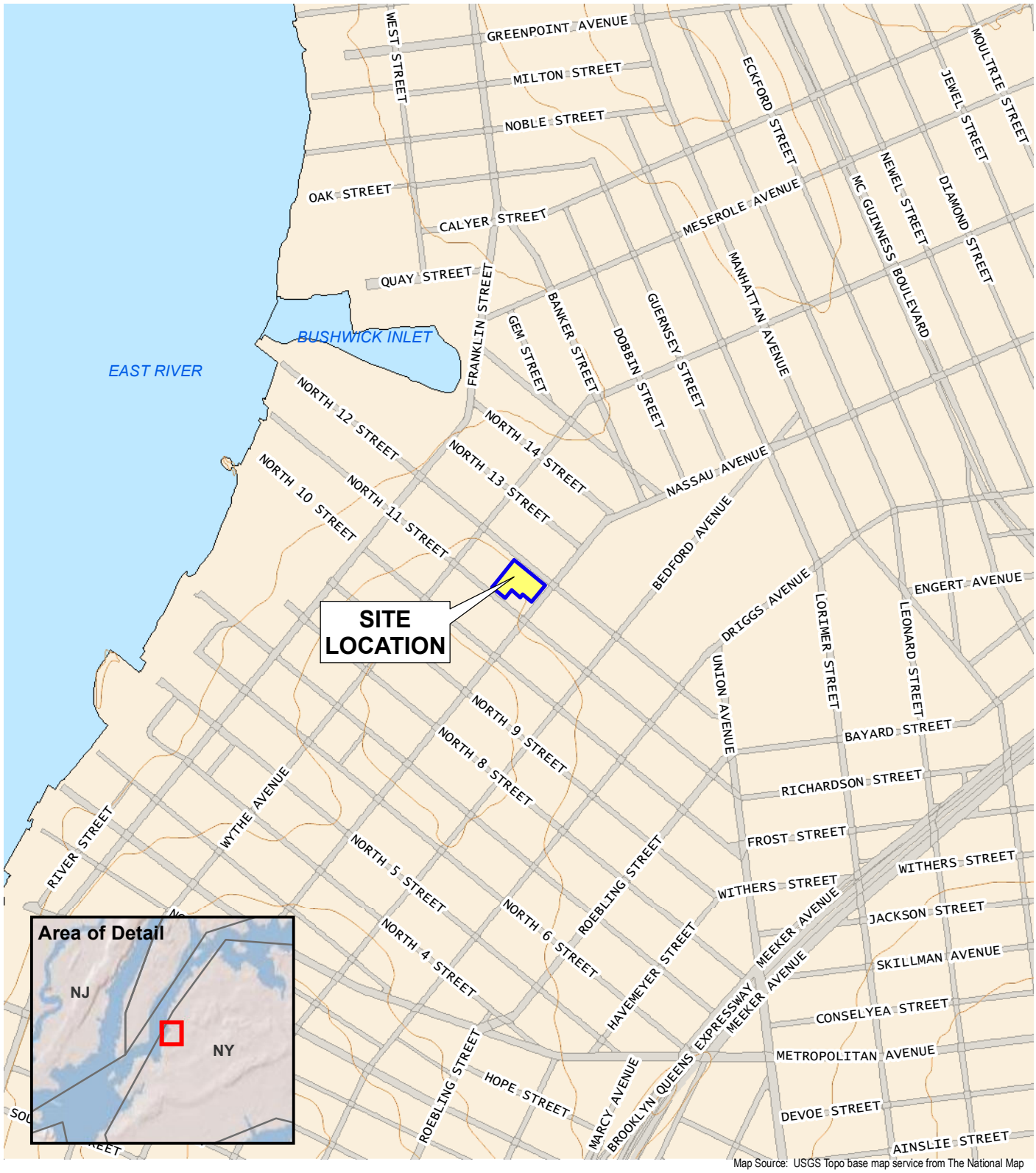
The following tentative schedule has been developed for the project. This schedule is subject to change, in consultation with NYSDEC.

Activity	Time To Complete
Submittal of BCP Application and Draft Remedial Investigation Work Plan (RIWP)	September 2017
NYSDEC Completeness Check of BCP Application and Determination that Application is Complete	September 2017
30-day Public Comment Period Initiated (Environmental News Bulletin, Newspaper)	September 2017
Public Comment Period Ends	October 2017
BCP and RIWP Acceptance	November 2017
Execute BCP Agreement	November 2017
Citizen Participation Plan	May 2018
Remedial Investigation is Initiated	August 2018
Remedial Investigation is Completed	September 2018
Draft Remedial Investigation Report (RIR) Submitted to NYSDEC	October 2018
Submittal of Draft Remedial Action Work Plan (RAWP) and Fact Sheet	November 2018
45-day Public Comment Period for RIR and RAWP is Initiated	November 2018
Public Comment Period for RIR and RAWP Ends	January 2019
Final RAWP Submitted/DEC Approves and Issues Decision Document	February 2019
Complete Remedial Action/Upgrades to ECs (SSDS if needed)	March 2019 – April 2019
Draft Final Engineering Report (FER), Site Management Plan (SMP), and Environmental Easement submitted to NYSDEC	May – September 2019
Execution of Environmental Easement	30 days after SMP approval
Certificate of Completion	December 2019
Post remediation monitoring (3 years)	December 2022
Long term annual inspection, maintenance, and monitoring (est. 10 year period)	December 2029

6.0 REFERENCES

- Phase I Environmental Site Assessment (ESA), 34 Berry Street, Brooklyn, New York; prepared by Langan Engineering and Environmental Services (Langan); prepared for Atherton-Newport; dated June 15, 2006.
- Phase II Environmental Site Investigation (ESI), 34 Berry Street, Brooklyn, New York; prepared by Langan; prepared for Atherton-Newport; dated June 27, 2006.
- Environmental Subsurface Investigation Report, 34 Berry Street, Brooklyn, New York; prepared by Landmark Consultants, Inc. (Landmark); prepared for Atherton-Newport; dated April 2007.
- Supplemental Remedial Investigation Report, 34 Berry Street, Brooklyn, New York; prepared by Landmark; prepared for New York State Department of Environmental Conservation (NYSDEC); dated March 20, 2008.
- Remedial Action Plan and Construction Health and Safety Plan, 34 Berry Street, Brooklyn, New York; prepared by Landmark, February 2008.
- Soil Corrective Action and Remedial Subsurface Investigation, 34 Berry Street, Brooklyn, New York; prepared by Impact Environmental Restoration, Inc. (Impact), September 2008.
- Soil Remedial Action Plan Addendum, 34 Berry Street, Brooklyn, New York; prepared by Landmark, April 2009.
- Remedial Closure Report, 34 Berry Street, Brooklyn, New York; AKRF Engineering, P.C.; prepared for NYSDEC; dated March 2010.
- U.S. Geological Survey, *Brooklyn, NY Quadrangle*, 7.5 minute Series (Topographic), Scale 1:2,500, 1995.
- 6 NYCRR Section 375-6: Remedial Program Soil Cleanup Objectives (SCOs), December 14, 2006.
- NYSDEC Division of Water Technical and Operational Guidance Series 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, March 1998.
- Off-Site Investigation Report, 34 Berry Street, Brooklyn, New York; AKRF, Inc.; dated November 2010.
- OM&M Status Report, 34 Berry Street, Brooklyn, New York; AKRF, Inc., May to June 2013.
- OM&M Monitoring Report, 34 Berry Street, Brooklyn, New York; AKRF, Inc., February to October 2016.

FIGURES



Map Source: USGS Topo base map service from The National Map

0 800 1,600

SCALE IN FEET

AKRF
440 Park Avenue South, New York, NY 10016

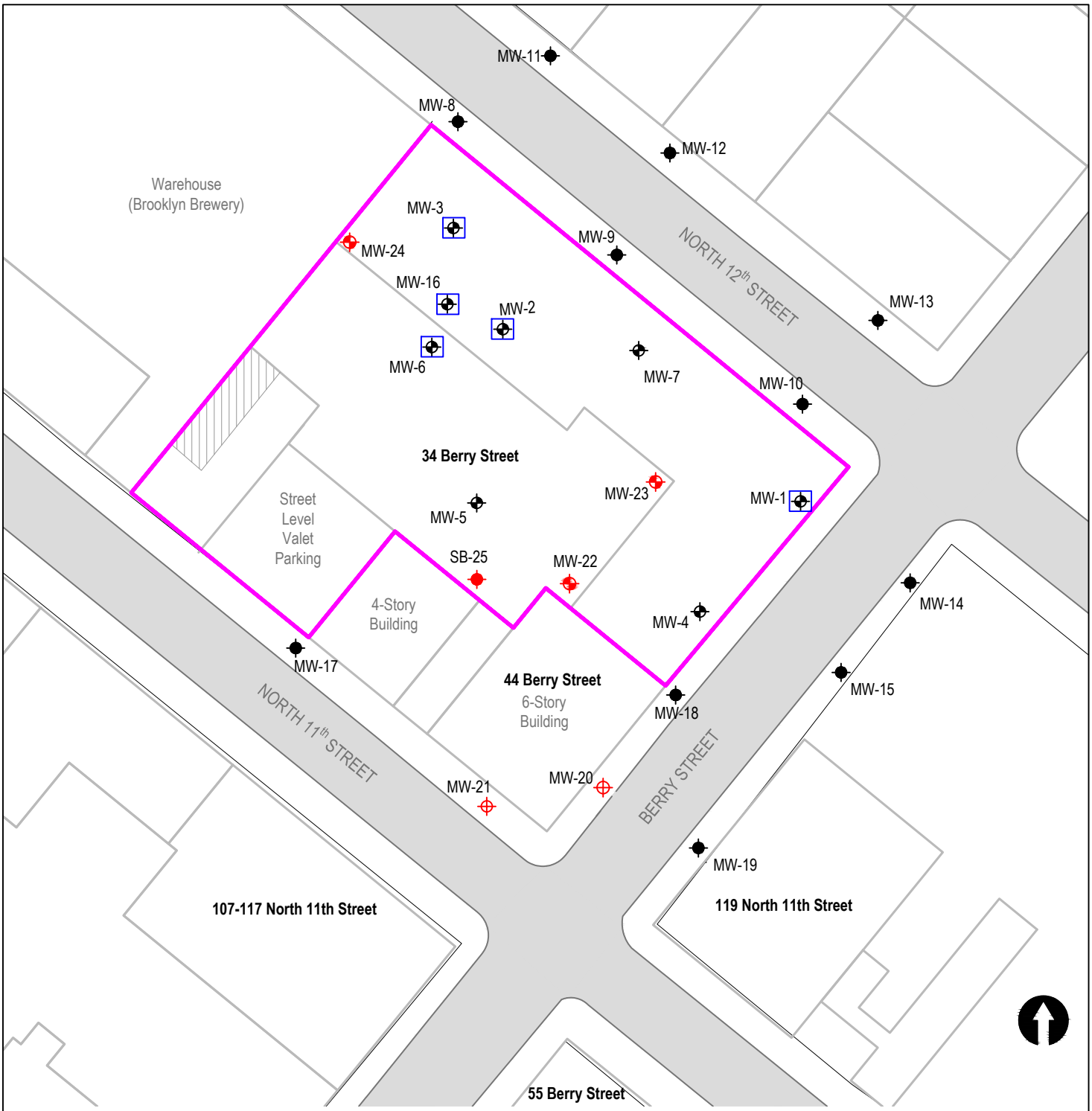
34 Berry Street
Brooklyn, New York

SITE LOCATION

DATE
5/4/2017

PROJECT NO.
11259

FIGURE
1



LEGEND

- PROJECT SITE BOUNDARY
- SB-25 — SOIL BORING LOCATION
- MW-2 — RECOVERY WELL
- MW-4 — ON-SITE MONITORING WELL
- MW-15 — OFF-SITE MONITORING WELL
- MW-20 — SUPPLEMENTAL OFF-SITE SOIL BORING/ MONITORING WELL LOCATION
- MW-22 — SUPPLEMENTAL ON-SITE SOIL BORING/ MONITORING WELL LOCATION

0 30 60 120

SCALE IN FEET

AKRF

440 Park Avenue South, New York, NY 10016

34 Berry Street

Brooklyn, New York

SITE PLAN

DATE **5/4/2017**

PROJECT NO. **11259**

FIGURE **2**

 M:\AKRF Project Files\11259 - 34 Berry St (LCOR)\BCP\CAD\11259 Fig 2 Site Plan.dwg last save: mvelleux 5/4/2017 9:52 AM

MW-8	
May-13	ND
Jul-15	ND
Oct-15	ND
Jan-16	ND
Apr-16	ND
Jun-16	ND
Jul-16	0.58J
Oct-16	0.70J

MW-3	
Dec-09	ND
Jun-12	2.2
Sep-12	2.8
Dec-12	3
May-13	1.1
Jul-13	ND
Oct-13	ND
Apr-14	1
Apr-15	3
Jul-15	0.45 J
Oct-15	3.4
Jan-16	24

MW-24	
Jul-16	19
Oct-16	0.72J

MW-9	
May-13	ND
Jul-15	ND
Oct-15	ND
Jan-16	ND
Apr-16	ND
Jun-16	ND
Jul-16	2.1
Oct-16	ND

MW-23	
Jul-16	ND
Oct-16	3.5

MW-1	
Oct-10	9.3
Sep-11	150
Dec-11	95
Mar-12	240
Jun-12	520
Dec-12	110
Jul-13	1.3
Apr-15	410
Jul-15	650

MW-4	
Dec-09	2500
Oct-10	27000
Jan-11	20000
Sep-11	32000
Dec-11	51000
Mar-12	30000
Jun-12	16000
Sep-12	13000
Dec-12	11000
May-13	2400
Jul-13	1000
Oct-13	1900
Apr-14	59
Oct-14	220
Apr-15	5.5
Jul-15	170
Oct-15	31
Jan-16	240
Apr-16	65
Jul-16	63
Oct-16	700

MW-2	
Dec-12	400
Jul-13	130
Oct-13	390
Apr-14	390
Oct-14	560
Apr-15	4100
Jul-15	5400
Oct-15	1800
Jan-16	2000
Apr-16	400
Jul-16	9.8

MW-6	
Mar-12	0.25 J
Jun-12	ND
Sep-12	1.7
Dec-12	0.54 J
May-13	0.43 J
Apr-14	0.34 J
Oct-14	ND

MW-18	
May-13	3800
Jul-13	NS
Apr-14	140
Oct-14	8800
Apr-15	0.62 J
Jul-15	1000
Oct-15	1500
Jan-16	1300
Apr-16	2000
Jul-16	1000
Oct-16	1400

MW-7	
Oct-10	4.7
Jan-11	1.2 J
Sep-11	7.7
Dec-11	ND
Mar-12	0.31 J
Jun-12	ND
Dec-12	0.32 J
May-13	0.60 J
Jul-13	0.66 J
Oct-13	ND
Apr-14	3.4
Oct-14	0.82 J
Apr-15	0.93 J
Jul-15	0.65 J
Oct-15	1.4
Jan-16	0.25
Apr-16	ND
Jul-16	0.77J
Oct-16	0.45J

MW-5	
Dec-09	NS
Oct-10	9.9
Jan-11	13
Sep-11	5.3
Dec-11	1.9
Mar-12	2.8
Jun-12	3.9
Sep-12	3.9
Dec-12	4.1
May-13	3.2
Jul-13	4.6
Oct-13	3.5
Apr-14	3.2
Oct-14	5.4
Apr-15	4000
Oct-15	1500
Jan-16	1100
Apr-16	330
Jun-16	NS
Jul-16	230
Oct-16	110

MW-17	
May-13	ND
Jul-13	0.5J
Apr-14	ND
Oct-14	ND
Apr-15	ND
Jul-15	ND
Oct-15	1.6
Jan-16	ND
Apr-16	ND
Jul-16	1.5
Oct-16	0.37J

MW-22	
Jul-16	2400
Oct-16	440

MW-21	
Jul-16	ND
Oct-16	0.36J

MW-20	
Jul-16	ND
Oct-16	0.26J

MW-19	
May-13	ND
Jul-13	NS
Apr-14	ND
Oct-14	22
Apr-15	ND
Jul-15	ND
Oct-15	4.7
Jan-16	ND
Apr-16	ND
Jul-16	ND
Oct-16	0.25J

MW-11, MW-8, MW-12, MW-3, MW-3R, MW-24, MW-9, MW-16, MW-2, SB/MW-26, MW-6, MW-13, MW-7, MW-10, MW-23, MW-5, SB/MW-29, SB-25, MW-22, MW-1, MW-4, MW-14, MW-17, SB/MW-27, SG/IA-4, SB/MW-28, SG/IA-5 Plan A, SB/MW-28, SG/IA-5 Plan B, MW-18, MW-15, SB-30, MW-21, MW-20, MW-19

NORTH 12th STREET

NORTH 11th STREET

BERRY STREET

Warehouse (Brooklyn Brewery)

34 Berry Street

Street Level Valet Parking

SG/IA-3

Building Entrance, Hallway to Elevator

SG/IA-2

Hallway to Electric Room

Elevator

SG/IA-1

Electric Room

4-Story Building

Basement Bar

44 Berry Street

Plumbing Room/Fire Pump Room/Retail Tenant Exit Hallway

107-117 North 11th Street

119 North 11th Street

LEGEND

- PROJECT SITE BOUNDARY
- SB-25 — SOIL BORING LOCATION
- MW-2 — RECOVERY WELL
- MW-4 — ON-SITE MONITORING WELL
- MW-15 — OFF-SITE MONITORING WELL
- SB/MW-26 — PROPOSED SOIL BORING/ MONITORING WELL LOCATION
- SG/IA-1 — PROPOSED SOIL GAS/INDOOR AIR SAMPLING LOCATION
- NAPL PRESENT

MW-20	
Jul-16	ND
Oct-16	0.26J

SAMPLE ID

SAMPLE DATE

1,2-DCA CONCENTRATION IN µg/l

ND = NOT DETECTED

J = ESTIMATED CONCENTRATION

DCA = DICHLOROETHANE

µg/l = MICROGRAMS PER LITER or PARTS PER BILLION (ppb)

NAPL = NON AQUEOUS PHASE LIQUID

0 25 50 100

SCALE IN FEET

AKRF

440 Park Avenue South, New York, NY 10016

34 Berry Street
Brooklyn, New York

PROPOSED SAMPLING LOCATIONS

DATE
5/8/2018

PROJECT NO.
11259

FIGURE
3

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APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

34 BERRY STREET

BROOKLYN, NEW YORK

Quality Assurance Project Plan

AKRF Project Number: 11259
BCP Site Number: C224268

Prepared for:

NYSDEC Region 2
1 Hunter's Point Plaza
47-40 21st Street
Long Island City, New York 11101

On Behalf Of:

34 Berry Street, LLC (LCOR)
34 Berry Street
Brooklyn, NY 11249

Prepared by:

AKRF, Inc.
440 Park Avenue South
New York, New York 10016
(212) 696-0670

JULY 2018

TABLE OF CONTENTS

TABLES

ATTACHMENTS

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) describes the protocols and procedures that will be followed during implementation of all environmental sampling, including under the Remedial Investigation Work Plan (RIWP) at the 34 Berry Street site, hereafter referred to as the Site The legal definition of the Site is Brooklyn Borough Tax Block 2289, Lot 14. The site is located on the western side of Berry Street, between North 11th and North 12th Streets, and is comprised of a seven-story residential building and courtyard area, with a basement level parking garage. A Site Location Plan is provided as Figure 1.

The objective of this QAPP is to provide for Quality Assurance (QA) and maintain Quality Control (QC) of environmental investigative, sampling, and remedial activities conducted under the New York State Department of Environmental Conservation (NYSDEC) oversight in the Brownfield Cleanup Program (BCP) (BCP Site No. C224234). Adherence to the QAPP will ensure that defensible data will be obtained during all environmental work at the Site.

2.0 PROJECT TEAM

The project team will be drawn from AKRF professional and technical personnel, and AKRF's subcontractors. All field personnel and subcontractors will have completed a 40-hour training course and updated 8-hour refresher course that meet the Occupational Safety and Health Administration (OSHA) requirements of 29 CFR Part 1910. The following sections describe the key project personnel and their responsibilities.

2.1 PROJECT DIRECTOR AND REMEDIAL ENGINEER

The project director will be responsible for the general oversight of all aspects of the project, including scheduling, budgeting, data management, and field program decision-making. The project director will communicate regularly with all members of the AKRF project team and the NYSDEC to ensure a smooth flow of information between involved parties. Marc Godick will serve as the project director for the RAWP. Mr. Godick's resume is included in Attachment A.

2.2 QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC) OFFICER

Mr. Marcus Simons will serve as the QA/QC officer and will be responsible for adherence to the QAPP. The QA/QC officer will review the procedures with all personnel prior to commencing any fieldwork and will conduct periodic Site visits to assess implementation of the procedures. The QA/QC officer will also be responsible for reviewing Data Usability Summary Reports (DUSRs) for soil analytical results. Mr. Simon's resume is included in Attachment A.

2.3 PROJECT MANAGER

The project manager will be responsible for directing and coordinating all elements of the RAWP. The project manager will prepare reports and participate in meetings with the Site owner/Volunteer, and/or the NYSDEC. Bryan Zieroff will serve as the project manager for the RAWP. Mr. Zieroff's resume is included in Attachment A.

2.4 PROJECT MANAGER ALTERNATE

The project manager alternate will be responsible for assisting the project manager. The project manager alternate will help prepare reports and will participate in meetings with the Site owner/Volunteer, and/or the NYSDEC. Mark Jepsen will serve as the project manager alternate for the RAWP. Mr. Jepsen's resume is included in Attachment A.

