Queens Plaza Off-Site
Tax Lot 14
Long Island City, New York
Site Number: C241105A

Remedial Action Work Plan

Prepared for:
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Submitted to
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CERTIFICATION

Professional Engineer's Certification

Queens Plaza Off-Site – Tax Lot 14
Long Island City, New York

Remedial Action Work Plan

January 2016

I, Joshua B. Levine, certify that I am currently a New York State registered professional engineer and Qualified Environmental Professional (QEP) as defined by 6 NYCRR Part 375 and that this Queens Plaza Off-Site Lot 14 Remedial Action Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with DER Technical Guidance for Site investigation and remediation (DER-10).

I, Joshua B. Levine, P.E., certify that this Remedial Action Work Plan was prepared by me or persons working under my direct supervision.

Joshua B

Joshua B. Levine, P.E.
NYS Professional Engineer
License Number 084925

February 3, 2016
Date

JOSHUA B. LEVINE
2/3/16
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It is a violation of Article 145 of New York State Education Law for any person to alter this document in any way without the express written verification of adoption by any New York State licensed engineer in accordance with Section 7209(2), Article 145, New York State Education Law.

1.0 INTRODUCTION AND OBJECTIVES

This Off-Site Remedial Action Work Plan ("RAWP") was prepared by Roux Associates Inc.'s associated engineering firm, Remedial Engineering P.C., and Fleming Lee-Shue, Inc. ("FLS") for LIC Operator Co. L.P. (the Respondent) to evaluate, select, and describe remedial measures for the off-site contamination associated with the Queens Plaza Residential Development ("QPRD"). The QPRD consists of Tax Lot 14 and three New York State Department of Environmental Conservation ("NYSDEC") Brownfield Cleanup Program ("BCP") sites located in Long Island City, Queens County, New York. Tax Lot 14 is not part of the BCP Sites. Specifically, this RAWP addresses the off-site BCP-related contamination identified at the immediately adjacent parcel located at 28-18 Jackson Avenue, Block 264, Tax Lot 14 (identified hereafter as "Tax Lot 14" or "Lot 14"), in Long Island City, New York.

The adjacent QPRD BCP sites are identified as Site A (BCP No. C241105), Site B (BCP No. C241151), and Site C (C241169) (collectively the "BCP Sites"). This RAWP has been prepared as part of the requirements outlined in the Order on Consent and Administrative Settlement CO2-2-15040406-218B (the "Lot 14 Order") to address off-site BCP-related contamination on Lot 14. Tax Lot 14 is bounded by BCP Site A to the west and south, Jackson Avenue to the north and a New York City Transit ("NYCT") substation building to the east. A NYCT subway tunnel is located immediately north, and below a portion of Tax Lot 14 and runs along Jackson Avenue. Figure 1 shows the Tax Lot 14 and BCP Site locations.

Historically, the principal activity on BCP Sites A and B was chemical manufacturing and storage (BCP Site C was used for deliveries of raw materials that supported the manufacturing operations). The former owner, West Chemical Company ("WCC"), manufactured soaps, disinfectants, floor waxes and other household and commercial cleaners and products. Creosote was the principal component in the manufacture of disinfectants and creosote spills represent the most significant impacts to soil and groundwater.

Remedial investigation results indicate that the primary impacts related to the BCP Sites detected in the soil and groundwater at Tax Lot 14 are associated with petroleum, creosote, or a petroleum/creosote mixture. The heaviest impacts are largely limited to the deep soils abutting

BCP Site A on the southernmost portion of Lot 14, with a comparatively small mass of impacted soil. This RAWP has been prepared to evaluate, select, and describe remedial measures for Tax Lot 14 based on the results of an investigation of Lot 14. It includes a summary of contamination, a qualitative human health exposure assessment, site specific remedial goals, and objectives, an evaluation of alternatives, and description of the selected remedy.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Description

Tax Lot 14 is located at 28-18 Jackson Avenue in Long Island City, Queens County, New York and is identified on a Tax Map as Block 264, Lot 14. LIC Development Owner, L.P. acquired title to Lot 14 in June 2014. The adjacent BCP Sites, which are currently undergoing remediation and development, are identified as Block 264, Lots 1, 1R, 17, and Block 263, Lots 1, 9, and 11. Figure 1 shows the layout of Tax Lot 14 and the adjacent BCP Sites.

The size and configuration of Tax Lot 14 present several access limitations and equipment constraints. Tax Lot 14 is 25 feet wide and approximately 125 long. The northern end overlies a subway tunnel and building foundation, where drilling access is restricted by the NYCT. The east side is bound by a NYCT subway electrical switching station. The western and southern sides are bound by BCP Site A and are currently inaccessible due to the Support of Excavation ("SOE") structures on these sides and the approximate 15-foot drop off imposed by the SOE. Along most of the southern side is SOE in the form of a three-foot-wide concrete secant wall. As of this date, building foundation elements block access to Tax Lot 14 and the only means of bringing equipment onto Lot 14 is via picking it with heavy equipment. A portion of the proposed residential building under construction, Tower A, extends from BCP Site A onto the northern portion of Lot 14. Tower A's footprint extends approximately 56 feet south from Jackson Avenue on Lot 14. South of the Tower A footprint, Lot 14 is currently being used as a staging area for construction supplies for adjacent BCP Site A.