2.5 FIELD TEAM LEADER,FIELD TECHNICIAN, AND SITE SAFETY OFFICER, AND ALTERNATES

The field team leader will be responsible for supervising the daily sampling and health and safety activities in the field and will ensure adherence to the work plan and Health and Safety Plan (HASP), included in Appendix B of the RIWP. The field team leader will also act as the field technician and Site safety officer (SSO), and will report to the project manager or project manager alternate on a regular basis regarding daily progress and any deviations from the work plan. The field team leader will be a qualified and responsible person able to act professionally and promptly during environmental work at the Site. Mr. Jepsen will also act at the field team leader. The field team leader alternate is Jacob Menken of AKRF. Resumes for Mr. Jepsen and Mr. Menken are included in Attachment A.

2.6 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) OFFICER

The laboratory QA/QC officer will be responsible for quality control procedures and checks in the laboratory and ensuring adherence to laboratory protocols. The QA/QC officer will track the movement of samples from the time they are checked in at the laboratory to the time that analytical results are issued, and will conduct a final check on the analytical calculations and sign off on the laboratory reports. The laboratory QA/QC officer will be Carl Ambruster of TestAmerica Laboratories (TestAmerica), the New York State Department of Health (NYSDOH) Environmental Laboratory Accreditation Program (ELAP)-certified laboratory being employed for all environmental sampling at the Site. Mr. Ambruster's resume is included in Attachment A.

2.7 LABORATORY DATA VALIDATOR

The laboratory data validator will be responsible for third party data validation and preparation of Data Usability Summary Reports (DUSRs). The third-party laboratory data validator will be Lori Beyer of L.A.B. Validation Corp. Ms. Beyer's resume is included in Attachment A.

3.0 STANDARD OPERATING PROCEDURES (SOPS)

The following sections describe the SOPs for the remedial activities included in the RIWP. During these operations, safety monitoring will be performed as described in the HASP, included as Appendix B of the RIWP.

3.1 SOIL SAMPLING

Restricted access, low clearance, and difficult drilling conditions with multiple refusals have limited previous investigation work at the site. The rate of success for achieving target drilling depth during previous investigations increased as the diameter of the drilling tools decreased. Previous drilling complications have dictated the PVC casing diameter of the monitoring wells and the final method in which the on-site soil boring and monitoring wells are installed. Section 3 includes the scope for achieving the investigation goals during drilling.

3.1.1 Soil Borings

Five soil borings (SB/MW-26 through SB/MW-29, and SB-30) will be completed to characterize subsurface soils and collect soil samples for laboratory analysis. Figure 3 in the RIWP depicts the soil boring locations as well as the locations of existing structures present at the site.

A limited access direct-push drill rig will be used to advance the soil borings. Off-site access at the 44 Berry street site is unknown at this time. For the purpose of this scope, limited access direct push technology will be proposed to advance SB-27 through SB-30. Soil borings SB-27 and SB-29 will utilize the core holes drilled for the soil gas sampling points, and an additional core hole will be drilled in the floor slab for SB-28 and SB-30.

Soil samples will be collected continuously until refusal or to a depth of 15 feet below the basement level to reach 10 feet below the water table, whichever is shallower. Soil cores will be collected using stainless steel macrocore piston rod samplers fitted with an internal acetate liner. Soil samples will be inspected and logged by AKRF field personnel, as described in Section 4.1.

One soil sample will be collected from each soil boring from the interval that exhibits the most evidence (i.e., PID readings, odors, staining) of contamination. In the absence of contamination, the sample will be collected from the groundwater interface. Additional samples would be collected for laboratory analysis if field observations (odor and/or staining) and PID readings indicate it is necessary. All sampling equipment (e.g., drilling rods and casing, macro core samplers and probe rods) will be either dedicated or decontaminated between sampling locations in accordance with Section 3.4 of this document.

Soil samples slated for laboratory analysis will be labeled and placed in laboratory-supplied containers and shipped to the laboratory via courier with appropriate chain of custody documentation in accordance with appropriate EPA protocols to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory. The sample(s) collected from on-site soil boring SB-26 will be analyzed for target compound list (TCL) VOCs by EPA Method 8260 and TCL SVOCs by EPA Method 8270. The samples collected from off-site soil borings SB-27 through SB-30 will be analyzed for TCL VOCs by EPA Method 8260. The laboratory report will be prepared using Category B deliverables. A standard turnaround time will be requested from the laboratory.

After the soil boring drilling is complete, soil borings not designated for installation of monitoring wells, or if multiple borings are needed at a location to reach the target depth, will be filled with hydrated bentonite and patched to match existing surface conditions. Each soil boring location will be identified by a hand held global positioning system (GPS) unit. All investigation derived waste (IDW) associated with drilling soil borings will be managed as described in Section 3.5.

3.2 GROUNDWATER MONITORING WELL INSTALLATION AND DEVELOPMENT

During recent site operations and maintenance inspections, AKRF discovered that on-site recovery well MW-3 had been compromised and required complete replacement. The replacement recovery well MW-3R will be advanced with limited access hollow stem auger technology. A target depth of approximately 13 feet below basement grade will be used for MW-3R. The first attempt will include 6.25 inch inside diameter augers to install a 4-inch PVC replacement well. If the target depth is not reachable, a second attempt will include 4.25 inch inside diameter augers to install a 2-inch PVC well. If necessary, additional attempts will be made from multiple locations adjacent to existing MW-3. Well construction details are included later in this section.

At on-site well MW-26, the first attempt for well installation will include the advancement of augers for the purpose of installing a 2-inch PVC well. If the augers are limited due to shallow refusal, a 3-inch macrocore tube will be used to install a 1-inch monitoring well with a pre-packed screen. The off-site wells will include well installation with the 1-inch PVC pre-packed well materials. The wells will be installed with 10 feet of well screen to a depth of 8 feet into the water table, estimated to range from 13 to 15 feet below basement grade.

Morie sand will be backfill around MW-3R (and MW-26 if a two-inch well is installed) to a depth of 2 feet above the screen. The annular space around the well riser will be sealed with bentonite extending one to two feet above the sand filter pack and completed with a non-shrinking cement mixture to approximately one foot below grade. Each monitoring well will be completed using flush to grade locking gate boxes. Due to the documented low yielding conditions, each well will be developed by agitating the well screen with a surge block and pumping out the sediment until clear, if practical. The location/elevation of each new PVC well will be surveyed by a licensed surveyor and incorporated into the existing site map.

3.3 SUB-SLAB SOIL GAS POINT INSTALLATION

Soil gas samples will be collected using a stainless steel probe, consisting of a drive point and internal perforated sampling port with a retractable tip, connected to Teflon sampling tubing. The sampling tubing will extend from the sampling port through a drive casing to above grade. Collectively, the retractable tip, sampling port and sampling tube are referred to as the "soil gas sampler". The soil gas sampler will be installed using the following procedures:

1. Prepare the sampling point location by drilling through the building slab using a concrete drill equipped with a 2-inch diameter drill bit.
2. Attach new, clean $^{3}/_{16}$-inch inside diameter Teflon tubing to the sampling probe.
3. Drive the sampling probe and attached tubing to a depth of 8-inches below the bottom of the concrete slab.
4. Backfill the soil gas sampler with 8-inches of clean sand filter pack to prevent intake clogging.
5. Retract the drive casing to expose the perforated sampling port.
6. Seal the gap between the foundation slab and tubing with hydrated bentonite.
7. Record total depths (interval below grade) to which probe is advanced and withdrawn for sample collection.

3.4 DECONTAMINATION OF SAMPLING EQUIPMENT

All sampling equipment (augers, drilling rods, split spoon samplers, probe rods, pumps, etc.) will be either dedicated or decontaminated between sampling locations. Decontamination will be conducted on plastic sheeting (or equivalent) that is bermed to prevent discharge to the ground. The decontamination procedure will be as follows:

1. Scrub using tap water/Simple Green® mixture and bristle brush.
2. Rinse with tap water.
3. Scrub again with tap water/Simple Green® mixture and bristle brush.
4. Rinse with tap water.
5. Rinse with distilled water.

6. Air-dry the equipment, if possible.

3.5 MANAGEMENT OF INVESTIGATION DERIVED WASTE (IDW)

IDW, with the exception of purged groundwater, will be containerized in New York State Department of Transportation (NYSDOT)-approved 55-gallon drums during the investigation activities. The drums will be sealed at the end of each work day and labeled with the date, the boring location(s), the type of waste (i.e., drill cuttings), and the name and phone number of an AKRF point-of-contact. All IDW collected into drums will be sampled and disposed of or treated according to applicable local, state, and federal regulations. Purged groundwater will be poured into the on-site LNAPL groundwater treatment system.

4.0 SAMPLING AND LABORATORY PROCEDURES

4.1 SOIL SAMPLING

The PID will be calibrated in accordance with manufacturer's recommendations prior to sampling.

Soil sampling will be conducted according to the following procedures:

- Characterize the sample according to the modified Burmister soil classification system.
- Describing any evidence of contamination (e.g., non-aqueous phase liquid (NAPL), staining, sheens, odors)
- Field screen the sample for evidence of contamination (e.g., odors, staining,) using visual and olfactory methods and screen for volatile organic compounds (VOCs) using a photoionization detector (PID) calibrated each day in accordance with the manufacturer's instructions. Since 1,2-DCA, a main constituent of concern (COC) at the Site, and has an electron volt (eV) value of 11.04, the PID will be equipped with an 11.7 eV lamp to be able to detect 1,2-DCA.
- Collect an aliquot of soil from each proposed sample location, place in laboratory-supplied glassware, label the sample in accordance with Section 4.6.1.1, Table 2 of this QAPP, and place in an ice-filled cooler for shipment to the laboratory.
- Complete the proper chain of custody paperwork and seal the cooler.
- Record sample location, sample depth, and sample observations (evidence of contamination, PID readings, soil classification, etc.) in field log book and boring log data sheet, if applicable.
- Decontaminate any soil sampling equipment between sample locations as described in Section 3.4 of this QAPP.

4.2 MONITORING WELL SAMPLING

Groundwater samples will be collected at least one week following well development. Low flow sampling techniques will be used, as described in U.S. EPA's Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers [EPA 542-S-02-001, May 2002]. The first full round of groundwater sampling indicated in the RIWP will include collection of samples for emerging contaminants [1,4-dioxane and perfluorinated compounds (PFCs)]. Whenever emerging contaminants are included in the sampling scope, groundwater samples will be collected in accordance with NYSDEC's published protocols, including the acceptable/specific sampling materials, equipment, and QA/QC requirements. A copy of NYSDEC's protocol and

guidance document is included in Appendix B. Sampling will be conducted according to the following procedure:

- Prepare the sampling area by placing plastic sheeting over the well. Cut a hole in the sheeting to provide access to the well cover.
- Slowly remove the locking cap and immediately measure the vapor concentrations in the well with a PID calibrated to the manufacturer's specifications.
- Measure the depth to water and total well depth, and check for the presence of NAPL using an oil/water interface probe. Measure the thickness of NAPL, if any, and record in field book and well log. Groundwater samples will not be collected from wells containing measurable NAPL.
- Use the water level and total well depth measurements to calculate the length of the mid-point of the water column within the screened interval. For example, for a well where the total depth is 20 feet, screened interval is 10 to 20 feet, and depth to water is 14 feet, the mid-point of the water column within the screened interval would be 17 feet.
- Connect dedicated tubing to either a submersible, bladder pump, or peristaltic pump, and lower the pump such that the intake of the pump is set at the mid-point of the water column within the screened interval of the well. Connect the discharge end of the tubing to the flow-through cell of a YSI multi-parameter (or equivalent) meter. Connect tubing to the output of the cell and place the discharge end of the tubing in a five-gallon bucket. Since each on-site NAPL recovery well requires purging with a peristaltic pump, the 1-inch wells (existing and proposed) have a limited diameter for access, and a peristaltic has been used for all previous sampling events, AKRF recommends purging each well with a peristaltic for consistency. The peristaltic pump will allow for sample collection without the need for high density bladders when analyzing for emerging contaminants and minimize the potential for tainting the samples during collection.
- Activate the pump at the lowest flow rate setting of the pump.
- Measure the depth to water within the well. The pump flow rate may be increased such that the water level measurements do not change by more than 0.3 feet as compared to the initial static reading. The well-purging rate should be adjusted so as to produce a smooth, constant (laminar) flow rate and so as not to produce excessive turbulence in the well. The expected targeted purge rate will be approximately 0.5 liters and will be no greater than 3.8 liters/minute.
- Transfer discharged water from the 5-gallon buckets to on-site LNAPL remediation system.
- During purging, collect periodic samples and analyze for water quality indicators (e.g., turbidity, pH, temperature, dissolved oxygen, reduction-oxidation potential, and specific conductivity) with measurements collected approximately every five minutes.
- Continue purging the well until turbidity is less than 50 NTU and water quality indicators have stabilized to the extent practicable. The criteria for stabilization will be three successive readings for the following parameters and criteria:

Table 1
Stabilization Criteria

Parameter	Stabilization Criteria
PH	+/- 0.1 pH units

Specific Conductance	+/- 3% mS/cm
ORP/Eh	+/- 10mV
Turbidity	<50 NTU
Dissolved Oxygen	+/- 0.3 mg/l

Notes: mS/cm = millisievert per centimeter
mV = millivolts
NTU = nephthalometric turbidity units
mg/l = milligrams per liter

- If the water quality parameters do not stabilize and/or turbidity is greater than 50 NTU within two hours, purging may be discontinued. Efforts to stabilize the water quality for the well must be recorded in the field book, and samples may then be collected as described herein.
- After purging, disconnect the tubing to the inlet of the flow-through cell. Collect groundwater samples directly from the discharge end of the tubing and place into the required sample containers as described in Section 4.4 of this QAPP. Label the containers as described in Section 4.6.1.1, Table 2 of this QAPP and place in a chilled cooler.
- Once sampling is complete, remove the pump and tubing from the well. Dispose of the sampling materials and PPE in a designated 55-gallon drum. The purge water will be managed as described in Section 3.5 of this QAPP.
- Decontaminate the pump (where necessary), oil/water interface probe, and flow-through cell, as described in Section 3.4 of this QAPP.
- Record all measurements (depth to water, depth to NAPL, water quality parameters, turbidity), calculations (well volume) and observations in the project logbook and field data sheet, if applicable.

4.3 SOIL GAS SAMPLING

The soil gas sampling (and concurrent indoor air sampling) will be conducted during the normal 8-hour workday at the facility. Eight-hour flow regulators will be used for the sampling. Soil gas samples will be collected using the following procedures

4.3.1 Sample Set-up

1. Install a 2-foot by 2-foot 6-mil plastic shroud over sampling point, seal to concrete floor using duct tape along the perimeter, and pull the Teflon soil gas sampling tubing through the shroud to allow for sampling collection.
2. Pierce the plastic shroud, insert one of new tubing into the shroud, and connect the other end of the tubing to the helium tank.
3. Install new flexible hose to a peristaltic pump and connect the Teflon sample tubing to the hose. Connect the other end (discharge end) of the flexible tubing to a 0.5-liter Tedlar bag. Purge the soil gas sampler of approximately three sampler volumes (0.4 liters) by activating the pump to fill the Tedlar bag to near capacity (see Attachment B for sampler volume calculations). The air withdrawal flow rate shall be 0.2 liters/minute or less.
4. During purging, a flow of helium gas will be introduced into the plastic shroud overlying the soil gas sampling point. The Tedlar bag will be analyzed in the field using a Marks Model 9822 helium detector to check for short-circuiting of outside air into the sampling port. If helium is detected at a concentration of greater than 10 percent, then the soil gas point will be

resealed with hydrated bentonite. The point will then be retested to ensure that the helium concentration is less than 10 percent.

5. Disconnect the sample tubing from the peristaltic pump and connect it to the inlet of a labeled 1-liter Summa canister.
6. Repeat procedure for all sampling locations.

4.3.2 Sample Collection

1. After Summa canisters are set up at all of the sampling locations, record the vacuum reading from the vacuum gauge on the canister at the beginning of the 8-hour sampling period. Open the valve of the canister and record the time in the field book.
2. At the end of the 8-hour sampling period, close the valve, remove the flow-rate controllers and vacuum gauges, install caps on canisters, and record the time at the end of the sampling period.
3. Place canisters in shipping containers for transportation to laboratory.
4. Repeat procedure for all sampling locations.

4.4 LABORATORY METHODS

Table 1 summarizes the laboratory methods that will be used to analyze field samples and the sample container type, preservation, and applicable holding times. TestAmerica of Edison, New Jersey, a NYSDOH ELAP-certified laboratory subcontracted to AKRF, will be used for all chemical analyses in accordance with the Division of Environmental Remediation (DER)-10 2.1(b) and 2.1(f) with Category B Deliverables. TestAmerica will achieve a minimum detection limit of 0.28 microgram per liter (µg/L) for 1,4-dioxane and 2 nanograms per liter (ng/L) for the standard list of 21 per- and polyfluoroalkyl substances (PFAS) compounds.

Table 1
Laboratory Analytical Methods for Analysis Groups

Matrix	Analysis	EPA Method	Bottle Type	Preservative	Hold Time
Soil	Volatile Organic Compounds (VOCs)	8260C	EnCore samplers (3) and 2 oz. plastic jar	≤ 6 °C	48 hours to extract; 14 days to analyze
	Semivolatile Organic Compounds (SVOCs)	8270D	8 oz. Glass Jar	≤ 6 °C	14 days to extract; 40 days to analyze
Groundwater	VOCs	8260C	3 40 mL Glass Vials	HCl to pH < 2 and ≤ 6 °C	14 days to analyze
	1,4-Dioxane	8270D - Selective Ion Monitoring (SIM)	2 x 250 mL amber bottles	≤ 6 °C	7 days to extract; 40 days to analyze
	SVOCs	8270D	2,000 mL Amber Jar	≤ 6 °C	7 days to extract; 40 days to analyze
	Standard List of 21 Per- and Polyfluoroalkyl Substances (PFAS) Compounds	Modified 537	2 x 250 mL plastic HDPE bottles (no Teflon)	≤ 6 °C,	14 days to extract, 28 days to analyze
Soil Vapor	VOCs	TO-15	6L SUMMA® Canister	None	14 days

Notes:
EPA - Environmental Protection Agency
RCRA – Resource Conservation and Recovery Act
HDPE – High Density Poly Ethylene

4.5 QUALITY CONTROL (QC) SAMPLING

In addition to the laboratory analysis of the soil samples, additional analysis will be included for QC measures, as required by the Category B sampling techniques. These samples will include field blank, trip blank, matrix spike/matrix spike duplicate (MS/MSD), and blind duplicate samples at a frequency of one sample per 20 field samples collected or per sample digestion group (SDG). QC samples will be analyzed for the same parameters as the accompanying samples, with the exception of any trip blanks, which will be analyzed for the VOC list only.

4.6 SAMPLE HANDLING

4.6.1 Sample Identification

All samples will be consistently identified in all field documentation, chain-of-custody (COC) documents, and laboratory reports. All samples will be amended with a collection date at the end of the sample same in a year, month, day (YYYYMMDD) format. Blind duplicate sample nomenclature will consist of the sample type, followed by an "X"; MS/MSD samples nomenclature will consist of the parent sample name, followed by "MS/MSD"; and trip and field blanks will consist of "TB-" and "FB-", respectively, followed by a sequential number of the trip/field blanks collected within the sample digestion group (SDG). Special characters, including primes/apostrophes (’), will not be used for sample nomenclature.

4.6.1.1. Remedial Investigation (RI) Sample Identification

Soil and groundwater samples collected during the RI will be identified with "SB-" for soil borings, "MW-" for groundwater monitoring wells, or "SG/IA" for soil gas/indoor air sampling locations, and the soil boring, groundwater monitoring well, or soil gas/indoor air number. Soil samples will also be amended with the sample collection depth interval in parentheses. Table 2 provides examples of the sampling identification scheme for samples collected during the site investigation.

Table 2
RI Sample Nomenclature

Sample Description	Sample Designation
Groundwater sample collected from groundwater monitoring well MW-7 on August 1, 2017	MW-7 20170801
Matrix spike/matrix spike duplicate sample of groundwater sample collected from groundwater monitoring well MW-7 on August 1, 2017	MW-7 MS/MSD 20170801
Blind duplicate sample of groundwater sample collected from groundwater monitoring well MW-7 on August 1, 2017	MW-X 20170801
Second field blank collected on August 1, 2017	TB-2 20170801
Soil sample collected from soil boring SB-26 between 12 and 14 feet below basement grade on August 1, 2017	SB-26 (12-14) 20170801
Blind duplicate sample of soil sample collected from soil boring SB-26 between 12 and 14 feet below grade on August 1, 2017	SB-X (12-14) 20170801
Soil gas and indoor air sample collected from soil gas point SG-1 on August 1, 2017	SG/IA-1 20170801

4.6.1.2. Waste Classification

Any waste classification samples will be amended with "WC-" and the alphanumeric drum identification. Table 3 provides examples of the sampling identification scheme for proposed waste classification samples and any hotspot or tank excavation samples.

Table 3
Waste Classification/Tank Excavation Sample Nomenclature

Sample Description	Sample Designation
Waste classification sample collected from Drum 1 on August 1, 2017	WC-D1 20170801

Sample Labeling and Shipping

All sample containers will be provided with labels containing the following information:

- Project identification, including Site name, BCP Site number, Site address
- Sample identification

- Date and time of collection
- Analysis(es) to be performed
- Sampler's initials

Once the samples are collected and labeled, they will be placed in chilled coolers and stored in a cool area away from direct sunlight to await shipment to the laboratory. All samples will be shipped to the laboratory at least twice per week. At the start and end of each workday, field personnel will add ice to the cooler(s) as needed.

The samples will be prepared for shipment by placing each sample in laboratory-supplied glassware, then wrapping each container in bubble wrap to prevent breakage, and adding freezer packs and/or fresh ice in sealable plastic bags. The COC form will be properly completed by the sampler in ink, and all sample shipment transactions will be documented with signatures, and the date and time of custody transfer. Samples will be shipped overnight (e.g., Federal Express) or transported by a laboratory courier. All coolers shipped to the laboratory will be sealed with mailing tape and a COC seal to ensure that the samples remain under strict COC protocol.

Sample Custody

Field personnel will be responsible for maintaining the sample coolers in a secured location until they are picked up and/or sent to the laboratory. The record of possession of samples from the time they are obtained in the field to the time they are delivered to the laboratory or shipped off-site will be documented on COC forms. The COC forms will contain the following information: project name; names of sampling personnel; sample number; date and time of collection and matrix; and signatures of individuals involved in sample transfer, and the dates and times of transfers. Laboratory personnel will note the condition of the custody seal and sample containers at sample check-in.

4.7 FIELD INSTRUMENTATION

Field personnel will be trained in the proper operation of all field instruments at the start of the field program. Instruction manuals for the equipment will be on file at the Site for referencing proper operation, maintenance, and calibration procedures. The equipment will be calibrated according to manufacturer specifications at the start of each day of fieldwork. If an instrument fails calibration, the project manager or QA/QC officer will be contacted immediately to obtain a replacement instrument. A calibration log will be maintained to record the date of each calibration, any failure to calibrate and corrective actions taken. The PID will be equipped with an 11.7 electron volt (eV) lamp and will be calibrated each day using 100 parts per million (ppm) isobutylene standard gas in accordance with the manufacturer's standards.

4.8 QUALITY ASSURANCE (QA)

All soil and groundwater laboratory analytical data will be reviewed by a third-party validator and a Data Usability Summary Report (DUSR) will be prepared to document the usability and validity of the data. The Final Engineering Report (FER) will include a detailed description of endpoint sampling activities, data summary tables, concentration map showing endpoint sample locations and concentrations, DUSR, and laboratory reports.

ATTACHMENT A

RESUMES OF PROJECT DIRECTOR, PROJECT MANAGER, PROJECT MANAGER ALTERNATE, AND FIELD TEAM LEADER

MARC S. GODICK, LEP

SENIOR VICE PRESIDENT

Marc S. Godick, a Senior Vice President of the firm, has 20 years of experience in the environmental consulting industry. Mr. Godick's broad-based environmental experience includes expertise in remedial investigation, design and implementation of remedial measures, environmental/compliance assessment, litigation support, and storage tank management.

RELEVANT EXPERIENCE

Queens West Development Project, AvalonBay Communities, Queens, NY

Mr. Godick managed one of the largest remediation projects completed to date under the New York State Department of Environmental Conservation (NYSDEC) Brownfields Cleanup Program (BCP). The remedy for the site, which was contaminated by coal tar and petroleum, included the installation of a hydraulic barrier (sheet pile cut off wall), excavation of contaminated soil under a temporary structure to control odors during remediation, a vapor mitigation system below the buildings, and implementation of institution controls. The investigation, remediation design, remedy implementation, and final sign-off (issuance of Certificate of Completion) were completed in two years. Total remediation costs were in excess of $13 million.

Williamsburg Waterfront Redevelopment, RD Management/L&M Equities/Toll Brothers, Brooklyn, NY

The project is one of the largest development projects in the Greenpoint/Williamsburg Rezoning Area, which includes the construction of nearly 1 million square feet of residential and retail space along the Williamsburg waterfront. The site had a variety of industrial uses, including a railyard, junk yard, and waste transfer station. As part of the City's rezoning, the site was assigned an E-designation for hazardous materials. Mr. Godick managed the preparation of the Phase I and II environmental site assessments, remedial action plan (RAP), and construction health and safety plan (CHASP). Mr. Godick obtained NYSDEC closure of an open spill associated with former underground storage tanks at the site. The NYCDEP-approved RAP and CHASP included provisions for reuse of the existing fill material, with the excess being disposed off-site, installation of a vapor barrier below the new buildings, installation of a site cap, and environmental monitoring during the construction activities. Mr. Godick is currently managing the environmental monitoring work that began in 2006. A Notice of Satisfaction has been issued by NYCDEP for the first phase of the development.

BACKGROUND

Education

M.E., Engineering Science/Environmental Engineering, Pennsylvania State University, 1998

B.S., Chemical Engineering, Carnegie Mellon University, 1989

Licenses/Certifications

Licensed Environmental Professional (License # 396) – State of Connecticut – 2003

40 Hour HAZWOPER and Annual Refresher Training, 1990-2008

Supervisors of Hazardous Waste Operations (8 Hour), 1990

Professional Memberships

Chair, Village of Larchmont/Town of Mamaroneck Coastal Zone Management Commission, 1997 - Present

Chair, Westchester County Soil and Water Conservation District, 2005 - Present

Member, NYSDEC Risk-Based Corrective Action (RBCA) Advisory Group for Petroleum-Impacted Sites, 1997

Community Leadership Alliance, Pace University School of Law, 2001

Years of Experience

Year started in company: 2002

Year started in industry: 1990

Landfill Closure & Compost Facility Application, White Plains, NY

Mr. Godick is currently managing the closure of a formal ash landfill, which is currently being utilized as a leaf and yard waste compost facility by the City of White Plains. The remedial investigation included on-site and off-site assessment of soil, groundwater, and soil gas to delineate the extent of methane and solvent contamination associated with the landfill. The landfill closure plan includes provisions for enhancing the existing cap, methane venting, and groundwater treatment for solvent contamination. Mr. Godick also managed the preparation of the compost facility permit application, which required modification to the facility's operations necessary to close the landfill and address other regulatory requirements.

Landfill Redevelopment – RD Management, Orangeburg, NY

Mr. Godick is currently managing the remediation of the former Orangeburg Pipe site under the NYSDEC Voluntary Cleanup Program. The site contains widespread fill material, which has fragments of Orangeburg pipe that is impregnated with asbestos and coal tar. The site is being redeveloped for retail use. The site's closure plan provides for reuse of all fill material on-site and methane mitigation (vapor barrier and passive sub-slab ventilation system) for all new buildings. The fill management activities will include dust and sediment control measures and air monitoring to prevent airborne dust in accordance with a closure plan, stormwater pollution prevention plan (SWPPP), and CHASP. In pervious areas, the site cap will consist of 2 feet of clean fill and a liner in larger areas.

National Grid – Halesite Manufactured Gas Plant Site, Town of Huntington, NY

Mr. Godick managed the remedial design and engineering work associated with remediation of National Grid's former manufactured gas plant (MGP) located in the Town of Huntington. The site is situated in a sensitive location along the waterfront, surrounded by commercial and residential properties, and half the property where the remediation was conducted is a steep slope. The remedy consisted of soil removal, oxygen injection, and non-aqueous phase liquid recovery. Mr. Godick was responsible for the development of the remedial work plans, design/construction documents, landscape architecture, confirmatory sampling, air monitoring, supervision, and preparation of close-out documentation in accordance with NYSDEC requirements.

Site Investigation–7 World Trade Center Substation, Con Edison, New York, NY

Mr. Godick managed the site investigation at the former 7 World Trade Center Substation in an effort to delineate and recover approximately 140,000 gallons of transformer and feeder oil following the collapse of the building. The project involved coordination with several crews, Con Edison, and other site personnel.

Site Investigation–Former Manufactured Gas Plant (MGP) Facilities, Con Edison, New York, NY

Mr. Godick managed site investigations at four former MGP facilities. The investigations at three of the four sites were completed at a Con Edison substation, flush pit facility, and service center, respectively. The details associated with the fourth site are confidential. Site characterizations at the substation and flush pit facility were conducted in preparation of expansion at these locations. The findings from these characterizations were used by Con Edison to make appropriate changes to the design specifications and to plan for appropriate handling of impacted materials and health and safety protocols during future construction activities.

Verizon, Investigation & Remediation, Various Locations, NY, PA and DE

Mr. Godick managed over 50 geologic/hydrogeologic assessments and site remediation projects related to petroleum releases at various facilities. Responsibilities included annual budgeting, day-to-day project management, development and implementation of soil and ground water investigation workplans, ground water modeling, risk evaluation, remedial action work plans, remedial design, system installation, waste disposal, well abandonment, and operation and maintenance. Many of the assessment and remedial projects followed a risk-based approach. Remedial technologies implemented included air sparging, soil vapor extraction, bioremediation, pump and treat, soil excavation, and natural attenuation.

Storage Tank Management, Verizon, Various Locations, NY, PA, DE, and MA

Mr. Godick managed the removal and replacement of underground and aboveground storage tank systems for Verizon in New York, Pennsylvania, Delaware, and Massachusetts. Responsibilities included the management of design, preparation of specifications, contractor bidding, construction oversight, project budget, and documentation. For selected AST sites, managed the development of Spill Control, Contingency and Countermeasures (SPCC) plans.

Brownfield Opportunity Area (BOA) Grant Program Services for the Town of Babylon, Wyandanch, NY

AKRF was retained by the Town of Babylon to prepare a blight study, market study, NYS BOA Step 2 Nomination, an Urban Renewal Plan, and a Generic Environmental Impact Statement (GEIS) as part of a revitalization and redevelopment effort for downtown Wyandanch. Mr. Godick was responsible for overseeing the environmental data collection effort for the 226 brownfields identified in the 105-acre project area, and for identifying strategic sites for which site assessment funding should be sought. He also prepared the Hazardous Materials section of the Wyandanch Downtown Revitalization Plan (which incorporates the Nomination, Urban Renewal Plan, and GEIS), involving a summary of available environmental reports, a review of regulatory records, and limited street-level site inspections.

Alexander Street Urban Renewal Plan, Master Plan, Brownfield Opportunity Area Plan, Yonkers, NY

AKRF was retained by the City of Yonkers to prepare an Urban Renewal Plan, Master Plan, Brownfield Opportunity Area Plan, and a Generic Environmental Impact Statement (GEIS) for a 153 acre industrial area along Alexander Street on the Yonkers Waterfront. Mr. Godick was responsible for the Hazardous Materials sections of the GEIS and Urban Renewal Plan. Mr. Godick managed the environmental data collection effort for the entire study area which involved review and summary of existing environmental reports, a review of regulatory records, and field inspections. The collected information was used to prioritize individual parcels for funding and remediation. The Master Plan for the area called for the development of a mixed-use neighborhood consisting of residential, neighborhood retail, and office space uses with substantial public open space, access to the Hudson River, and marina facilities.

SEMINARS, LECTURES & PUBLICATIONS

"Let Nature Do the Work – Onsite Stormwater Management," Westchester County Department of Parks, Recreation and Conservation, Fall 2003

"Water Pollution Control and Site Assessments and Audits," Environmental Health and Safety Issues Course, Building Owners and Managers Institute (BOMI), 1997-1999

"Hydrogeologic and Geological Aspects of Tank Closures and Remedial Action," Underground Storage Tanks Course, Government Institutes, Summer 1996, Fall 1997

BRYAN ZIEROFF, LEP

SENIOR HYDROGEOLOGIST

Bryan Zieroff has 15 years of experience in the environmental consulting industry. Mr. Zieroff's experience includes the conceptual design, implementation and reporting of detailed field investigations including assessments of ground-water supplies for residential, municipal and industrial users, and evaluation, monitoring and remediation of soil and ground-water contamination for sites regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), Connecticut's Remediation Standard Regulations, and by the New York State Department of Environmental Conservation's (New York State Department of Environmental Conservation's (NYSDEC)) cleanup programs. These studies include investigations at sites impacted by petroleum products, chlorinated solvents, metals and landfill leachate. Mr. Zieroff's tasks often include characterization of the extent of contamination in soil, ground water, and soil vapor, evaluation of compliance with the established regulatory criteria, and operation and maintenance of remediation systems. Mr. Zieroff's familiarity with various field investigation techniques enhances his management skills.

BACKGROUND

Education

B.S., Geological Sciences, The Ohio State University, 1994

Licenses/Certifications

Certified Professional Geologist-American Institute of Professional Geologists, License # CPG-11197

40 Hour HAZWOPER and Annual Refresher Training

Supervisors of Hazardous Waste Operations (8 Hour)

Professional Memberships

American Institute of Professional Geologists

Association of Ground-Water Scientists and Engineers (National Ground Water Association)

Environmental Professionals' Organization of Connecticut (EPOC)

Years of Experience

Year started in company: 2006

Year started in industry: 1995

RELEVANT EXPERIENCE

Gedney Way Leaf and Yard Waste Composting Facility, White Plains, NY

Mr. Zieroff is Project Manager for a remediation and landfill closure project at an existing composting facility. The project included documenting the entire disposal history and completing a site-wide investigation to confirm the extent of a solvent release and to provide data necessary to complete landfill closure. The investigation was required to satisfy the requirements in the NYSDEC DER-10 and 6NYCRR Part 360. After receiving state approval of the Site Investigation Report, the project has moved into the remediation and landfill closure design phase. The remedial design includes the testing and implementation of a chemical oxidation injection program, and landfill closure includes design, state approval, and construction of a landfill cap.

New City Plaza, New City, NY

Mr. Zieroff is Project Manager for an investigation and remediation project at a former dry cleaning facility. Investigation and remediation at the site currently are being conducted under review of the NYSDEC Brownfield Cleanup Program. Tasks have included preparation and state approval of a Site Investigation Work Plan, Site Quality Assurance Project Plan, Health and Safety Plan, a Community Participation Plan, and completion of the investigation phase of the Brownfield's program. Interim Remedial activities include contamination source removal from soil and installation of a sub-slab depressurization system to address soil vapor. A feasibility study is currently being completed to determine the optimal remedial approach for site-wide remediation.

Orangeburg Pipe Site, Orangeburg, NY

Mr. Zieroff completed a subsurface investigation to determine the extent of soil and groundwater contamination at the former Orangeburg Pipe facility. The investigation results were used to develop a Remedial Action Plan to address solid waste, petroleum contamination, worker safety during site development, and capping requirements to satisfy the NYSDEC Voluntary Remediation Program. The Remedial Action Plan included a Heath and Safety Plan, Community Air Monitoring Plan, and specifications for soil management, a vapor mitigation system and dewatering procedures during the construction of multiple commercial buildings.

Magna Metals Facility, Cortlandt, NY

Mr. Zieroff managed a soil-gas investigation project at an existing commercial warehouse and office building. The project included installation of permanent soil gas sampling points and completion of a sampling program that met the requirements of the New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York. Site activities included a pre-sampling investigation with the NYSDOH to document materials storage, air flow specifications, historical uses, site uses and areas of concern for sub-slab and ambient air sampling. The investigation work was being conducted to satisfy the NYSDEC consent order.

Paragon Paint Company Facility, Long Island City, NY

Mr. Zieroff was Project Manager for an investigation and remediation project at a former paint manufacturing facility. The project has included a multiple subsurface investigations to determine the extent of solvent and petroleum contamination at the site. All phases of remediation at the site are being completed under review of the NYSDEC Brownfield Cleanup Program. Tasks include completion and state approval of a Site Investigation Work Plan, Quality Assurance Project Plan, Health and Safety Plan, Community Participation Plan, Remedial Action Plan, and Final Remediation Report.

Pathmark Stores Site, Bronx, NY

Mr. Zieroff completed a Remedial Action Plan, Construction Health and Safety Plan and a Soil Management Plan for a former materials storage facility associated with Manhattan College. The plans were completed to provide worker safety and soil handling guidelines during the construction of a large retail facility and parking garage. Development activities at the site were conducted under oversight of the New York City Department of Environmental Protection (NYCDEP). A Notice of Satisfaction was received after project completion.

Yale and Towne Site, Stamford, CT

Mr. Zieroff provided oversight services for a remediation project at a former industrial site. The site included over 35 buildings and 87 areas of environmental concern that required investigation and remediation. Tasks included providing technical support in understanding the Connecticut regulatory requirements, investigation and remediation costs, and confirmation of appropriate schedules to address the environmental issues during redevelopment of the project site.

Aluminum Company of America (ALCOA) Facility, Guilford, CT

Mr. Zieroff managed a ground-water remediation project at an existing aluminum manufacturing facility. The project included soil, vapor and ground-water sampling to confirm the extent of a solvent release, determination of ground water and aquifer characteristics, operation and maintenance of a ground-water pump-and-treat system and compliance sampling in association with a Connecticut Department of Environmental Protections (CTDEP) consent order.

Coats North America Facility, Watertown, CT

Mr. Zieroff was the Project Manager for site compliance work at an existing synthetic treads facility. The project included an evaluation of activities, chemical uses and waste handling practices to determine areas of environmental concern. Investigations to determine the status of these areas included installation of monitoring wells, soil and ground-water sampling, soil-vapor sampling, liquid storage tank removal and Resource Conservation and Recovery Act (RCRA) closure of waste storage areas. The project activities were completed in compliance with the CTDEP property transfer program.

United Parcel Service, Storm Water Management, 9 Connecticut Facilities

Mr. Zieroff managed the design and implementation of a storm water pollution prevention project at nine United Parcel Service facilities. The project included analysis of drainage areas, determination of sheet flow characteristics and the collection of storm-water discharge samples and SMR reporting in accordance with the CTDEP General Permit for the Discharge of Storm Water.

Meriden Enterprise Center, Meriden, CT

Mr. Zieroff developed and directed a subsurface investigation to determine the nature and extent of contamination related to releases from multiple underground storage tank farms, silverware plating, machining and furniture stripping operations. Project activities included ground-penetrating radar, drilling of test borings, installation of monitoring wells, developing a conceptual site model for the established releases and preparing a report detailing remedial alternatives for the property and owner requirements under the CTDEP Property Transfer Act.

Development properties in Kent, Ridgefield, and Greenwich, CT and Mahopac and Brewster, NY

Mr. Zieroff directed an evaluation and testing program of bedrock water-supply wells to determine long-term yield, impact on local users, and water quality results. The project included compilation of data, construction of hydrographs, determination of aquifer characteristics and reporting.

Bettsville Quarry, Bettsville, OH

Mr. Zieroff directed a pumping test of dewatering wells to determine yield requirements for dewatering a carbonate rock quarry. The dewatering program included a determination of offsite impacts to local ground-water users. Mr. Zieroff developed an offsite monitoring program to document and protect local users during the quarry dewatering process.

Burning Tree Country Club, Greenwich, CT

Mr. Zieroff directed an in-situ percolation test to determine recharge rates for a proposed upgrade to the facility septic system. The project included compilation of slug test data and software analysis to determine K values.

MARCUS SIMONS

SENIOR VICE PRESIDENT

Marcus Simons is a Senior Vice President of AKRF with more than 25 years of environmental consulting experience, specializing in the assessment and cleanup of contaminated sites, including federal and state superfund, RCRA, TSCA, brownfield, voluntary cleanup and spill sites. His expertise includes health risk assessment, development of sampling plans, economic evaluations of remedial alternatives, and regulatory analysis. He is also AKRF's Health and Safety Officer with extensive experience of Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) issues during sampling and remediation of contaminated sites.

Mr. Simons directs much of AKRF environmental due diligence work (recently managing environmental due diligence for the Peter Cooper/Stuyvesant Town acquisition, reportedly the largest real estate transaction in US history), including supervising preparation of numerous Phase I and Phase II Environmental Site Assessments, as well as more complex multi-site and litigation-related projects. Mr. Simons manages preparation of the contaminated-materials portions of AKRF's Environmental Impact Statements and Environmental Assessments and has experience with procedures for hazardous material requirements under NEPA and New York SEQRA/CEQR, E-designation, BCP and VCP programs. He also has extensive experience in statistics, selection of sites for controversial facilities, and federal and state wetland regulations and waterfront permitting. In addition to analytical work, Mr. Simons has considerable experience in presenting results to regulatory agencies and the general public.

Mr. Simons has managed some of the most complex cleanup sites in New York State including: the cleanup of a 12-acre PCB-contaminated former utility property in Flushing, Queens where a 3 million square foot retail/residential building was constructed (remediation was performed under the State Brownfield Cleanup Program, though the site was also subject to City jurisdiction under its E-Designation program); cleanup of the nation's largest former dental factory in Staten Island for reuse as single family housing; the investigation of several former manufactured gas plants; and the investigation and remediation associated with the reconstruction of the West Side Highway and Hudson River Park in Manhattan (from the Battery to 59th Street), Brooklyn Bridge Park, and Governors Island. Mr. Simons also has extensive experience with transportation projects (Second Avenue Subway, MTA/LIRR East Side Access, 7-Train Extension, Cross Harbor Freight Movement Study, Route 9A Reconstruction), large-scale rezoning projects (Long Island City, Greenpoint/Williamsburg, Downtown Brooklyn, Jamaica) and public and private redevelopment work (World Trade Center Reconstruction, The New York Wheel, Atlantic Yards, School Construction Authority, Queens West)

BACKGROUND

Education

M.S., Engineering and Public Policy, Carnegie-Mellon University, 1988

M.A. and B.A. (Honors), Mathematics/Engineering, Cambridge University, England, 1986

Certifications

Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) – 40 Hour Site Worker and 8 Hour Site Supervisor

Years of Experience

Year started in company: 1995

Year started in industry: 1988

RELEVANT EXPERIENCE

CE Flushing Site, Flushing, NY

Mr. Simons directed the remediation of a former industrial site in Flushing, Queens, NY prior to its redevelopment as a 3 million square foot retail/residential complex. The property was cleaned up under the NYS Department of Environmental Conservation Brownfield Cleanup Program and the NYC Department of Environmental Protection's E-Designation requirements. The remedial measures included the removal of aboveground and underground storage tanks, excavation and off-site disposal of TSCA, RCRA and non-hazardous wastes, NAPL removal, and removal and investigation of on-site drainage structures. The remediation and subsequent construction involved obtaining (or obtaining waivers from) numerous permits including those for NYSDEC Tidal Wetlands, NYSDEC Long Island Wells, NYSDEC SPDES/Stormwater and NYCDEP Sewer Use.