The site is located in an area designated as M1-6/R10 within the Long Island City Special Purpose District assigned by the Department of City Planning. The Long Island City Special Purpose District is a particular zoning provision to promote development and transformation of historical industrial/manufacturing areas into mixed use commercial and residential spaces.

2.2 Site History

Tax Lot 14 was historically occupied by a blacksmith, wagon, and carpenters shop in the 19th century. It was occupied by a five-story mixed use residential and commercial building from 1915 until 2014 when it was demolished as part of the QPRD. This former building was historically occupied by primarily commercial occupants, including a battery and ignition service, a paint store, a restaurant, a liquor store, and exterminator. The building was also historically utilized for residential purposes.

WCC occupied the adjacent BCP Sites A and B from the early 1900s until 1977, during which time it manufactured and stored a variety of commercial and household disinfectants, soaps, floor waxes, insecticides, and paper product dispensing machines. Among the materials stored in above-ground tanks was creosote, a flammable material then used as the active ingredient in the manufacture of disinfectants, one of WCC's main product lines.

In the 1950s a fire began at the former WCC facility within what is now the BCP Site A tract. In an effort to contain the blaze, the New York City Fire Department ("FDNY") reportedly cut down the creosote tank. The tank ruptured and the contents ran over the ground and infiltrated the underlying soils. This release is believed to be the principal cause of soil and groundwater impacts at the BCP Sites and on the southern portion of Tax Lot 14.

The zoning map for Tax Lot 14 contained an "e" designation for hazardous materials in connection with the 2001 rezoning. Pursuant to section 11-15 of Zoning Resolution of the City of New York, a Hazardous Materials ("Haz Mat") "e" designation may be assigned to tax lots as part of the City Environmental Quality Review ("CEQR"). An "e" designation may be assigned to tax lots based on historic uses of the tax lot or adjacent lots that may pose environmental concerns. The "e" was assigned to Lot 14 because of its proximity to the former WCC facility.

3.0 SUMMARY OF REMEDIAL INVESTIGATION RESULTS

Initially, Tax Lot 14 was administered under the auspices of the New York City Mayor's Office of Environmental Remediation ("OER"). A sampling plan (including the installation of soil boring to bedrock and the collection of soil and soil vapor samples), Remedial Investigation Report, and Remedial Action Work Plan were approved by OER in 2014. The proposed remediation included some minor soil removal in the upper two feet along the extreme southern side of Tax Lot 14, installation of a composite cover over the entire lot and installation of an active sub-slab depressurization system ("SSDS") in the areas that will be developed with buildings. Based on these remedial actions, OER issued a Notice to Proceed in December 2014.

During construction and foundation pile drilling activities at the adjacent BCP Site A (C241105), on June 29, 2015, product was observed migrating from Tax Lot 14's southern support of excavation soldier pile and wood lagging wall onto BCP Site A. It is believed that the product mobilized because of site operations including vibration and water-injection associated with installation of the pilings. On July 2, 2015 FLS met with NYSDEC and was informed that Tax Lot 14 was considered "off-site" contamination and would be addressed pursuant to the Lot 14 Order. At this point, the NYSDEC took over as the lead agency managing Tax Lot 14.

Subsequently, FLS, on behalf of Respondent, proposed advancing several soil borings and two monitoring wells to assess the nature and extent of contamination on Tax Lot 14. The NYSDEC approved the investigation scope on July 30, 2015, and the sampling was completed by August 13, 2015. A sample of the product observed migrating from Lot 14 onto BCP Site A was also collected and analyzed for specific gravity and reserved for future treatability study pilot testing.

Five soil borings were advanced to bedrock to characterize soils and the extent of impacts and two monitoring wells were installed to determine groundwater quality. Figure 2 shows the locations of the soil borings and monitoring wells. Soil boring and well construction logs are provided in Appendix A. A total of 21 soil samples (including one duplicate) were collected and analyzed for volatile organic compounds ("VOCs"), semi-volatile organic compounds ("SVOCs"), metals, pesticides, and polychlorinated biphenyls ("PCBs"). The principal impacts occurred in the samples collected from borings SB-4, SB-5, and SB-6, located in the southern portion of Tax Lot 14. The location and concentrations of contaminants detected in soil at levels exceeding regulatory standards is shown in Figure 3. The compounds indicated that the impacts were primarily from VOCs and SVOCs associated with petroleum, creosote, or a petroleum/creosote mixture. Most soils results, except naphthalene, two VOCs, and polycyclic aromatic hydrocarbons ("PAHs"), were below the Part 375 Restricted Residential Soil Cleanup Objectives ("SCOs") but were above the Protection of Groundwater SCOs.