Peter Cooper Village/Stuyvesant Town, New York, NY

Mr. Simons directed environmental due diligence efforts for the two most recent purchasers of this 80-acre property in Manhattan. Much of the 110-building complex is underlain by former manufactured gas plants and Con Edison entered the site into NYSDEC's Voluntary Cleanup Program. Going forward Mr. Simons manages oversight of activities that involve disturbance of MGP-contaminated soils, as well as future testing and potentially remediation.

The New York Wheel, Staten Island, NY

Mr. Simons directed the hazardous materials environmental review for the project which is being built on the site of an old railyard and is subject to both NYSDEC Brownfield Cleanup Program and NYCDEP remediation requirements. Remediation of the site is being performed during the ongoing construction.

Governors Island, New York, NY

Mr. Simons directed the hazardous materials environmental review for the project which involves converting one of the nation's oldest military bases to primarily park usage. In addition to managing the hazardous materials environmental review for the project's approvals, Mr. Simons developed testing requirements for the millions of yards of imported 9and reused0 soils/materials necessary to create the new park's topography and landscape.

MTA New York City Transit Manhattan East Side Transit Alternative (MESA)/Second Avenue Subway, New York, NY

Mr. Simons directed the contaminated material assessment for this multi-billion dollar transit initiative that would provide subway service to Manhattan's East Side. The assessment identified several hundred facilities along the alignment that could have impacted soil and/or groundwater and could require special materials handling and enhanced health and safety procedures. Additional evaluation of these sites is underway.

Ferry Point Park, Bronx, NY

Mr. Simons developed the material acceptance criteria (soil standards for capping materials) for the development of Ferry Point Park (including a golf course) in the Bronx. The New York City Department of Environmental Protection DEP and the New York State Departments of Health (DOH) and Environmental Conservation (DEC) agreed for the first time to relax their then strict (TAGM 4046) criteria for clean soil, based on statistical analyses of background conditions and risk-based modeling.

Prince's Point, Staten Island, NY

Mr. Simons managed the complex cleanup (including the relocation of a contaminated tidal creek) of the nation's largest former dental factory site on Staten Island's waterfront. The site was on the State Superfund list. The future use of the site as single-family residential property entailed extensive negotiations with NYSDEC and NYSDOH. The project required obtaining (or obtaining waivers from) numerous permits including those for NYSDEC Tidal

and Fresh Water Wetlands, USACOE (Nationwide) Permits, NYSDEC Coastal Erosion Hazard Area, NYSDEC SPDES and Stormwater, FEMA Modifications to Land in Floodplain, and USEPA Notification of PCB Waste Activity.

Route 9A Reconstruction, New York, NY

AKRF directed extensive studies for the reconstruction in Lower Manhattan proposed by the New York State Department of Transportation (NYSDOT) in cooperation with the Federal Highway Administration (FHWA). The project is arguably the most complex environmental analyses performed for a federally funded transportation project in New York City in the last 10 years. The firm was responsible for all environmental tasks as well as the preparation for the Draft, Supplementary, and Final Environmental Impact Statements (EISs) and Section 4(f) Evaluation for this 5-mile $250 million reconstruction of Route 9A as part of the recovery effort following the events of September 11th, 2001. Mr. Simons managed the extensive hazardous materials investigations and prepared the contract specifications for contaminated soil and tank removal, including Health and Safety oversight.

Hudson River Park, New York, NY

Mr. Simons is managing hazardous materials issues for the ongoing Hudson River Park construction, located adjacent to the Route 9A roadway. Construction is ongoing and Mr. Simons directs health and safety oversight and remediation during construction.

Jamaica Rezoning, Queens, NY

As part of the preparation of an Environmental Impact Statement, Mr. Simons managed the hazardous materials assessment of a multi-block area. In addition to conducting the assessment, Mr. Simons made recommendation as to the properties where "E-Designations" (city-recorded institutional controls on future development) should be placed.

Outlet City, Long Island City, Queens, NY

In Long Island City, Mr. Simons managed the investigation and interim remediation of an old factory complex where large volumes of creosote were spilled. The investigations and interim remedial measures (IRMs) took place under the New York State's Voluntary Cleanup Program (VCP).

MTA/LIRR East Side Access Project, New York, NY

Mr. Simons managed the hazardous materials investigations for multiple sites in the Bronx, Manhattan, and Queens associated with the Environmental Impact Statement (EIS) for the Long Island Rail Road connection to Grand Central Terminal. Mr. Simons continues to be involved in health and safety oversight related to the construction of the project.

New York City Department of Transportation, Lead Paint Removal and Disposal on Bridges Project, New York, NY

Mr. Simons conducted a regulatory analysis of related to the removal of lead paint from nearly 800 bridges. This analysis included an evaluation of the regulatory compliance of various proposed procedures with federal and state hazardous and solid waste management requirements.

American Felt and Filter Company, New Windsor, NY

Mr. Simons prepared a Remedial Investigation (including exposure assessment) and Feasibility Study for the country's oldest active felt manufacturing facility, located in Orange County. This solvent-contaminated site is on the State Superfund List.

MARK JEPSEN

ENVIRONMENTAL SCIENTIST

Mark Jepsen is an Environmental Scientist in AKRF's Hazardous Materials group. He has a great deal of experience in both environmental science and natural resources, including environmental remediation and consulting, groundwater quality and soil science, hydrology, and geology.

Since Joining AKRF at the beginning of 2014, Mr. Jepsen has overseen a wide variety of environmental investigations. He has performed oversight at large scale construction sites entailing complex remediation techniques. He has performed various Phase I site visits and reports. Additionally, Mr. Jepsen has followed up these Phase I investigations with performing Phase II remedial investigations including soil, groundwater, and soil vapor sampling. Also, Mr. Jepsen has a great deal of experience creating environmental reports discussing results found during the preliminary and supplemental investigations, Remedial Action Work Plans (RAWPs), Construction Health and Safety Plans (CHASP), Remedial Closure Reports, Environmental Bid Specifications and Design Coordination. Mr. Jepsen has a knowledgeable background in environmental issues and challenges pertaining to the New York metropolitan area and technical guidelines. Mr. Jepsen has a great deal of experience working on projects involved with multiple governmental regulators including NYSDEC, NJDEP, NYCDEP, and NYCOER.

Before joining AKRF, Mr. Jepsen worked for Bluestone Environmental Services in Somerset, New Jersey. He was responsible for performing a wide array of field work activities including groundwater sampling, monitoring well gauging, soil sampling, and more for Bluestone's various clients including: ExxonMobil, International-Matex Tank Terminals (IMTT) and various gas stations. He was responsible for maintaining an understanding of large and active remediation sites and dealing with an extensive groundwater monitoring well network, as well as acting as an on-site safety supervisor for all Bluestone employees and subcontractors.

BACKGROUND

Education
B.S., Environmental Science, The Ohio State University, 2012

New Jersey Regulatory Seminars
Combined Sewer Outfalls (CSO) for LSRPs: Remediation Alternatives to Better Manage Storm Water

Certifications
40 Hour OSHA HAZWOPER – annual refresher every year
10 Hour OSHA Construction Training
Gold Certified Brownfield Professional by New York City Office of Environmental Remediation
Transportation Worker Identification Credential (TWIC)
NYSDEC Erosion and Sediment Control Inspector
Boating license

Years of Experience
Date started at AKRF: March 2014
Prior industry experience: Bluestone Environmental Services (NJ) – January 2013 to March 2014

RELEVANT AKRF EXPERIENCE

432 East 14th Street, Environmental Management Specifications, Design Coordination and Pre-Characterization of Soil for Off-site Disposal, New York, NY

Mr. Jepsen supported AKRF's preparation of Environmental Management Specifications and Design Coordination, and collection and laboratory analysis of soil samples to pre-characterize soil beneath the Site for off-site disposal. Mr. Jepsen also performed the Phase II remedial investigation of this site which included soil, groundwater, and soil vapor sampling. Mr. Jepsen was also responsible for construction oversight during the foundation excavation for the proposed building. Following completion of excavation, Mr. Jepsen was responsible for inspecting the vapor barrier system installed as an engineering control for the proposed building. He has also been involved with creating the Remedial Closure Report.

77 Commercial Street, Environmental Services, Greenpoint, NY

Mr. Jepsen supported AKRF's environmental services, including Preparation of a Remedial Investigation (Phase II) Work Plan; Remedial Investigation (RI) and Report; Preparation of a Remedial Action Work Plan (RAWP) and Construction Health and Safety Plan (CHASP); Pre-Characterization of Soil for Off-site Disposal; Environmental Monitoring; Remedial Closure Report; and Environmental Bid Specifications and Design Coordination.

Bronx Pro 2264-2272 Morris Avenue, Environmental Consulting Services, Bronx, NY

Mr. Jepsen is supporting AKRF's environmental consulting services for this site including, Phase I Environmental Site Assessment (ESA) and update, Phase II remedial site investigations and subsurface sampling, ongoing construction oversight and vapor barrier inspections.

Memorial Sloan Kettering Cancer Center Hospital 74th Street, Environmental Services, New York, NY

Mr. Jepsen supported AKRF's environmental services, including construction oversight and air monitoring, groundwater sampling, and monitoring well decommissioning. Also, Mr. Jepsen has overseen large scale UST closure and removal at this site. Mr. Jepsen was responsible for the on-site implementation of AKRF's Remedial Action Work Plan (RAWP) and Construction Health and Safety Plan (CHASP). He has also been involved with creating the Remedial Closure Report.

School Construction Authority, New York, NY

Under an on-call contract, AKRF provides the New York City School Construction Authority (NYCSCA) with hazardous materials consulting services. Mr. Jepsen is involved with various due diligence and environmental assessment projects including Phase I Environmental Site Assessments (ESAs); Phase II (Subsurface) Environmental Site Investigations (soil, groundwater and soil vapor intrusion investigations); Indoor Air Quality (IAQ) Assessments; Underground Storage Tank (UST) and Aboveground Storage Tank (AST) inspections relating to boiler conversions; and peer review of other consultant's due diligence reports.

Indoor Air Quality Monitoring, New York, NY

Mr. Jepsen has performed a variety of indoor air quality investigations and surveys at sites including educational institutions and various residential buildings. Mr. Jepsen performed interviews pertaining to environmental site conditions and background with property owners and operators.

11 Greene Street, Environmental Consulting Services, New York, NY

Investigation and remediation of the Site is being conducted to satisfy NYC Office of Environmental Remediation (NYCOER) requirements under the Voluntary Clean-Up Program (VCP) and CEQR. Mr. Jepsen is supporting AKRF's environmental consulting services for this site including Waste Classification testing and delineation, preparation of a Remedial Investigation (Phase II) Work Plan; Remedial Investigation (RI) and Report; Preparation

of a NYCDEP Dewatering Application and Permit; Preparation of a Remedial Action Work Plan (RAWP) and Construction Health and Safety Plan (CHASP); Pre-Characterization of Soil for Off-site Disposal; Environmental Monitoring; and Environmental Bid Specifications and Design Coordination.

3200 Jerome Avenue, Environmental Consulting Services, Bronx, New York

AKRF conducted a Phase I ESA and an Indoor Air Quality Survey of this property in the Bronx during due diligence investigations for the NYCSCA which identified levels of trichloroethene (TCE) in indoor air that exceeded the New York State Department of Health (NYSDOH) standards. NYCSCA subsequently terminated its lease of the site and discontinued its use as a school. Following the termination of NYCSCA's lease of the site, AKRF was retained by the owner to conduct an investigation and cleanup. Mr. Jepsen helped to conduct groundwater sampling requirements set by the NYSDEC as part of the Brownfield Cleanup Agreement for the project site. Mr. Jepsen is supporting the ongoing operations and maintenance of an active sub-slab depressurization system installed beneath the building. Mr. Jepsen has also overseen in-situ chemical oxidation (ISCO) groundwater treatment injection activities performed on-site.

98-100 Franklin Street, Manhattan, NY

AKRF completed a Phase I Environmental Site Assessment (ESA), Phase II ESI, prepared a Remedial Action Work Plan, a NYCDEP Dewatering Application and Permit, and performed soil waste classification sampling (which required the preparation of a NYC Transit Subsurface Investigation Permit to perform the associated soil borings) for the proposed redevelopment for a 29,564-square foot, eight-story mixed-use building with a cellar. As the assistant project manager, Mr. Jepsen coordinated with the client and contactors and performed oversight of on-site remediation activities.

NYSDOT/NYSTA Tappan Zee Hudson River Crossing, Rockland and Westchester Counties, NY

AKRF completed an EIS for this project on a fast-track schedule. Findings of the study were utilized to develop numerous documents prepared to guide the construction team, including a Remedial Action Plan and a Construction Health and Safety Plan for the five-year bridge replacement project. As part of the findings of the study, additional mitigation was required to ensure safety of endangered species inhabiting the Hudson River. Mr. Jepsen has been responsible for captaining and assisting in vessel-based monitoring of endangered species within and surrounding the marine construction zone of the new Tappan Zee Bridge located in Tarrytown and Nyack, NY on the Hudson River.

Previous Experience

International-Matex Tank Terminals (IMTT) and ExxonMobil, Environmental Consulting Services, Bayonne, NJ

Mr. Jepsen was responsible for conducting operations and maintenance of an extensive groundwater monitoring well network at an active storage tank terminal located in Bayonne, NJ. Mr. Jepsen also conducted site investigation field activities; including soil, groundwater sampling, and monitoring well installation. Mr. Jepsen aided with the operation and maintenance of active remedial systems, including oil recovery skimming systems and water treatment and discharge systems. Mr. Jepsen was responsible for maintaining client relationships and acting as an on-site safety supervisor for all Bluestone employees and subcontractors. Mr. Jepsen assisted with relevant compliance reporting requirements, remedial work plans, and general work permitting

Various Gas Stations, Environmental Consulting Services, Various Locations, NJ

Mr. Jepsen conducted site investigation field activities, including groundwater sampling and monitoring well installation at various gas stations with open petroleum spills reported the NJDEP. Mr. Jepsen acted as an on-site safety supervisor for all Bluestone employees and subcontractors. Mr. Jepsen assisted with relevant compliance reporting requirements.

JACOB MENKEN

FIELD TECHNICIAN

Mr. Menken has a Master of Science in Geology, Bachelor of Arts in Geology, and Bachelor of Science in Environmental Science from the University of Vermont. He is familiar with the following professional techniques: powder and single crystal x-ray diffraction; field geology; remote sensing of natural resources using airborne and satellite imagery; geophysical survey using ground penetrating radar, electromagnetic induction and seismic refraction; optical and hand sample identification of minerals; aseptic laboratory techniques; and stable isotope geochemistry. Mr. Menken's familiarity with hardware includes the following: Crystallography: APEX II Single Crystal X-Ray Diffractometer, Rigaku Powder X- Ray Diffractometer; Geophysical: Ground Penetrating Radar: GSSI SIR 3000 with 400 and 200MHz antennas, Electromagnetic Induction: SSI Profiler EMP-400; Stable Isotope: VG/Fisons SIRA Series II Stable Isotope Ratio Mass Spectrometer Honeywell Photoionization Detector; HACH Portable Water Quality Meter. Mr. Menken is familiar with the following software: X-Ray Crystallography: PDXL, Standard Measurement, APEX 2, ATOMS; Statistical Software: R, SPSS, Geophysical, Geogiga Pro, GSSI Radan 7, GSSI Profiler; Microsoft Office Suite, Adobe Creative Suite; Geospatial: ENVI 5.0, 4.0 and Classic ArcGIS.

BACKGROUND

Education

M.S., Geology, University of Vermont, 2014

B.A., Geology, University of Vermont, 2012

B.S., Environmental Science, University of Vermont, 2012

Certifications

OSHA 40-Hour Health & Safety Training for Hazardous Waste Operations, May 2011

OSHA 8-Hour Health & Safety Training for Hazardous Waste Operations, September, 2016

OSHA 10-Hour Health & Safety Training for Hazardous Waste Operations, August, 2016

Professional Memberships

Mineralogical Society of America

Mineralogical Society of Canada

Geological Society of America

The Society of Sigma Gamma Epsilon, Eta Kappa, National Honor Society in the Earth Sciences

Burlington Gem and Mineral Club

Years of Experience

Year started in company: 2016

Year started in industry: 2012

RELEVANT EXPERIENCE - AKRF

3200 Jerome Ave, Bronx, NY 10468 – Groundwater and Soil Vapor Sampling

AKRF provided groundwater and soil vapor testing for the NYCSCA at the former P.S. 51X. Mr. Menken assisted with the collection of groundwater and soil vapor sampling for waste characterization purposes. Groundwater was sampled from wellheads and soil vapor was sampled from a Sub-Slab Depressurization System (SSDS). All samples were collected in accordance with existing protocol.

112 Atlantic Ave, Brooklyn, NY 11201 – Construction Oversite and Community Air Monitoring

AKRF provided community air monitoring on this site for dust and volatile organic compounds (VOCs) in accordance with existing community air quality standards. Additionally, AKRF provided onsite oversite to ensure additional discovered soil contamination was left in place for determination of the extent of soil. AKRF was also responsible for logging any incoming or outgoing soil or fill laden trucks. For this project Mr. Menken provided on-site monitoring.

285 East 138th Street, Bronx, NY 10454 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the NYSDEC-approved RAWP and Site Management Plan (SMP) for this BCP site in the Bronx. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management, conducts community air monitoring, and prepares daily reports for submittal to the AKRF and NYSDEC project managers. For this project Mr. Menken provided on-site monitoring.

4950 Arthur Kill Road, Staten Island, NY 10309 – Groundwater and Soil Vapor Sampling and Subsurface Characterization Phase II

AKRF provided Phase II services for a wooded site in Staten Island. AKRF characterized eight drill bores drilled by a contractor. Groundwater and soil vapor samples from four of the sites. Additionally, AKRF provided oversite for the excavation of six test pits on the site to characterize the surficial materials and explore subsurface anomalies as detected by previously conducted ground penetrating radar (GPR).

32 N. Main Street, New City, NY – Wastewater Drum Disposal

Mr. Menken oversaw the disposal of two wastewater drums by a contractor. Mr. Menken ensured that the contractor completed the appropriate documented, the wastewater was properly transferred from a damaged to undamaged drum and that the appropriate drums were removed from the site.

158th Street and Brooks Ave, Bronx, NY – Wastewater Drum Disposal

Mr. Menken oversaw the disposal of two wastewater drums by a contractor. Mr. Menken ensured that the contractor completed the appropriate documented, the wastewater was properly transferred from a damaged to undamaged drum and that the appropriate drums were removed from the site.

3610 Glenwood Rd, Brooklyn, NY 11210 – Drinking Water Sampling Oversight

AKRF provided oversight of water quality testing for the NYCSCA at K042. AKRF oversaw the drinking water sampling of a newly installed pluming at a Brooklyn, NY pre-kindergarten for compliance with drinking water bacteria level guidelines. Sampling was observed to ensure compliance with pre-existing water disinfecting and

testing standard operating procedures (SOPs) for total coliform, E. Coli bacteria and heterotrophic plate count analysis.

34 Berry Street, Williamsburg, NY

AKRF was retained to prepare close-out documentation for this former industrial/warehouse facility in Williamsburg, which was remediated under the New York City Office of Environmental Remediation (OER) E-designation and NYSDEC Spills programs. The closure report, which was based on documentation provided by the environmental contractor, was prepared on an expedited basis so that the developer could obtain a Certificate of Occupancy in time for the scheduled opening of the new building. AKRF is currently providing on-going remediation monitoring services to fulfill NYSDEC Spill closure requirements. For this project, Mr. Menken performed monthly/quarterly groundwater monitoring.

11 Greene Street, Manhattan, NY 10013 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the approved RAWP and Site Management Plan (SMP) for this OER site in Manhattan. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management and conducts community air monitoring and completes daily reports for submittal to the AKRF and NYCDEP project managers. For this project Mr. Menken provided on-site monitoring.

SCA City Wide Portable Water Lead Sampling – Drinking Water Sampling

As part of an on-call contract with the SCA, AKRF provided water sampling services at various public schools in New York City. AKRF sampled potable water fixtures for lead concentration at public schools in all five boroughs. Work was performed at night or when school was not in session and coordinated with the SCA, custodial engineers and various contractors.

Staten Island Wheel, Staten Island, New York 10301 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the approved RAWP and Site Management Plan (SMP) for this site in the Staten Island. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management, conducts community air monitoring, and prepares daily reports for submittal to the AKRF. For this project Mr. Menken provided on-site monitoring.

Adelaar/Concord Resort, 219 Concord Road, Monticello, New York 12751 – Construction Oversite and Community Air Monitoring

AKRF is overseeing implementation of the NYSDEC-approved RAWP and Site Management Plan (SMP) for this BCP site in the Catskills. AKRF serves as the on-site contact who conducts waste characterization sampling, oversees soil management and conducts community air monitoring for submittal to the AKRF and NYSDEC project managers. For this project Mr. Menken provided on-site monitoring.

References:

Ilan Rubinstein

11 Greene Street LLC
174 Hudson Street
Sixth Floor
New York, New York 10013
inquiries@rubyventures.com

Jason Persico
OTL Enterprises
58 Thomas Street
New York, New York 10013
jason@otl.net

Mr. Paul Sherwood
Industrial and Environmental Hygiene Division
New York City School Construction Authority
30-30 Thompson Avenue
Long Island City, NY 11101
psherwood@nycsca.org

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Personnel Resume

Melissa Haas
Project Manager II

Qualifications Summary

Ms. Haas has over 20 years of experience in the environmental laboratory industry which includes project management, inorganic chemistry department management, LIMS implementation, human resources, and data reporting. She has a proven ability to handle multiple projects and tasks and a passion for the highest achievable level of quality and customer service.

Professional Experience

Project Manager – TestAmerica - 2012 to Present

Ms. Haas coordinates and manages clients' projects through all phases of the laboratory operations, ensuring fulfillment of TestAmerica's commitments to client requirements and on-time delivery. She maintains communications with clients and account executives and serves as a liaison between clients and laboratory operations to meet clients' needs. She reviews contractual documents and Quality Assurance Project Plans (QAPPs) to ensure certification and laboratory analytical requirements. Ms. Haas assists clients in identifying project requirements and manages project setup on behalf of the laboratory. She also develops business relationships with clients to further enhance client service and sales. She ensures accuracy and on-time delivery of client reports.

Laboratory Information Management (LIMS) Implementor – TestAmerica − 2011 to 2012

Ms. Haas was responsible for method and reference data setup for laboratories that were scheduled to implement the TALS LIMs system. She communicated with laboratory personnel to acquire information about standard operating procedures to ensure that methods and reference data were set up to meet the needs of the laboratory. She also provided on-site support for laboratories during the Go-Live period of the implementation and was the primary lead for the newly developed Certification Module. She trained laboratory and corporate personnel on the specifications of the software. She also provided remote data review assistance for laboratories to aid in the validation of the methods and reference data setup as well as the accuracy of the analysts' review process.

Metals Department Manager – TestAmerica – 2009-2011

Ms. Haas managed the operational activities of the metals department, including managing staff through clearly setting goals and providing performance reviews and feedback. She monitored the daily laboratory workload and ensured resources and staff were in place to complete projects on time. She prepared inorganic chemistry data packages and reviewed data for accuracy while prioritizing work to ensured timely delivery of quality data packages to clients. She oversaw the quality control of the department including demonstration of capabilities, method detection limit studies, SOP updates, audit responses, and performance evaluation responses.

Human Resources Coordinator – TestAmerica – 2007-2009

Ms. Haas provided support to the laboratory and Corporate Human Resources by implementing and administering Human Resources programs and procedures. She advised managers on Human Resources-related issues and managed the interview process for laboratory hires. She also served as a resource to the lab employees with HR-related issues and coordinated employee recognition programs and special events to promote employee satisfaction.

Wet Chemistry Department Manager – TestAmerica – 2001-2007

Ms. Haas managed the operational activities of the wet chemistry department and supervised a staff of eight analysts. She was responsible for data review, training, and quality control for the department. She increased productivity levels by providing key contributions toward automation of laboratory.

Wet Chemistry Analyst – Severn Trent Labs/AEN – 1997-2001

Veterinary Technician− Mobile Veterinary Clinic − 1994-1997

Campus Organizer –NJ Public Interest Research Group − 1990-1993

Education

- Rutgers University, New Brunswick, NJ 1986-1990, Bachelor of Science, Animal Science

L.A.B. Validation Corp., 14 West Point Drive, East Northport, New York 11731

Lori A. Beyer

SUMMARY: General Manager/Laboratory Director with a solid technical background combined with Management experience in environmental testing industry. Outstanding organizational, leadership, communication and technical skills. Customer focused, quality oriented professional with consistently high marks in customer/employee satisfaction.

EXPERIENCE:

1998-Present L.A.B. Validation Corporation, 14 West Point Drive, East Northport, NY
President

- Perform Data Validation activities relating to laboratory generated Organic and Inorganic Environmental Data.

1998-Present American Analytical Laboratories, LLC. 56 Toledo Street, Farmingdale, NY
Laboratory Director/Technical Director

- Plan, direct and control the operation, development and implementation of programs for the entire laboratory in order to meet AAL's financial and operational performance standards.
- Ensures that all operations are in compliance with AAL's QA manual and other appropriate regulatory requirements.
- Actively maintains a safe and healthy working environmental that is demanded by local laws/regulations.
- Monitors and manages group's performance with respect to data quality, on time delivery, safety, analyst development/goal achievement and any other key performance indices.
- Reviews work for accuracy and completeness prior to release of results to customers.

1996-1998 Nytest Environmental, Inc. (NEI) Port Washington, New York
General Manager

- Responsible for controlling the operation of an 18,000 square foot facility to meet NEI's financial and operational performance standards.
- Management of 65 FTEs including Sales and Operations
- Ensure that all operations are in compliance with NEI's QA procedures
- Ensures that productivity indicators, staffing levels and other cost factors are held within established guidelines
- Maintains a quantified model of laboratory's capacity and uses this model as the basis for controlling the flow of work into and through the lab so as to ensure that customer requirements and lab's revenue and contribution targets are achieved.

1994-1996 Nytest Environmental, Inc. (NEI) Port Washington, New York
Technical Project Manager

- Responsible for the coordination and implementation of environmental testing programs requirements between NEI and their customers
- Supervise Customer Service Department
- Assist in the development of major proposals
- Complete management of all Federal and State Contracts and assigned commercial contracts
- Provide technical assistance to the customer, including data validation and interpretation
- Review and implement Project specific QAPP's.

1995-1996 Nytest Environmental, Inc. (NEI) Port Washington, New York
Corporate QA/QC Officer

- Responsible for the implementation of QA practices as required in the NJDEP and EPA Contracts
- Primary contact for NJDEP QA/QC issues including SOP preparation, review and approval
- Responsible for review, verification and adherence to the Contract requirements and NEI QA Plan

1992-1994 Nytest Environmental, Inc. (NEI) Port Washington, New York
Data Review Manager

- Responsible for the accurate compilation, review and delivery of analytical data to the company's customers. Directly and effectively supervised a department of 22 personnel.
- Managed activities of the data processing software including method development, form creation, and production
- Implement new protocol requirements for report and data management formats
- Maintained control of data storage/archival areas as EPA/CLP document control officer

1987-1991 Nytest Environmental, Inc. (NEI) Port Washington, New York
Data Review Specialist

- Responsible for the review of GC, GC/MS, Metals and Wet Chemistry data in accordance with regulatory requirements
- Proficient with USEPA, NYSDEC, NJDEP and NEESA requirements
- Review data generated in accordance with SW846, NYSDEC ASP, EPA/CLP and 40 CFR Methodologies

1986-1987 Nytest Environmental, Inc (NEI) Port Washington, New York
GC/MS VOA Analyst

EDUCATION:

1982-1985 State University of New York at Stony Brook, New York; BS Biology/Biochemistry
1981-1982 University of Delaware; Biology/Chemistry
5/91 Rutgers University; Mass Spectral Data Interpretation Course, GC/MS Training
8/92 Westchester Community College; Organic Data Validation Course
9/93 Westchester Community College; Inorganic Data Validation Course

Westchester Community College

Professional Development Center

Awards this Certificate of Achievement To

LORI BEYER

for Successfully Completing

ORGANIC DATA VALIDATION COURSE (35 HOURS)

Dr. John Samuelian

Date AUGUST 1992

Assistant Dean
Professional Development Center

President

The Professional
Development Center

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

Westchester Community College

Professional Development Center

Awards this Certificate of Achievement To

LORI BEYER

for Successfully Completing

INORGANIC DATA VALIDATION

Instructor: Dale Boshart

Date MARCH 1993

Assistant Dean
Professional Development Center

President

The Professional
Development Center

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

July 8, 1992

Ms. Elaine Sall
Program Coordinator
Westchester Community College
Valhalla, NY 10595-1698

Dear Elaine,

Thank you for your letter of June 29, 1992. I have reviewed the course outline for organic data validation, qualifications for teachers and qualifications for students. The course that you propose to offer would be deemed equivalent to that which is offered by EPA. The individuals who successfully complete the course and pass the final written exam would be acceptable to perform the task of organic data validation for the Department of Environmental Conservation, Division of Hazardous Waste Remediation.

As we have discussed in our conversation of July 7, 1992, you will forward to me prior to the August course deadline, the differences between the EPA SOW/90 and the NYSDEC ASP 12/91. You stated these differences will be compiled by Mr. John Samulian.

I strongly encourage you to offer an inorganic data validation course. I anticipate the same list of candidates would be interested in an inorganic validation course as well, since most of the data to be validated consists of both organic and inorganic data.

Thank you for you efforts and please contact me if I can be of any further assistance.

Sincerely,

Maureen P. Serafini

Maureen P. Serafini
Environmental Chemist II
Division of Hazardous Waste
Remediation

The Professional
Development Center
AT
WESTCHESTER COMMUNITY COLLEGE

914 285-6619

October 2, 1992

Ms. Lori Beyer
3 sparkill Drive
East Northport, NY 11731

Dear Ms. Beyer:

Congratulations upon successful completion of the Organic Data Validation course held August 17 - 21, 1992, through Westchester Community College, Professional Development Center. This course has been deemed by New York State Department of Environmental Conservation as equivalent to EPA's Organic Data Validation Course.

Enclosed is your Certificate. Holders of this Certificate are deemed competent to perform organic data validation for the New York State DEC Division of Hazardous Waste Remediation.

The Professional Development Center at Westchester Community College plans to continue to offer courses and seminars which will be valuable to environmental engineers, chemists and related personnel. Current plans include a TCLP seminar on November 17th and a conference on Environmental Monitoring Regulations on November 18th.

We look forward to seeing you again soon at another environmental program or event. Again, congratulations.

Very truly yours,

Passing Grade is 70%
Your Grade is 99%

Elaine Sall
Program Coordinator

ES/bf

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

The Professional
Development Center
AT
WESTCHESTER COMMUNITY COLLEGE

914 285-6619

June 21, 1993

Dear Ms. Beyer:

Enclosed is your graded final examination in the Inorganic Data Validation course you completed this past March. A score of 70% was required in order to receive a certificate of satisfactory completion. Persons holding this certificate are deemed acceptable to perform Inorganic Data Validation for the New York State Department of Environmental Conservation, Division of Hazardous Waste Remediation.

I am also enclosing a course evaluation for you to complete if you have not already done so. The information you provide will greatly aid us in structuring further courses. We wish to make these course offerings as relevant, targeted and comprehensive as possible. Your evaluation is vital to that end.

Congratulations on your achievement. I look forward to seeing you again at another professional conference or course. We will be co-sponsoring an environmental monitoring conference on October 21, 1993 with the New York Water Pollution Control Association, Lower Hudson Chapter, at IBM's Yorktown Heights, NY site. Information regarding this event will be going out in August.

Very truly yours,

Elaine Sall

Elaine Sall
Program Coordinator

ES/bf

Enclosures

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Personnel Resume

Carl Armbruster
QA Manager

Qualifications Summary

Mr. Armbruster has over 30 years of experience in the environmental laboratory and engineering industry that includes extensive technical, management/leadership experience in all aspects of the laboratory business. He is an action-oriented manager dedicated to ensuring the laboratory maintains a quality program that holds the highest credentials in PT scores, accreditations and customer satisfaction. His unique experience lends itself to working successfully with employees, managers and clients at all levels.

Professional Experience

Quality Assurance Manager – TestAmerica Edison - 2005 to Present

Mr. Armbruster is responsible for establishing and implementing the quality assurance program at the Edison facility; and for interfacing with the corporate Quality Assurance Director to ensure adherence with the overall Quality Management Plan. He is also responsible for monitoring implementation and compliance with NELAC and TestAmerica's QMP, conducting annual management system audits and data audits, as well as providing regulatory updates and technical support to the Laboratory Director, Operations Manager, Client Services and Sales department.

Project Manager/Assistant Technical Director – STL Edison --2000 to 2005

Laboratory Director − STL Whippany − 1998 to 2000

Account Manager − Clean Harbors Environmental Services − 1997 to 1998

Laboratory Manager − Waste Management Inc., and Chemical Waste Management Inc − 1988 to 1997

Environmental Scientist − ICF Technology − 1987 to 1988

Analytical Chemist − IT Corporation – 1985 to 1987

Analytical Chemist − Hess Environmental Laboratories – 1983 to 1985

Education

- MS in Biology – East Stroudsburg University, 1984
- BS in Environmental Studies - East Stroudsburg University, 1980

ATTACHMENT B

NYSDEC REVISED PROTOCOL FOR EMERGING CONTAMINANTS

Collection of Groundwater Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537.

The procedure used must be consistent with the NYSDEC March 1991 Sampling Guidelines and Protocols http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), PVC, silicone, acetate and polypropylene. Equipment blanks should be generated at least daily. Additional materials may be acceptable if pre-approved by NYSDEC. Requests to use alternate equipment should include clean equipment blanks. **NOTE: Grunfos pumps and bladder pumps are known to contain PFC materials (e.g. Teflon™ washers for Grunfos pumps and LDPE bladders for bladder pumps).** All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFC materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. Many food and drink packaging materials and “plumbers thread seal tape” contain PFCs.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 500 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Groundwater Sampling for Emerging Contaminants

February 2018

Issue: NYSDEC has committed to analyzing representative groundwater samples at remediation sites for emerging contaminants (1,4-dioxane and PFAS) as described in the below guidance.

Implementation

NYSDEC project managers will be contacting site owners to schedule sampling for these chemicals. Only groundwater sampling is required. The number of samples required will be similar to the number of samples where "full TAL/TCL sampling" would typically be required in a remedial investigation. If sampling is not feasible (e.g., the site no longer has any monitoring wells in place), sampling may be waived on a site-specific basis after first considering potential sources of these chemicals and whether there are water supplies nearby.

Upon a new site being brought into any program (i.e., SSF, BCP), PFAS and 1,4-dioxane will be incorporated into the investigation of groundwater as part of the standard "full TAL/TCL" sampling. Until an SCO is established for PFAS, soil samples do not need to be analyzed for PFAS unless groundwater contamination is detected. Separate guidance will be developed to address sites where emerging contaminants are found in the groundwater. The analysis currently performed for SVOCs in soil is adequate for evaluation of 1,4-dioxane, which already has an established SCO.

Analysis and Reporting

Labs should provide a full category B deliverable, and a DUSR should be prepared by a data validator.

The work plan should explicitly describe analysis and reporting requirements.

PFAS sample analysis: Samples should be analyzed by an environmental laboratory certified by ELAP to use EPA method 537 or ISO 25101. ELAP does not currently offer certification for PFAS analysis of non-drinking water samples (including groundwater, soil and sediment), so there is no requirement to use an ELAP certified method. The preferred method is the modified EPA Method 537. Labs have been able to achieve reporting limits for PFOA and PFOS of 2 ng/l (part per trillion). If labs are not able to achieve similar reporting limits, the NYSDEC project manager will make case-by-case decisions as to whether the analysis can meet the needs for the specific site.

PFAS sample reporting: DER has developed a PFAS target analyte list (below) with the intent of achieving reporting consistency between labs for commonly reportable analytes. It is expected that reported results for PFAS will include, at a minimum, all the compounds listed. This list may be updated in the future as new information is learned and as labs develop new capabilities. If lab and/or matrix specific issues are encountered for any particular compounds, the NYSDEC project manager will make case-by-case decisions as to whether particular analytes may be temporarily or permanently discontinued from analysis for each site. Any technical lab issues should be brought to the attention of a NYSDEC chemist.

Some sampling using this full PFAS target analyte list is needed to understand the nature of contamination. It may also be critical to differentiate PFAS compounds associated with a site from other sources of these chemicals. Like routine refinements to parameter lists based on investigative findings, the full PFAS target analyte list may not be needed for all sampling intended to define the extent of

contamination. Project managers may approve a shorter analyte list (e.g., just the UCMR3 list) for some reporting on a case by case basis.

1,4-Dioxane Analysis and Reporting: The method detection limit (MDL) for 1,4-dioxane should be no higher than 0.28 µg/l (ppb). ELAP offers certification for both EPA Methods 8260 and 8270. In order to get the appropriate detection limits, the lab would need to run either of these methods in "selective ion monitoring" (SIM) mode. DER is advising PMS to use 8270, since this method provides a more robust extraction procedure, uses a larger sample volume, and is less vulnerable to interference from chlorinated solvents (we acknowledge that 8260 has been shown to have a higher recovery in some studies).

Full PFAS Target Analyte List

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonates	**Perfluorobutanesulfonic acid**	**PFBS**	**375-73-5**
	Perfluorohexanesulfonic acid	**PFHxS**	**355-46-4**
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanessulfonic acid	**PFOS**	**1763-23-1**
	Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluoroalkyl carboxylates	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	**PFHpA**	**375-85-9**
	Perfluorooctanoic acid	**PFOA**	**335-67-1**
	Perfluorononanoic acid	**PFNA**	**375-95-1**
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUA/PFUdA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTriA/PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTA/PFTeDA	376-06-7
Fluorinated Telomer Sulfonates	6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
	8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
Perfluorooctane-sulfonamides	Perfluroroctanesulfonamide	FOSA	754-91-6
Perfluorooctane-sulfonamidoacetic acids	N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6

Bold entries depict the 6 original UCMR3 chemicals

ATTACHMENT C

SOIL GAS PURGE VOLUME CALCULATIONS

Soil Gas Sampler Purge Volume Calculation

Volume of Sampling Tip & Disturbed Boring

Inside Diameter =	2	in
Length (sampling tip + drive tube) =	2	in

$V_1 = pi * [2/(2*12)]^2 * 6/12 =$ 3.6E-03 ft^3

Volume of Teflon Tubing

Inside Diameter = 3/16" = 0.1875"	0.1875	in
Length =	3	ft

$V_2 = pi * [0.1875/(2*12)]^2 * 5 =$ 5.8E-04 ft^3

Total Volume of Sampler

$V = V_1 + V_2 =$ 4.2E-03 ft^3 = 1.2E-01 liter

3x volume = 0.4 liter

APPENDIX B

HEALTH AND SAFETY PLAN

34 Berry Street

BROOKLYN, NEW YORK

Health and Safety Plan (HASP) and
Community Air Monitoring Plan (CAMP)

BCP Site #: C224268

AKRF Project Number: 11259

Prepared for:

34 Berry Street LLC (LCOR)
34 Berry Street
Brooklyn, NY 11249

Prepared by:

AKRF, Inc.
440 Park Avenue South, 7th Floor
New York, NY 10016
212-696-0670

JULY 2018

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FIGURES

APPENDICES

1.0 INTRODUCTION

The project site (Site) is located at 34 Berry Street in Brooklyn, New York (also identified as Tax Block 2289, Lot 14). The project site consists of a 36,000 square foot, irregularly shaped lot. The lot is occupied by an L-shaped, seven-story residential building that fronts Berry and North 12th Streets, with an open courtyard area located behind the building, in the central portion of the site. A basement level parking garage is located under the building and courtyard, with an entrance ramp located on North 11th Street. A small, street-level valet parking lot is also located on North 11th Street, immediately east of the garage entrance ramp.

The subsurface investigation will include the drilling of soil borings, installation of monitoring wells and soil gas points, and the collection of soil, groundwater, and soil gas samples. This environmental Health and Safety Plan (HASP) has been developed for implementation during site investigation activities conducted by all personnel on-site, both AKRF employees and others. This HASP does not discuss routine health and safety issues common to general construction/excavation, including but not limited to slips, trips, falls, shoring, and other physical hazards.

Available records have documented that the property was historically developed with industrial and manufacturing uses. Based on investigations conducted to date, identified contamination at the Site includes light non-aqueous phase liquid (LNAPL), volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs) associated with a petroleum spill, and chlorinated VOCs associated with a solvent plume in groundwater. Operation, monitoring, and maintenance (OM&M) activities completed to monitor remediation efforts to clean up the spill has identified a chlorinated solvent plume in groundwater. This HASP identifies the hazards of concern, the specific chemicals associated with the Site-specific hazards, and measures to provide protection from exposure to the hazards during the investigation work.

All AKRF employees are directed that all work must be performed in accordance with the Company's Generic HASP and all OSHA applicable regulations for the work activities required for the project. All project personnel are furthermore directed that they are not permitted to enter Permit Required Confined Spaces (as defined by OSHA). For issues unrelated to contaminated materials, all non-AKRF employees are to be bound by all applicable OSHA regulations as well as any more stringent requirements specified by their employer in their corporate HASP or otherwise. AKRF is not responsible for providing oversight for issues unrelated to contaminated materials for non-employees. This oversight shall be the responsibility of the employer of that worker or other official designated by that employer.

2.0 HEALTH AND SAFETY GUIDELINES AND PROCEDURES

2.1 Hazard Evaluation

2.1.1 Hazards of Concern

Check all that apply		
(**X**) Organic Chemicals	(**X**) Inorganic Chemicals	( ) Radiological
( ) Biological	( ) Explosive/Flammable	( ) Oxygen Deficient Atm
(**X**) Heat Stress	(**X**) Cold Stress	( ) Carbon Monoxide
Comments: No personnel are permitted to enter permit confined spaces.		

2.1.2 Physical Characteristics

Check all that apply		
(**X**) Liquid	(**X**) Solid	( ) Sludge
(**X**) Vapors	( ) Unknown	( ) Other
Comments:		

2.1.3 Hazardous Materials

Check all that apply					
Chemicals	**Solids**	**Sludges**	**Solvents**	**Oils**	**Other**
( ) Acids	( ) Ash	( ) Paints	(**X**) Halogens	( ) Transformer	( ) Lab
( ) Caustics	( ) Asbestos	( ) Metals	( ) Petroleum	( ) Other DF	( ) Pharm
( ) Pesticides	( ) Tailings	( ) POTW	( ) Other	( ) Motor or Hydraulic Oil	( ) Hospital
(**X**) Petroleum	(**X**) Other	( ) Other		(**X**) Gasoline	( ) Rad
( ) Inks	Historic fill material			(**X**) Fuel Oil	( ) MGP
( ) PCBs					( ) Mold
( ) Metals					( ) Cyanide
(**X**)Other: VOCs & SVOCs					

2.1.4 Chemicals of Concern

Chemicals	REL/PEL/STEL	Health Hazards
1,2 Dichloroethane (DCA)	REL = 1 ppm PEL = 50 ppm	Headaches, lung irritation, dizziness, poor coordination, impaired heart function, unconsciousness, and nerve, kidney and liver damage.
Benzene	REL = 0.1 ppm PEL = 1 ppm STEL = 5 ppm	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude, dermatitis; bone marrow depression, potential occupational carcinogen.
Toluene	REL = 100 ppm PEL = 200 ppm STEL = 300 ppm	Irritation eyes, nose; lassitude, confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia (skin tingling or numbness); dermatitis; liver, kidney damage.
Ethylbenzene	REL = 100 ppm PEL = 100 ppm	Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma.
Xylenes	REL = 100 ppm PEL = 100 ppm	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, poor coordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis.
Naphthalene	REL = 10 ppm PEL = 10 ppm	Irritation eyes; headache, confusion, excitement, malaise; nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage.
Polycyclic Aromatic Hydrocarbons (PAHs)	PEL = 5 mg/m^3	Harmful effects to skin, bodily fluids, and ability to fight disease, reproductive problems; [potential occupational carcinogen]
Fuel Oil	REL = 350 mg/m^3 PEL = 400 ppm	Nausea, irritation – eyes, hypertension, headache, light-headedness, loss of appetite, poor coordination; long-term exposure – kidney damage, blood clotting problems; potential carcinogen.
Tetrachloroethylene (PCE)	REL = Lowest possible PEL = 100 ppm STEL = 100 ppm	Irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination, headache, drowsiness, skin erythema (skin redness), and liver damage.
Trichloroethylene (TCE)	REL = 25 ppm PEL = 100 ppm	Headaches, lung irritation, dizziness, poor coordination, impaired heart function, unconsciousness, and nerve, kidney and liver damage.
1,2 Dichloroethene (DCE)	REL = 200 ppm PEL = 200 ppm	Nausea, drowsy, tiredness possible heart damage.
Comments: REL = NIOSH Recommended Exposure Limit PEL = OSHA Permissible Exposure Limit STEL = OSHA Short Term Exposure Limit ppm = parts per million mg/m^3 = milligrams per cubic meter		

2.2 Designated Personnel

AKRF will appoint one of its on-site personnel as the Site Safety Officer (SSO). This individual will be responsible for the implementation of the HASP. The SSO will have a 4-year college degree in occupational safety or a related science/engineering field, and experience in implementation of air monitoring and hazardous materials sampling programs. Health and safety training required for the SSO and all field personnel are outlined in Section 2.3 of this HASP.

2.3 Training

All personnel who enter the work area while intrusive activities are being performed will have completed a 40-hour training course that meets OSHA requirements of 29 CFR Part 1910, Occupational Safety and Health Standards. In addition, all personnel will have up-to-date 8-hour refresher training. The training will allow personnel to recognize and understand the potential hazards to health and safety. All field personnel must attend a training program, whose purpose is to:

- Make them aware of the potential hazards they may encounter;
- Provide the knowledge and skills necessary for them to perform the work with minimal risk to health and safety; Make them aware of the purpose and limitations of safety equipment; and
- Ensure that they can safely avoid or escape from emergencies.

Each member of the field crew will be instructed in these objectives before he/she goes onto the Site. A site safety meeting will be conducted at the start of the project. Additional meetings shall be conducted, as necessary, for new personnel working at the Site.

2.4 Medical Surveillance Program

All AKRF and subcontractor personnel performing field work involving subsurface disturbance at the Site are required to have passed a complete medical surveillance examination in accordance with 29 CFR 1910.120 (f). A physician's medical release for work will be confirmed by the SSO before an employee can begin site activities. The medical release shall consider the type of work to be performed and the required PPE. The medical examination will, at a minimum, be provided annually and upon termination of hazardous waste site work.

2.5 Site Work Zones

During any activities involving subsurface disturbance, the work area must be divided into various zones to prevent the spread of contamination, ensure that proper protective equipment is donned, and provide an area for decontamination.

The Exclusion Zone is defined as the area where exposure to impacted media could be encountered. The Contamination Reduction Zone (CRZ) is the area where decontamination procedures take place and is located next to the Exclusion Zone. The Support is the zone area where support facilities such as vehicles, fire extinguisher, and first aid supplies are located. The emergency staging area (part of the Support Zone) is the area where all workers on-site would assemble in the event of an emergency. A summary of these areas is provided below. These zones may changed by SSO, depending on that day's activities. All field personnel will be informed of the location of these zones before work begins.

Task	**Exclusion Zone**	**CRZ**	**Support Zone**
Soil Borings/Soil Gas Points/ Monitoring Wells	**10 ft from drilling equipment**	**25 ft from drilling equipment**	**As Needed**
Comments: Control measures such as "caution tape" and/or traffic cones will be placed around the perimeter of the work area when work is being done in a public area.			

2.6 Air Monitoring

The purpose of the air monitoring program is to identify any exposure of the field personnel to potential environmental hazards associated with the documented soil and groundwater contamination. Results of the air monitoring will be used to determine the appropriate response action, if needed.

2.6.1 Volatile Organic Compounds

A photoionization detector (PID) will be used to perform air monitoring during soil disturbance activities to determine airborne levels of total VOCs. The PID will be calibrated at the start of the work day with a 100 ppm isobutylene standard.

2.6.2 Work Zone Air Monitoring

Real time air monitoring will be performed with the PID. Measurements will be taken prior to commencement of work and continuously during the work, as outlined in the following table. Measurements will be made as close to the workers as practicable and at the breathing height of the workers. The SSO shall set up the equipment and confirm that it is working properly. His/her designee may oversee the air measurements during the day. The initial measurement for the day will be performed before the start of work and will establish the background level for that day. The final measurement for the day will be performed after the end of work. The action levels and required responses are listed in the following table.

Instrument	Action Level	Response Action
PID	Less than 10 ppm in breathing zone	Level D or D-Modified
	Between 10 ppm and 20 ppm	Level C
	More than 20 ppm	Stop work. Resume work when readings are less then 20 ppm.
Notes: ppm = parts per million		

2.6.3 Community Air Monitoring Plan

Community air monitoring will be conducted during all intrusive site activities in compliance with the New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan (CAMP). Real-time air monitoring for volatile compounds at the perimeter of the exclusion zone will be performed as described below.

VOC Monitoring

Periodic monitoring for VOCs will be conducted during non-intrusive activities such as the collection of groundwater samples. Periodic monitoring may include obtaining measurements upon arrival at a location, while opening a monitoring well cap, when bailing/purging a well, and upon leaving the location. In some instances, depending on the proximity of exposed individuals, continuous monitoring may be conducted during these activities.

Continuous monitoring for VOCs will be conducted during all ground intrusive activities (i.e., soil boring and monitoring well/soil gas point installation). VOC concentrations will be measured in the work zone and at each selected monitoring station at the start of each workday, and periodically thereafter to establish background concentrations. Since all of

the work described in the RIWP is being completed indoors, monitoring locations will selected based on access points (i.e., hallways) and any ventilation structures that would potentially be connected to air flow within the work area to provide for appropriate protection for building occupants.

Exclusion Zone Monitoring

VOCs will be monitored continuously within the exclusion zone. Monitoring will be conducted with a photoionization detector (PID) equipped with a 10.6 eV lamp capable of calculating 15-minute running average concentrations. The following actions will be taken based on organic vapor levels measured:

- If total organic vapor levels exceed 5 ppm above background for the 15-minute average at the exclusion zone perimeter, work activities will be temporarily halted and monitoring continued. If levels readily decrease (per instantaneous readings) below 5 ppm above background, work activities will resume with continued monitoring.
- If total organic vapor levels at the perimeter of the exclusion zone persist at levels in excess of 5 ppm above background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities will resume provided that the total organic vapor level 200 feet downwind of the hot zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less – but in no case less than 20 feet – is below 5 ppm above background for the 15-minute average.
- If the total organic vapor level is above 25 ppm at the perimeter of the exclusion zone, activities will be shut down, and the Major Vapor Emission Response Plan will be automatically implemented.

More frequent intervals of monitoring will be conducted if required as determined by the SSO. All 15-minute readings will be recorded and available for NYSDEC and NYSDOH personnel to review. Instantaneous readings, if any, will also be recorded.

Fixed Air Monitoring Stations

Fixed monitoring stations will be included outside of the exclusion zone at potential work zone exposure points for building occupants. These locations may include hallways and/or areas adjacent to ventilation features that connect with the work zone. The fixed monitoring stations will be fully enclosed and equipped with the following:

- A PID equipped with an 10.6 eV lamp capable of calculating 15-minute running average VOC concentrations;

All air monitoring data recorded at the fixed monitoring stations will be available for NYSDOH and/or NYSDEC review and will be included in the Remedial Investigation Report (RIR).

Major Vapor Emission Response Plan

If any organic levels greater than 1 ppm over background are identified at a fixed monitoring station, all work activities must be halted or vapor controls must be implemented.

If, following the cessation of the work activities, or as the result of an emergency, organic levels persist above 1 ppm above background at a monitoring station, then the following contingency measures will be implemented:

- If total organic vapor levels exceed 1 ppm above background for the 15-minute average at the monitoring station, work activities will be temporarily halted and monitoring continued. If levels readily decrease (per instantaneous readings) below 1 ppm above background, work activities will resume with continued monitoring.
- If total organic vapor levels at the perimeter of the exclusion zone persist at levels in excess of 1 ppm above background, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities will resume provided that the total organic vapor level at the monitoring station is below 1 ppm above background for the 15-minute average.
- If the total organic vapor level remains above 1 ppm at the monitoring station, activities will be shut down, and the Major Vapor Emission Response Plan will be automatically implemented.

Major Vapor Emission Response Plan

Upon activation, the following activities shall be undertaken as part of the Major Vapor Emission Response Plan:

- The NYSDEC, NYSDOH, and local police authorities will immediately be contacted by the SSO and advised of the situation;
- Frequent air monitoring will be conducted at 30-minute intervals at the monitoring stations. If two successive readings below action levels are measured, air monitoring may be halted or modified by the Site Health and Safety Officer; and
- All Emergency contacts will go into effect as appropriate.

All readings will be recorded and be available for NYSDEC and NYSDOH personnel to review.

2.7 Personal Protection Equipment

The personal protection equipment required for various kinds of site investigation tasks are based on 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

AKRF field personnel and other site personnel shall wear, at a minimum, Level D personal protective equipment. The protection will be based on the air monitoring described in Section 2.6.

LEVEL OF PROTECTION & PPE		**Soil Boring/Water Sampling**
Level D (**X**) Steel Toe Shoes (**X**) Hard Hat (within 25 ft of drill rig) (**X**) Work Gloves	(**X**) Safety Glasses ( ) Face Shield (**X**) Ear Plugs (within 25 ft of drill rig) (**X**) Nitrile Gloves (**X**) Tyvek for drill operator if	Yes

LEVEL OF PROTECTION & PPE		**Soil Boring/Water Sampling**
	NAPL present	
Level C ***(in addition to Level D)*** (**X**) Half-Face Respirator OR (**X**) Full Face Respirator ( ) Full-Face PAPR	( ) Particulate Cartridge ( ) Organic Cartridge (**X**) Dual Organic/ Particulate Cartridge	If PID > 10 ppm (breathing zone)
Comments: Cartridges to be changed out at least once per shift unless warranted beforehand (e.g., more difficult to breathe or any odors detected).		

2.8 General Work Practices

To protect the health and safety of the field personnel, field personnel will adhere to the guidelines listed below during activities involving subsurface disturbance:

- Eating, drinking, chewing gum or tobacco, and smoking are prohibited, except in designated areas on the Site. These areas will be designated by the SSO.
- Workers must wash their hands thoroughly on leaving the work area and before eating, drinking, or any other such activity.
- The workers should shower as soon as possible after leaving the Site. Contact with contaminated or suspected surfaces should be avoided.
- The buddy system should always be used; each buddy should watch for signs of fatigue, exposure, and heat/cold stress.

3.0 EMERGENCY PROCEDURES AND EMERGENCY RESPONSE PLAN

The field crew will be equipped with emergency equipment, such as a first aid kit and disposable eye washes. In the case of a medical emergency, the SSO will determine the nature of the emergency and he/she will have someone call for an ambulance, if needed. If the nature of the injury is not serious, i.e., the person can be moved without expert emergency medical personnel, he/she should be taken to a hospital by on-site personnel. Directions to the hospital are provided below, and a hospital route map is attached.

3.1 Hospital Directions

Hospital Name:	Woodhull Medical Center
Phone Number:	(718) 963-8000
Address/Location:	760 Broadway Brooklyn, NY 11206 (The Emergency Department is located at the intersection of Flushing Avenue and Throop Avenue)
Directions:	1. Go NORTHEAST on *Berry Street* 2. Continue onto *Nassau Avenue* 3. Turn LEFT onto *Bedford Avenue* 4. Turn RIGHT onto *Lorimer Street* 5. Turn LEFT onto *Broadway* 6. Turn RIGHT on *Flushing Avenue* The Emergency Department entrance will be at the intersection of Flushing Avenue and Throop Avenue.

3.2 Emergency Contacts

Company	Individual Name	Title	Contact Number
AKRF	Marc Godick	Project Director	914-922-2356
	Bryan Zieroff	Project Manager	914-922-2382 (office) 203-246-1566 (cell)
	Mark Jepsen	Site Safety Officer (SSO)	646-388-9567 (office) 614-560-5425 (cell)
	Jacob Menken	Alternate SSO	914-922-2373 (office) 914-552-7694 (cell)
34 Berry Street, LLC (LCOR)	Joseph C. Venuto, Jr.	Asset Manager	610-408-4436
Ambulance, Fire Department & Police Department	-	-	911
NYSDEC Spill Hotline	-	-	800-457-7362

4.0 APPROVAL & ACKNOWLEDGMENTS OF HASP

APPROVAL

Signed: _____ Date: _____

AKRF Project Manager

Signed: _____ Date: _____

AKRF Health and Safety Officer

Below is an affidavit that must be signed by all workers who enter the Site. A copy of the HASP must be on-site at all times and will be kept by the SSO.

AFFIDAVIT

I,_____(name), of_____(company name), have read the Health and Safety Plan (HASP) for the 34 Berry Street site. I agree to conduct all on-site work in accordance with the requirements set forth in this HASP and understand that failure to comply with this HASP could lead to my removal from the Site.

Signed: _____ Company: _____ Date: _____
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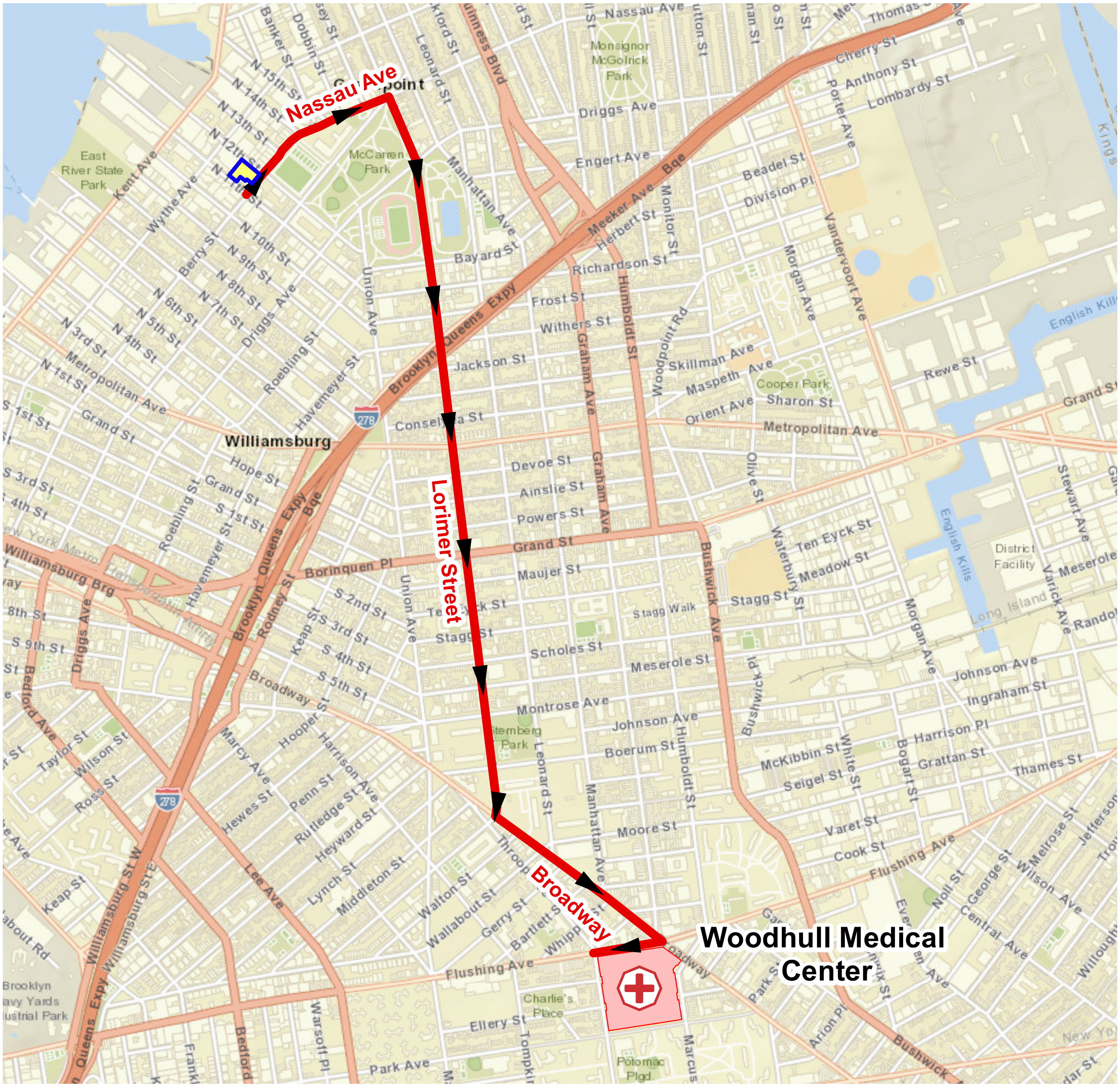
FIGURE 1

HOSPITAL ROUTE MAP



Service Layer Credits: ESRC World Street Map 2016

LEGEND

ROUTE TO HOSPITAL

PROJECT SITE BOUNDARY

HOSPITAL LOCATION

Woodhull Medical Center
760 Broadway
Brooklyn, NY 11206

0 1,500 3,000
SCALE IN FEET

AKRF
440 Park Avenue South, New York, NY 10016

34 Berry Street
Brooklyn, New York

HOSPITAL ROUTE MAP

DATE	**6/16/2017**
PROJECT NO.	**11259**
FIGURE	**1**

APPENDIX A

POTENTIAL HEALTH EFFECTS FROM ON-SITE CONTAMINANTS

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

1,2-DICHLOROETHANE

CAS #107-06-2

Division of Toxicology ToxFAQs™ **September 2001**

This fact sheet answers the most frequently asked health questions (FAQs) about 1,2-Dichloroethane. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to 1,2-dichloroethane usually occurs by breathing contaminated air in workplaces that use 1,2-dichloroethane. Breathing or ingesting high levels of 1,2-dichloroethane can cause damage to the nervous system, liver, kidneys, and lungs and may cause cancer. This substance has been found in at least 570 of the 1,585 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is 1,2-dichloroethane?

1,2-Dichloroethane, also called ethylene dichloride, is a manufactured chemical that is not found naturally in the environment. It is a clear liquid and has a pleasant smell and sweet taste.

The most common use of 1,2-dichloroethane is in the production of vinyl chloride which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. It is also used to as a solvent and is added to leaded gasoline to remove lead.

What happens to 1,2-dichloroethane when it enters the environment?

❑ Most of the 1,2-dichloroethane released to the environment is released to the air. In the air, 1,2-dichloroethane breaks down by reacting with other compounds formed by sunlight. It can stay in the air for more than 5 months before it is broken down.
❑ 1,2-Dichloroethane can also be released into rivers and lakes. It breaks down very slowly in water and most of it will evaporate to the air.
❑ 1,2-Dichloroethane released in soil will either evaporate into the air or travel down through the soil and enter underground water.

How might I be exposed to 1,2-dichloroethane?

❑ The general population may be exposed to 1,2-dichloroethane by breathing air or drinking water that contains 1,2-dichloroethane.
❑ People who work or live near a factory where 1,2-dichloroethane is used, may be exposed to higher than usual levels.
❑ People living near uncontrolled hazardous waste sites may also be exposed to higher than usual levels of 1,2-dichloroethane.

How can 1,2-dichloroethane affect my health?

Nervous system disorders, liver and kidney diseases, and lung effects have been reported in humans ingesting or inhaling large amounts of 1,2-dichloroethane.

In laboratory animals, breathing or ingesting large amounts of 1,2-dichloroethane have also caused nervous system disorders and liver, kidney, and lung effects. Animal studies also suggest that 1,2-dichloroethane may damage the

immune system. Kidney disease has also been seen in animals ingesting low doses of 1,2-dichloroethane for a long time. Studies in animals indicate that 1,2-dichloroethane does not affect reproduction.

How likely is 1,2-dichloroethane to cause cancer?

Human studies examining whether 1,2-dichloroethane can cause cancer have been considered inadequate. In animals, increases in the occurrence of stomach, mammary gland, liver, lung, and endometrium cancers have been seen following inhalation, oral, and dermal exposure.

The Department of Health and Human Services (DHHS) has determined that 1,2-dichloroethane may reasonably be expected to cause cancer. The EPA has determined that 1,2-dichloroethane is a probable human carcinogen and the International Agency for Cancer Research (IARC) considers it to be a possible human carcinogen.

How can 1,2-dichloroethane affect children?

We do not know if exposure to 1,2-dichloroethane will result in birth defects or other developmental effects in people. Studies in animals suggest that 1,2-dichloroethane does not produce birth defects.

It is likely that health effects seen in children exposed to high levels of 1,2-dichloroethane will be similar to the effects seen in adults.

How can families reduce the risk of exposure to 1,2-dichloroethane?

The general population is not likely to be exposed to large amounts of 1,2-dichloroethane. In the past, it was used in small amounts in household products such as cleaning agents, pesticides, and wallpaper and carpet glue. Risk of exposure from this source could be eliminated if these older products were immediately discarded.

Children should avoid playing in soils near uncontrolled hazardous waste sites where 1,2-dichloroethane may have been discarded.

Is there a medical test to show whether I've been exposed to 1,2-dichloroethane?

Tests are available to measure 1,2-dichloroethane in breath, blood, breast milk, and urine of exposed people. Because 1,2-dichloroethane leaves the body fairly quickly, these tests need to be done within a couple of days of exposure. These tests cannot be used to predict the nature or severity of toxic effects. These tests are not usually done in the doctor's office.

Has the federal government made recommendations to protect human health?

The EPA allows 0.005 milligrams of 1,2-dichloroethane per liter of drinking water (0.005 mg/L).

The Occupational Safety and Health Administration has set a limit of 50 parts of 1,2-dichloroethane per million parts of air (50 ppm) in workplace air for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Toxicological Profile for 1,2-Dichloroethane. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

BENZENE
CAS # 71-43-2

This fact sheet answers the most frequently asked health questions (FAQs) about benzene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Benzene is a widely used chemical formed from both natural processes and human activities. Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia. Benzene has been found in at least 813 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is benzene?

(Pronounced bĕn′zēn′)

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

- Industrial processes are the main source of benzene in the environment.
- Benzene can pass into the air from water and soil.
- It reacts with other chemicals in the air and breaks down within a few days.
- Benzene in the air can attach to rain or snow and be carried back down to the ground.
- It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- Benzene does not build up in plants or animals.

How might I be exposed to benzene?

- Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
- Indoor air generally contains higher levels of benzene from products that contain it such as glues, paints, furniture wax, and detergents.
- Air around hazardous waste sites or gas stations will contain higher levels of benzene.
- Leakage from underground storage tanks or from hazardous waste sites containing benzene can result in benzene contamination of well water.
- People working in industries that make or use benzene may be exposed to the highest levels of it.
- A major source of benzene exposures is tobacco smoke.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html

The major effect of benzene from long-term (365 days or longer) exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries. It is not known whether benzene exposure affects the developing fetus in pregnant women or fertility in men.

Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How likely is benzene to cause cancer?

The Department of Health and Human Services (DHHS) has determined that benzene is a known human carcinogen. Long-term exposure to high levels of benzene in the air can cause leukemia, cancer of the blood-forming organs.

Is there a medical test to show whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood, however, since benzene disappears rapidly from the blood, measurements are accurate only for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum permissible level of benzene in drinking water at 0.005 milligrams per liter (0.005 mgL). The EPA requires that spills or accidental releases into the environment of 10 pounds or more of benzene be reported to the EPA.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit of 1 part of benzene per million parts of air (1 ppm) in the workplace during an 8-hour workday, 40-hour workweek.

Glossary

Anemia: A decreased ability of the blood to transport oxygen.

Carcinogen: A substance with the ability to cause cancer.

CAS: Chemical Abstracts Service.

Chromosomes: Parts of the cells responsible for the development of hereditary characteristics.

Metabolites: Breakdown products of chemicals.

Milligram (mg): One thousandth of a gram.

Pesticide: A substance that kills pests.

References

This ToxFAQs information is taken from the 1997 Toxicological Profile for Benzene (update) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-29, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 404-498-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ETHYLBENZENE
CAS # 100-41-4

Agency for Toxic Substances and Disease Registry ToxFAQs **June 1999**

This fact sheet answers the most frequently asked health questions (FAQs) about ethylbenzene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Ethylbenzene is a colorless liquid found in a number of products including gasoline and paints. Breathing very high levels can cause dizziness and throat and eye irritation. Ethylbenzene has been found in at least 731 of the 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is ethylbenzene?

(Pronounced ĕthʹ əl bĕnʹ zēnʹ)

Ethylbenzene is a colorless, flammable liquid that smells like gasoline. It is found in natural products such as coal tar and petroleum and is also found in manufactured products such as inks, insecticides, and paints.

Ethylbenzene is used primarily to make another chemical, styrene. Other uses include as a solvent, in fuels, and to make other chemicals.

What happens to ethylbenzene when it enters the environment?

- Ethylbenzene moves easily into the air from water and soil.
- It takes about 3 days for ethylbenzene to be broken down in air into other chemicals.
- Ethylbenzene may be released to water from industrial discharges or leaking underground storage tanks.
- In surface water, ethylbenzene breaks down by reacting with other chemicals found naturally in water.
- In soil, it is broken down by soil bacteria.

How might I be exposed to ethylbenzene?

- Breathing air containing ethylbenzene, particularly in areas near factories or highways.
- Drinking contaminated tap water.
- Working in an industry where ethylbenzene is used or made.
- Using products containing it, such as gasoline, carpet glues, varnishes, and paints.

How can ethylbenzene affect my health?

Limited information is available on the effects of ethylbenzene on people's health. The available information shows dizziness, throat and eye irritation, tightening of the chest, and a burning sensation in the eyes of people exposed to high levels of ethylbenzene in air.

Animals studies have shown effects on the nervous system, liver, kidneys, and eyes from breathing ethylbenzene in air.

How likely is ethylbenzene to cause cancer?

The EPA has determined that ethylbenzene is not classifiable as to human carcinogenicity.

ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html

No studies in people have shown that ethylbenzene exposure can result in cancer. Two available animal studies suggest that ethylbenzene may cause tumors.

How can ethylbenzene affect children?

Children may be exposed to ethylbenzene through inhalation of consumer products, including gasoline, paints, inks, pesticides, and carpet glue. We do not know whether children are more sensitive to the effects of ethylbenzene than adults.

It is not known whether ethylbenzene can affect the development of the human fetus. Animal studies have shown that when pregnant animals were exposed to ethylbenzene in air, their babies had an increased number of birth defects.

How can families reduce the risk of exposure to ethylbenzene?

Exposure to ethylbenzene vapors from household products and newly installed carpeting can be minimized by using adequate ventilation.

Household chemicals should be stored out of reach of children to prevent accidental poisoning. Always store household chemicals in their original containers; never store them in containers children would find attractive to eat or drink from, such as old soda bottles. Gasoline should be stored in a gasoline can with a locked cap.

Sometimes older children sniff household chemicals, including ethylbenzene, in an attempt to get high. Talk with your children about the dangers of sniffing chemicals.

Is there a medical test to show whether I've been exposed to ethylbenzene?

Ethylbenzene is found in the blood, urine, breath, and some body tissues of exposed people. The most common way to test for ethylbenzene is in the urine. This test measures substances formed by the breakdown of ethylbenzene. This test needs to be done within a few hours after exposure occurs, because the substances leave the body very quickly.

These tests can show you were exposed to ethylbenzene, but cannot predict the kind of health effects that might occur.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum contaminant level of 0.7 milligrams of ethylbenzene per liter of drinking water (0.7 mg/L).

The EPA requires that spills or accidental releases into the environment of 1,000 pounds or more of ethylbenzene be reported to the EPA.

The Occupational Safety and Health Administration (OSHA) has set an occupational exposure limit of 100 parts of ethylbenzene per million parts of air (100 ppm) for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for ethylbenzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

TOLUENE
CAS # 108-88-3

Division of Toxicology ToxFAQs™ **February 2001**

This fact sheet answers the most frequently asked health questions (FAQs) about toluene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to toluene occurs from breathing contaminated workplace air, in automobile exhaust, some consumer products paints, paint thinners, fingernail polish, lacquers, and adhesives. Toluene affects the nervous system. Toluene has been found at 959 of the 1,591 National Priority List sites identified by the Environmental Protection Agency

What is toluene?

Toluene is a clear, colorless liquid with a distinctive smell. Toluene occurs naturally in crude oil and in the tolu tree. It is also produced in the process of making gasoline and other fuels from crude oil and making coke from coal.

Toluene is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes.

What happens to toluene when it enters the environment?

❑ Toluene enters the environment when you use materials that contain it. It can also enter surface water and groundwater from spills of solvents and petrolieum products as well as from leasking underground storage tanks at gasoline stations and other facilities.

❑ When toluene-containing products are placed in landfills or waste disposal sites, the toluene can enter the soil or water near the waste site.

❑ Toluene does not usually stay in the environment long.

❑ Toluene does not concentrate or buildup to high levels in animals.

How might I be exposed to toluene?

❑ Breathing contaminated workplace air or automobile exhaust.

❑ Working with gasoline, kerosene, heating oil, paints, and lacquers.

❑ Drinking contaminated well-water.

❑ Living near uncontrolled hazardous waste sites containing toluene products.

How can toluene affect my health?

Toluene may affect the nervous system. Low to moderate levles can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, loss of appetite, and

hearing and color vision loss. These symptoms usually disappear when exposure is stopped.

Inhaling High levels of toluene in a short time can make you feel light-headed, dizzy, or sleepy. It can also cause unconsciousness, and even death.

High levels of toluene may affect your kidneys.

How likely is toluene to cause cancer?

Studies in humans and animals generally indicate that toluene does not cause cancer.

The EPA has determined that the carcinogenicity of toluene can not be classified.

How can toluene affect children?

It is likely that health effects seen in children exposed to toluene will be similar to the effects seen in adults. Some studies in animals suggest that babies may be more sensitive than adults.

Breathing very high levels of toluene during pregnancy can result in children with birth defects and retard mental abilities, and growth. We do not know if toluene harms the unborn child if the mother is exposed to low levels of toluene during pregnancy.

How can families reduce the risk of exposure to toluene?

❑ Use toluene-containing products in well-ventilated areas.

❑ When not in use, toluene-containing products should be tightly covered to prevent evaporation into the air.

Is there a medical test to show whether I've been exposed to toluene?

There are tests to measure the level of toluene or its breakdown products in exhaled air, urine, and blood. To determine if you have been exposed to toluene, your urine or blood must be checked within 12 hours of exposure. Several other chemicals are also changed into the same breakdown products as toluene, so some of these tests are not specific for toluene.

Has the federal government made recommendations to protect human health?

EPA has set a limit of 1 milligram per liter of drinking water (1 mg/L).

Discharges, releases, or spills of more than 1,000 pounds of toluene must be reported to the National Response Center.

The Occupational Safety and Health Administration has set a limit of 200 parts toluene per million of workplace air (200 ppm).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profile for Toluene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html . ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

XYLENE
CAS # 1330-20-7

This fact sheet answers the most frequently asked health questions (FAQs) about xylene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to xylene occurs in the workplace and when you use paint, gasoline, paint thinners and other products that contain it. People who breathe high levels may have dizziness, confusion, and a change in their sense of balance. This substance has been found in at least 658 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is xylene?

(Pronounced zī′lēn)

Xylene is a colorless, sweet-smelling liquid that catches on fire easily. It occurs naturally in petroleum and coal tar and is formed during forest fires. You can smell xylene in air at 0.08–3.7 parts of xylene per million parts of air (ppm) and begin to taste it in water at 0.53–1.8 ppm.

Chemical industries produce xylene from petroleum. It's one of the top 30 chemicals produced in the United States in terms of volume.

Xylene is used as a solvent and in the printing, rubber, and leather industries. It is also used as a cleaning agent, a thinner for paint, and in paints and varnishes. It is found in small amounts in airplane fuel and gasoline.

What happens to xylene when it enters the environment?

- Xylene has been found in waste sites and landfills when discarded as used solvent, or in varnish, paint, or paint thinners.
- It evaporates quickly from the soil and surface water into the air.
- In the air, it is broken down by sunlight into other less harmful chemicals.
- It is broken down by microorganisms in soil and water.
- Only a small amount of it builds up in fish, shellfish, plants, and animals living in xylene-contaminated water.

How might I be exposed to xylene?

- Breathing xylene in workplace air or in automobile exhaust.
- Breathing contaminated air.
- Touching gasoline, paint, paint removers, varnish, shellac, and rust preventatives that contain it.
- Breathing cigarette smoke that has small amounts of xylene in it.
- Drinking contaminated water or breathing air near waste sites and landfills that contain xylene.
- The amount of xylene in food is likely to be low.

How can xylene affect my health?

Xylene affects the brain. High levels from exposure for short periods (14 days or less) or long periods (more than 1 year) can cause headaches, lack of muscle coordination, dizziness, confusion, and changes in one's sense of balance. Exposure of

people to high levels of xylene for short periods can also cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; problems with the lungs; delayed reaction time; memory difficulties; stomach discomfort; and possibly changes in the liver and kidneys. It can cause unconsciousness and even death at very high levels.

Studies of unborn animals indicate that high concentrations of xylene may cause increased numbers of deaths, and delayed growth and development. In many instances, these same concentrations also cause damage to the mothers. We do not know if xylene harms the unborn child if the mother is exposed to low levels of xylene during pregnancy.

How likely is xylene to cause cancer?

The International Agency for Research on Cancer (IARC) has determined that xylene is not classifiable as to its carcinogenicity in humans.

Human and animal studies have not shown xylene to be carcinogenic, but these studies are not conclusive and do not provide enough information to conclude that xylene does not cause cancer.

Is there a medical test to show whether I've been exposed to xylene?

Laboratory tests can detect xylene or its breakdown products in exhaled air, blood, or urine. There is a high degree of agreement between the levels of exposure to xylene and the levels of xylene breakdown products in the urine. However, a urine sample must be provided very soon after exposure ends because xylene quickly leaves the body. These tests are not routinely available at your doctor's office.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 10 ppm of xylene in drinking water.

The EPA requires that spills or accidental releases of xylenes into the environment of 1,000 pounds or more must be reported.

The Occupational Safety and Health Administration (OSHA) has set a maximum level of 100 ppm xylene in workplace air for an 8-hour workday, 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) also recommend exposure limits of 100 ppm in workplace air.

NIOSH has recommended that 900 ppm of xylene be considered immediately dangerous to life or health. This is the exposure level of a chemical that is likely to cause permanent health problems or death.

Glossary

Evaporate: To change from a liquid into a vapor or a gas.

Carcinogenic: Having the ability to cause cancer.

CAS: Chemical Abstracts Service.

ppm: Parts per million.

Solvent: A liquid that can dissolve other substances.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for xylenes (update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-29, Atlanta, GA 30333. Phone:1-888-422-8737, FAX: 404-498-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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NAPHTHALENE
CAS # 91-20-3

1-METHYLNAPHTHALENE
CAS # 90-12-0

2-METHYLNAPHTHALENE
CAS # 91-57-6

Division of Toxicology ToxFAQs™ **August 2005**

This fact sheet answers the most frequently asked health questions (FAQs) about naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene happens mostly from breathing air contaminated from the burning of wood, tobacco, or fossil fuels, industrial discharges, or moth repellents. Exposure to large amounts of naphthalene may damage or destroy some of your red blood cells. Naphthalene has caused cancer in animals. Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene have been found in at least 687, 36, and 412, respectively, of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).

What are naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

Naphthalene is a white solid that evaporates easily. Fuels such as petroleum and coal contain naphthalene. It is also called white tar, and tar camphor, and has been used in mothballs and moth flakes. Burning tobacco or wood produces naphthalene. It has a strong, but not unpleasant smell. The major commercial use of naphthalene is in the manufacture of polyvinyl chloride (PVC) plastics. Its major consumer use is in moth repellents and toilet deodorant blocks.

1-Methylnaphthalene and 2-methylnaphthalene are naphthalene-related compounds. 1-Methylnaphthalene is a clear liquid and 2-methylnaphthalene is a solid; both can be smelled in air and in water at very low concentrations.

1-Methylnaphthalene and 2-methylnaphthalene are used to make other chemicals such as dyes and resins. 2-Methylnaphthalene is also used to make vitamin K.

What happens to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene when they enter the environment?

- ❏ Naphthalene enters the environment from industrial and domestic sources, and from accidental spills.
- ❏ Naphthalene can dissolve in water to a limited degree and may be present in drinking water from wells close to hazardous waste sites and landfills.
- ❏ Naphthalene can become weakly attached to soil or pass through soil into underground water.
- ❏ In air, moisture and sunlight break it down within 1 day. In water, bacteria break it down or it evaporates into the air.
- ❏ Naphthalene does not accumulate in the flesh of animals or fish that you might eat.
- ❏ 1-Methylnaphthalene and 2-methylnaphthalene are expected to act like naphthalene in air, water, or soil because they have similar chemical and physical properties.

How might I be exposed to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

- ❏ Breathing low levels in outdoor air.
- ❏ Breathing air contaminated from industrial discharges or smoke from burning wood, tobacco, or fossil fuels.
- ❏ Using or making moth repellents, coal tar products, dyes or inks could expose you to these chemicals in the air.
- ❏ Drinking water from contaminated wells.
- ❏ Touching fabrics that are treated with moth repellents containing naphthalene.
- ❏ Exposure to naphthalene, 1-methylnaphthalene and 2-methylnaphthalene from eating foods or drinking beverages is unlikely.

How can naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene affect my health?

Exposure to large amounts of naphthalene may damage or destroy some of your red blood cells. This could cause you to have too few red blood cells until your body replaces the destroyed cells. This condition is called hemolytic anemia. Some symptoms of hemolytic anemia are fatigue, lack of appetite, restlessness, and pale skin. Exposure to large amounts of naphthalene may also cause nausea, vomiting, diarrhea, blood in the urine, and a yellow color to the skin. Animals sometimes develop cloudiness in their eyes after swallowing high amounts of naphthalene. It is not clear whether this also develops in people. Rats and mice that breathed naphthalene vapors daily for a lifetime developed irritation and inflammation of their nose and lungs. It is unclear if naphthalene

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

causes reproductive effects in animals; most evidence says it does not.

There are no studies of humans exposed to 1-methylnaphthalene or 2-methylnaphthalene.

Mice fed food containing 1-methylnaphthalene and 2-methylnaphthalene for most of their lives had part of their lungs filled with an abnormal material.

How likely are naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene to cause cancer?

There is no direct evidence in humans that naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene cause cancer. However, cancer from naphthalene exposure has been seen in animal studies. Some female mice that breathed naphthalene vapors daily for a lifetime developed lung tumors. Some male and female rats exposed to naphthalene in a similar manner also developed nose tumors.

Based on the results from animal studies, the Department of Health and Humans Services (DHHS) concluded that naphthalene is reasonably anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) concluded that naphthalene is possibly carcinogenic to humans. The EPA determined that naphthalene is a possible human carcinogen (Group C) and that the data are inadequate to assess the human carcinogenic potential of 2-methylnaphthalene.

How can naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene affect children?

Hospitals have reported many cases of hemolytic anemia in children, including newborns and infants, who either ate naphthalene mothballs or deodorants cakes or who were in close contact with clothing or blankets stored in naphthalene mothballs. Naphthalene can move from a pregnant woman's blood to the unborn baby's blood. Naphthalene has been detected in some samples of breast milk from the general U.S. population, but not at levels that are expected to be of concern.

There is no information on whether naphthalene has affected development in humans. No developmental abnormalities were observed in the offspring from rats, mice, and rabbits fed naphthalene during pregnancy.

We do not have any information on possible health effects of 1-methylnaphthalene or 2-methylnaphthalene on children.

How can families reduce the risks of exposure to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

❑ Families can reduce the risks of exposure to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene by avoiding smoking tobacco, generating smoke during cooking, or using fireplaces or heating appliances in the their homes.

❑ If families use naphthalene-containing moth repellents, the material should be enclosed in containers that prevent vapors from escaping, and kept out of the reach from children.

❑ Blankets and clothing stored with naphthalene moth repellents should be aired outdoors to remove naphthalene odors and washed before they are used.

❑ Families should inform themselves of the contents of air deodorizers that are used in their homes and refrain from using deodorizers with naphthalene.

Is there a medical test to determine whether I've been exposed to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

Tests are available that measure levels of these chemicals and their breakdown products in samples of urine, feces, blood, maternal milk, or body fat. These tests are not routinely available in a doctor's office because they require special equipment, but samples can be sent to special testing laboratories. These tests cannot determine exactly how much naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene you were exposed to or predict whether harmful effects will occur. If the samples are collected within a day or two of exposure, then the tests can show if you were exposed to a large or small amount of naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene.

Has the federal government made recommendations to protect human health?

The EPA recommends that children not drink water with over 0.5 parts per million (0.5 ppm) naphthalene for more than 10 days or over 0.4 ppm for any longer than 7 years. Adults should not drink water with more than 1 ppm for more than 7 years. For water consumed over a lifetime (70 years), the EPA suggests that it contain no more than 0.1 ppm naphthalene.

The Occupational Safety and Health Administration (OSHA) set a limit of 10 ppm for the level of naphthalene in workplace air during an 8-hour workday, 40-hour workweek. The National Institute for Occupational Safety and Health (NIOSH) considers more than 500 ppm of naphthalene in air to be immediately dangerous to life or health. This is the exposure level of a chemical that is likely to impair a worker's ability to leave a contaminate area and therefore, results in permanent health problems or death.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

Agency for Toxic Substances and Disease Registry ToxFAQs **September 1996**

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- PAHs enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- Coming in contact with air, water, or soil near hazardous waste sites.
- Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- Drinking contaminated water or cow's milk.

- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-29, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 404-498-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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FUEL OILS

CAS # 8008-20-6, 70892-10-3, 68476-30-2, 68476-34-6, 68476-31-3

This fact sheet answers the most frequently asked health questions (FAQs) about fuel oils. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Fuel oils are liquid mixtures produced from petroleum, and their use mostly involves burning them as fuels. Drinking or breathing fuel oils may cause nausea or nervous system effects. However, exposure under normal use conditions is not likely to be harmful. Fuel oils have been found in at least 26 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are fuel oils?

(Pronounced fyo͞o′əl oilz)

Fuel oils are a variety of yellowish to light brown liquid mixtures that come from crude petroleum. Some chemicals found in fuel oils may evaporate easily, while others may more easily dissolve in water.

Fuel oils are produced by different petroleum refining processes, depending on their intended uses. Fuel oils may be used as fuel for engines, lamps, heaters, furnaces, and stoves, or as solvents.

Some commonly found fuel oils include kerosene, diesel fuel, jet fuel, range oil, and home heating oil. These fuel oils differ from one another by their hydrocarbon compositions, boiling point ranges, chemical additives, and uses.

What happens to fuel oils when they enter the environment?

- Some chemicals found in fuel oils may evaporate into the air from open containers or contaminated soil or water.
- Some chemicals found in fuel oils may dissolve in water after spills to surface waters or leaks from underground storage tanks.
- Some chemicals found in fuel oils may stick to particles in water, which will eventually cause them to settle to the bottom sediment.
- Some of the chemicals found in fuel oils may be broken down slowly in air, water, and soil by sunlight or small organisms.
- Some of the chemicals found in fuel oils may build up significantly in plants and animals.

How might I be exposed to fuel oils?

- Using a home kerosene heater or stove, or using fuel oils at work.
- Breathing air in home or building basements that has been contaminated with fuel oil vapors entering from the soil.
- Drinking or swimming in water that has been contaminated with fuel oils from a spill or a leaking underground storage tank.
- Touching soil contaminated with fuel oils.
- Using fuel oils to wash paint or grease from skin or equipment.

How can fuel oils affect my health?

Little information is available about the health effects that may be caused by fuel oils. People who use kerosene

stoves for cooking do not seem to have any health problems related to their exposure.

Breathing some fuel oils for short periods may cause nausea, eye irritation, increased blood pressure, headache, lightheadedness, loss of appetite, poor coordination, and difficulty concentrating. Breathing diesel fuel vapors for long periods may cause kidney damage and lower your blood's ability to clot.

Drinking small amounts of kerosene may cause vomiting, diarrhea, coughing, stomach swelling and cramps, drowsiness, restlessness, painful breathing, irritability, and unconsciousness. Drinking large amounts of kerosene may cause convulsions, coma, or death. Skin contact with kerosene for short periods may cause itchy, red, sore, or peeling skin.

How likely are fuel oils to cause cancer?

The International Agency for Research on Cancer (IARC) has determined that some fuel oils (heavy) may possibly cause cancer in humans, but for other fuel oils (light) there is not enough information to make a determination. IARC has also determined that occupational exposures to fuel oils during petroleum refining are probably carcinogenic in humans.

Some studies with mice have suggested that repeated contact with fuel oils may cause liver or skin cancer. However, other mouse studies have found this not to be the case. No studies are available in other animals or in people on the carcinogenic effects of fuel oils.

Is there a medical test to show whether I've been exposed to fuel oils?

There is no medical test that shows if you have been exposed to fuel oils. Tests are available to determine if some of the chemicals commonly found in fuel oils are in your blood. However, the presence of these chemicals in blood may not necessarily mean that you have been exposed to fuel oils.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) and the Air Force Office of Safety and Health (AFOSH) have set a permissible exposure level (PEL) of 400 parts of petroleum distillates per million parts of air (400 ppm) for an 8-hour workday, 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) recommends that average workplace air levels not exceed 350 milligrams of petroleum distillates per cubic meter of air (350 mg/m^3) for a 40-hour workweek.

The Department of Transportation (DOT) lists fuel oils as hazardous materials and, therefore, regulates their transportation.

Glossary

Carcinogenic: Able to cause cancer.

CAS: Chemical Abstracts Service.

Evaporate: To change into a vapor or a gas.

Hydrocarbon: Any compound made up of hydrogen and carbon.

Milligram (mg): One thousandth of a gram.

ppm: Parts per million.

Sediment: Mud and debris that have settled to the bottom of a body of water.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for fuel oils. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-29, Atlanta, GA 30333. Phone:1-888-422-8737, FAX: 404-498-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

TRICHLOROETHYLENE

CAS # 79-01-6

Division of Toxicology ToxFAQs™ **July 2003**

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Trichloroethylene is a colorless liquid which is used as a solvent for cleaning metal parts. Drinking or breathing high levels of trichloroethylene may cause nervous system effects, liver and lung damage, abnormal heartbeat, coma, and possibly death. Trichloroethylene has been found in at least 852 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is trichloroethylene?

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers.

Trichloroethylene is not thought to occur naturally in the environment. However, it has been found in underground water sources and many surface waters as a result of the manufacture, use, and disposal of the chemical.

What happens to trichloroethylene when it enters the environment?

- Trichloroethylene dissolves a little in water, but it can remain in ground water for a long time.
- Trichloroethylene quickly evaporates from surface water, so it is commonly found as a vapor in the air.
- Trichloroethylene evaporates less easily from the soil than from surface water. It may stick to particles and remain for a long time.
- Trichloroethylene may stick to particles in water, which will cause it to eventually settle to the bottom sediment.
- Trichloroethylene does not build up significantly in plants and animals.

How might I be exposed to trichloroethylene?

- Breathing air in and around the home which has been contaminated with trichloroethylene vapors from shower water or household products such as spot removers and typewriter correction fluid.
- Drinking, swimming, or showering in water that has been contaminated with trichloroethylene.
- Contact with soil contaminated with trichloroethylene, such as near a hazardous waste site.
- Contact with the skin or breathing contaminated air while manufacturing trichloroethylene or using it at work to wash paint or grease from skin or equipment.

How can trichloroethylene affect my health?

Breathing small amounts may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating.

Breathing large amounts of trichloroethylene may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage.

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

Drinking large amounts of trichloroethylene may cause nausea, liver damage, unconsciousness, impaired heart function, or death.

Drinking small amounts of trichloroethylene for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear.

Skin contact with trichloroethylene for short periods may cause skin rashes.

How likely is trichloroethylene to cause cancer?

Some studies with mice and rats have suggested that high levels of trichloroethylene may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of trichloroethylene in drinking water or in workplace air have found evidence of increased cancer. Although, there are some concerns about the studies of people who were exposed to trichloroethylene, some of the effects found in people were similar to effects in animals.

In its 9th Report on Carcinogens, the National Toxicology Program (NTP) determined that trichloroethylene is "reasonably anticipated to be a human carcinogen." The International Agency for Research on Cancer (IARC) has determined that trichloroethylene is "probably carcinogenic to humans."

Is there a medical test to show whether I've been exposed to trichloroethylene?

If you have recently been exposed to trichloroethylene, it can be detected in your breath, blood, or urine. The breath test, if it is performed soon after exposure, can tell if you have been exposed to even a small amount of trichloroethylene.

Exposure to larger amounts is assessed by blood and urine tests, which can detect trichloroethylene and many of its breakdown products for up to a week after exposure. However, exposure to other similar chemicals can produce the same breakdown products, so their detection is not absolute proof of exposure to trichloroethylene. This test isn't available at most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum contaminant level for trichloroethylene in drinking water at 0.005 milligrams per liter (0.005 mg/L) or 5 parts of TCE per billion parts water.

The EPA has also developed regulations for the handling and disposal of trichloroethylene.

The Occupational Safety and Health Administration (OSHA) has set an exposure limit of 100 parts of trichloroethylene per million parts of air (100 ppm) for an 8-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: The ability of a substance to cause cancer.
CAS: Chemical Abstracts Service.
Evaporate: To change into a vapor or gas.
Milligram (mg): One thousandth of a gram.
Nonflammable: Will not burn.
ppm: Parts per million.
Sediment: Mud and debris that have settled to the bottom of a body of water.
Solvent: A chemical that dissolves other substances.

References

This ToxFAQs information is taken from the 1997 Toxicological Profile for Trichloroethylene (update) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html . ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Tetrachloroethylene - ToxFAQs™

CAS # 127-18-4

This fact sheet answers the most frequently asked health questions (FAQs) about tetrachloroethylene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Tetrachloroethylene is a manufactured chemical used for dry cleaning and metal degreasing. Exposure to very high concentrations of tetrachloroethylene can cause dizziness, headaches, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Tetrachloroethylene has been found in at least 771 of the 1,430 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is tetrachloroethylene?

(Pronounced tĕt'rə-klôr' ō-ĕth'ə-lēn')

Tetrachloroethylene is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal-degreasing. It is also used to make other chemicals and is used in some consumer products.

Other names for tetrachloroethylene include perchloroethylene(PERC), PCE, and tetrachloroethene. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell tetrachloroethylene when it is present in the air at a level of 1 part tetrachloroethylene per million parts of air (1 ppm) or more, although some can smell it at even lower levels.

What happens to tetrachloroethylene when it enters the environment?

- Much of the tetrachloroethylene that gets into water or soil evaporates into the air.
- Microorganisms can break down some of the tetrachloroethylene in soil or underground water.
- In the air, it is broken down by sunlight into other chemicals or brought back to the soil and water by rain.
- It does not appear to collect in fish or other animals that live in water.

How might I be exposed to tetrachloroethylene?

- When you bring clothes from the dry cleaners, they will release small amounts of tetrachloroethylene into the air.
- When you drink water containing tetrachloroethylene, you are exposed to it.

How can tetrachloroethylene affect my health?

High concentrations of tetrachloroethylene (particularly in closed, poorly ventilated areas) can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death.

Irritation may result from repeated or extended skin contact with it. These symptoms occur almost entirely in work (or hobby) environments when people have been accidentally exposed to high concentrations or have intentionally used tetrachloroethylene to get a "high."

In industry, most workers are exposed to levels lower than those causing obvious nervous system effects. The health effects of breathing in air or drinking water with low levels of tetrachloroethylene are not known.

Results from some studies suggest that women who work in dry cleaning industries where exposures to tetrachloroethylene can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known if tetrachloroethylene was responsible for these problems because other possible causes were not considered.

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

ATSDR

CS249955-AH

Tetrachloroethylene

CAS # 127-18-4

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage. Exposure to very high levels of tetrachloroethylene can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant.

How likely is tetrachloroethylene to cause cancer?

The Department of Health and Human Services (DHHS) has determined that tetrachloroethylene may reasonably be anticipated to be a carcinogen. Tetrachloroethylene has been shown to cause liver tumors in mice and kidney tumors in male rats.

Is there a medical test to show whether I've been exposed to tetrachloroethylene?

One way of testing for tetrachloroethylene exposure is to measure the amount of the chemical in the breath, much the same way breath-alcohol measurements are used to determine the amount of alcohol in the blood.

Because it is stored in the body's fat and slowly released into the bloodstream, tetrachloroethylene can be detected in the breath for weeks following a heavy exposure.

Tetrachloroethylene and trichloroacetic acid (TCA), a breakdown product of tetrachloroethylene, can be detected in the blood. These tests are relatively simple to perform. These tests aren't available at most doctors' offices, but can be per formed at special laboratories that have the right equipment.

Because exposure to other chemicals can produce the same breakdown products in the urine and blood, the tests for breakdown products cannot determine if you have been exposed to tetrachloroethylene or the other chemicals.

Has the federal government made recommendations to protect human health?

The EPA maximum contaminant level for the amount of tetrachloroethylene that can be in drinking water is 0.005 milligrams tetrachloroethylene per liter of water (0.005 mg/L).

The Occupational Safety and Health Administration (OSHA) has set a limit of 100 ppm for an 8-hour workday over a 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) recommends that tetrachloroethylene be handled as a potential carcinogen and recommends that levels in workplace air should be as low as possible.

Glossary

Carcinogenicity: The ability of a substance to cause cancer.

CAS: Chemical Abstracts Service.

Milligram (mg): One thousandth of a gram.

Nonflammable: Will not burn.

References

This ToxFAQs™ information is taken from the 1997 Toxicological Profile for Tetrachloroethylene (update) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

1,2-DICHLOROETHENE
CAS # 540-59-0, 156-59-2, and 156-60-5

This fact sheet answers the most frequently asked health questions (FAQs) about 1,2-dichloroethene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to 1,2-dichloroethene occurs mainly in workplaces where it is made or used. Breathing high levels of 1,2-dichloroethene can make you feel nauseous, drowsy, and tired. *cis*-1,2-Dichloroethene has been found in at least 146 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA). *trans*-1,2-Dichloroethene was found in at least 563 NPL sites. 1,2-Dichloroethene was found at 336 sites, but the isomer (*cis*- or *trans*-) was not specified.

What is 1,2-dichloroethene?

(Pronounced 1,2-dī-klôr′ ō-ĕth′ēn)

1,2-Dichloroethene, also called 1,2-dichloroethylene, is a highly flammable, colorless liquid with a sharp, harsh odor. It is used to produce solvents and in chemical mixtures. You can smell very small amounts of 1,2-dichloroethene in air (about 17 parts of 1,2-dichloroethene per million parts of air [17 ppm]).

There are two forms of 1,2-dichloroethene; one is called *cis*-1,2-dichloroethene and the other is called *trans*-1,2-dichloroethene. Sometimes both forms are present as a mixture.

What happens to 1,2-dichloroethene when it enters the environment?

- 1,2-Dichloroethene evaporates rapidly into air.
- In the air, it takes about 5-12 days for half of it to break down.
- Most 1,2-dichloroethene in the soil surface or bodies of water will evaporate into air.
- 1,2-Dichloroethene can travel through soil or dissolve in water in the soil. It is possible that it can contaminate groundwater.
- In groundwater, it takes about 13-48 weeks to break down.
- There is a slight chance that 1,2-dichloroethene will break down into vinyl chloride, a different chemical which is believed to be more toxic than 1,2-dichloroethene.

How might I be exposed to 1,2-dichloroethene?

- Breathing 1,2-dichloroethene that has leaked from hazardous waste sites and landfills.
- Drinking contaminated tap water or breathing vapors from contaminated water while cooking, bathing, or washing dishes.
- Breathing 1,2-dichloroethene, touching it, or touching contaminated materials in the workplace.

How can 1,2-dichloroethene affect my health?

Breathing high levels of 1,2-dichloroethene can make you feel nauseous, drowsy, and tired; breathing very high levels can kill you.

When animals breathed high levels of *trans*-1,2-dichloroethene for short or longer periods of time, their livers and lungs were damaged and the effects were more severe with longer exposure times. Animals that breathed very high

levels of *trans*-1,2-dichloroethene had damaged hearts.

Animals that ingested extremely high doses of *cis*- or *trans*-1,2-dichloroethene died.

Lower doses of *cis*-1,2-dichloroethene caused effects on the blood, such as decreased numbers of red blood cells, and also effects on the liver.

The long-term (365 days or longer) human health effects after exposure to low concentrations of 1,2-dichloroethene aren't known. One animal study suggested that an exposed fetus may not grow as quickly as one that hasn't been exposed.

Exposure to 1,2-dichloroethene hasn't been shown to affect fertility in people or animals.

How likely is 1,2-dichloroethene to cause cancer?

The EPA has determined that *cis*-1,2-dichloroethene is not classifiable as to its human carcinogenicity.

No EPA cancer classification is available for *trans*-1,2-dichloroethene.

Is there a medical test to show whether I've been exposed to 1,2-dichloroethene?

Tests are available to measure concentrations of the breakdown products of 1,2-dichloroethene in blood, urine, and tissues. However, these tests aren't used routinely to determine whether a person has been exposed to this compound. This is because after you are exposed to 1,2-dichloroethene, the breakdown products in your body that are detected with these tests may be the same as those that come from exposure to other chemicals. These tests aren't available in most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum allowable level of *cis*-1,2-dichloroethene in drinking water at 0.07 milligrams per liter of water (0.07 mg/L) and *trans*-1,2-dichloroethene at 0.1 mg/L.

The EPA requires that any spills or accidental release of 1,000 pounds or more of 1,2-dichloroethene must be reported to the EPA.

The Occupational Health Safety and Health Administration (OSHA) has set the maximum allowable amount of 1,2-dichloroethene in workroom air during an 8-hour workday in a 40-hour workweek at 200 parts of 1,2-dichloroethene per million parts of air (200 ppm).

Glossary

Carcinogenicity: Ability of a substance to cause cancer.

CAS: Chemical Abstracts Service.

Fertility: Ability to reproduce.

Ingest: To eat or drink something.

Milligram (mg): One thousandth of a gram.

ppm: Parts per million.

Solvent: A chemical that can dissolve other substances.

References

This ToxFAQs information is taken from the 1996 Toxicological Profile for 1,2-Dichloroethene produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

APPENDIX B
REPORT FORMS

WEEKLY SAFETY REPORT FORM

Week Ending: _____ Project Name/Number: _____

Report Date: _____ Project Manager Name: _____

Summary of any violations of procedures occurring that week:

_____

_____

_____

Summary of any job related injuries, illnesses, or near misses that week:

_____

_____

_____

_____

Summary of air monitoring data that week (include and sample analyses, action levels exceeded, and actions taken):

_____

_____

_____

Comments:

_____

_____

_____

Name: _____ Company: _____

Signature: _____ Title: _____

INCIDENT REPORT FORM

Date of Report: _____

Injured: _____

Employer: _____

Site: _____ Site Location: _____

Report Prepared By: _____ _____
Signature Title

ACCIDENT/INCIDENT CATEGORY (check all that applies)

___Injury	___ Illness	___ Near Miss
__ Property Damage	___ Fire	___ Chemical Exposure
__ On-site Equipment	___ Motor Vehicle	___ Electrical
__ Mechanical	___ Spill	___ Other

DATE AND TIME OF ACCIDENT/INCIDENT: Narrative report of Accident/Incident: Identify: 1) actions leading to or contributing to the accident/incident; 2) the accident/incident occurrence; and 3) actions following the accident/incident.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

WITNESS TO ACCIDENT/INCIDENT:

Name:	_____	Company:	_____
Address:	_____	Address:	_____
Phone No.:	_____	Phone No.:	_____
Name:	_____	Company:	_____
Address:	_____	Address:	_____
Phone No.:	_____	Phone No.:	_____

INJURED - ILL:

Name: _____ SSN: _____

Address: _____ Age: _____

Length of Service: _____ Time on Present Job: _____

Time/Classification: _____

SEVERITY OF INJURY OR ILLNESS:

____ Disabling ___ Non-disabling ___ Fatality

____ Medical Treatment ___ First Aid Only

ESTIMATED NUMBER OF DAYS AWAY FROM JOB: _____

NATURE OF INJURY OR ILLNESS: _____

_____

_____

_____

CLASSIFICATION OF INJURY:

__ Abrasions _____ Dislocations ____ Punctures

__ Bites _____ Faint/Dizziness ____ Radiation Burns

__ Blisters _____ Fractures ____ Respiratory Allergy

__ Bruises _____ Frostbite ____ Sprains

__ Chemical Burns _____ Heat Burns ____ Toxic Resp. Exposure

__ Cold Exposure _____ Heat Exhaustion ____ Toxic Ingestion

__ Concussion _____ Heat Stroke ____ Dermal Allergy

__ Lacerations

Part of Body Affected: _____

Degree of Disability: _____

Date Medical Care was Received: _____

Where Medical Care was Received: _____

Address (if off-site): _____

(If two or more injuries, record on separate sheets)

PROPERTY DAMAGE:

Description of Damage: _____

_____

Cost of Damage: $ _____

ACCIDENT/INCIDENT LOCATION: _____

ACCIDENT/INCIDENT ANALYSIS: Causative agent most directly related to accident/incident (Object, substance, material, machinery, equipment, conditions)

_____

_____

_____

_____

Was weather a factor?:_____

_____

Unsafe mechanical/physical/environmental condition at time of accident/incident (Be specific):

_____

_____

_____

Personal factors (Attitude, knowledge or skill, reaction time, fatigue):

_____

_____

ON-SITE ACCIDENTS/INCIDENTS:

Level of personal protection equipment required in Site Safety Plan:

_____

_____

Modifications:

_____

Was injured using required equipment?:

_____

_____

If not, how did actual equipment use differ from plan?:

_____

_____

ACTION TAKEN TO PREVENT RECURRENCE: (Be specific. What has or will be done? When will it be done? Who is the responsible party to insure that the correction is made?

ACCIDENT/INCIDENT REPORT REVIEWED BY:

SSO Name Printed SSO Signature

OTHERS PARTICIPATING IN INVESTIGATION:

Signature Title

Signature Title

Signature Title

ACCIDENT/INCIDENT FOLLOW-UP: Date:

Outcome of accident/incident:

Physician's recommendations:

Date injured returned to work:
Follow-up performed by:

Signature Title

ATTACH ANY ADDITIONAL INFORMATION TO THIS FORM

APPENDIX C
EMERGENCY HAND SIGNALS

EMERGENCY SIGNALS

In most cases, field personnel will carry portable radios for communication. If this is the case, a transmission that indicates an emergency will take priority over all other transmissions. All other site radios will yield the frequency to the emergency transmissions.

Where radio communications is not available, the following air-horn and/or hand signals will be used:

EMERGENCY HAND SIGNALS

OUT OF AIR, CAN'T BREATHE!

Hand gripping throat

LEAVE AREA IMMEDIATELY, NO DEBATE!

(No Picture) Grip partner's wrist or place both hands around waist

NEED ASSISTANCE!

Hands on top of head

OKAY! – I'M ALL RIGHT!

- I UNDERSTAND!

Thumbs up

NO! - NEGATIVE!

Thumbs down