Soils stained with Non-aqueous Phase Liquid ("NAPL") were limited to SB-5 and SB-6 located along the southernmost edge of Tax Lot 14. Stained soils in these borings were identified near the bedrock contact. A specific gravity sample of product from Lot 14 measured 0.96, making the material a Light Non-Aqueous Phase Liquid ("LNAPL").

Two groundwater samples were collected from monitoring wells MW-5 and MW-6. The results identified a number of VOCs and SVOCs above Technical and Operational Guidance Series 1.1.1 ("TOGS") criteria. The location and concentrations of contaminants detected in groundwater at levels exceeding regulatory standards is shown in Figure 4. Most of these compounds are associated with petroleum, creosote, or a petroleum/creosote mixture. A number of chlorinated VOCs were also identified above TOGS criteria.

Source Zone Mass Estimate

The contaminant mass estimates for Lot 14 were based on two source areas surrounding soil boring SB-4 and a combined zone surrounding SB-5 and SB-6 along the southern border of the site. The northern area surrounding SB-4 is 17 feet long by 25 feet wide by five feet thick. The combined SB-5 and SB-6 zone in the southern portion of the site is 18 feet long by 25 feet wide and has a depth of 7.5 feet on the western half and 10 feet on the eastern half of the zone near SB-6. SB-6 had elevated PID readings throughout the 18 feet deep soil boring and elevated SVOC concentrations in the 4-5 feet below land surface (ft bls) depth interval, but the contaminant source zone was limited to the deeper 8 to 18 ft bls depth interval in the saturated zone where both VOCs and SVOCs are serving as a direct source to groundwater contamination. Land surface was approximately elevation +11 NAVD88 at the time of this investigation.

The total contaminant mass determined by Total Petroleum Hydrocarbon ("TPH") Diesel Range Organics ("DRO") and Gasoline Range Organics ("GRO") concentrations calculated in the two source areas is provided below.

Boring	**Length** (ft)	**Width** (ft)	**Thickness** (depth ft)	**Volume** ft^3	**Volume** m^3
SB-6	18	12.5	10	2,250	63.7
SB-5	18	12.5	7.5	1,688	47.8
SB-4	17	25	5	2,125	60.2
Total	35	25	--	6,063	172

Source Area	**Average Contaminant Mass Conc.** (mg/kg)	**Bulk Density** (kg/m^3)	**Soil Volume** (m^3)	**Contaminant Mass** (kg)	**Contaminant Mass** (lbs)	**Percent Contaminant Mass** (%)
SB-5 and SB-6	2,946	1,600	111.5	525.6	1,156	79.2
SB-4	1,429	1,600	60.2	137.6	303	20.8
Total	--	--	171.7	663.2	1,459	100%

TPH concentrations were used to estimate contaminant mass because they include all the regulated compounds plus the many additional compounds that are not on the regulatory lists. The analytical laboratory results and a summary of the statistical analyses used to calculate the average contaminant mass for each zone is provided in Appendix B. Bulk density was analyzed for eight undisturbed soil samples collected from a Sonic drill core submitted to Accutest Laboratory for analysis of bulk dry density. The eight bulk density values ranged from 0.99 to 1.9 gram per milliliter (g/mL). An average value of 1.44 g/mL was calculated and a conservative value of 1.6 g/mL (equivalent to 1,600 kg/m^3) was used for the calculation of source zone mass. Typical dry density values of well graded silty sand range from 1.41 g/mL (loose) to 2.06 g/mL (dense), so the dry density value used in the calculation falls within the range of expected values (Kovacs, 1981).

The estimated total volume of spilled creosote in the source zone is as follows:

Contaminant Mass kg (lbs)	Creosote Density, g/mL	kg/g	mL/Liter	Liters	Gallons	55-Gallon Drums
663.2 (1,459)	0.96	0.001	1,000	691	183	3.3

4.0 QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

The objective of the qualitative exposure assessment is to describe how human and environmental receptors may be exposed to site contaminants based upon the site-specific conditions and to assess whether there are any complete or potentially complete exposure pathways. As specified in ECL 27-1415(2) and DER-10, the exposure assessment should consider the current conditions, as well as the reasonably anticipated future land use of the site and the affected off-site areas, and the reasonably anticipated future groundwater use.

As discussed above, the contaminants of concern ("COCs") at the BCP Sites that have impacted Tax Lot 14 include petroleum related VOCs (i.e., BTEX) and SVOCs, creosote, and chlorinated solvents. These COCs were detected in soil and groundwater at concentrations above their respective NYSDEC standards. The NYSDEC TOGS Class GA Groundwater Quality Standards were developed to be protective of public health based upon consideration of groundwater as a potential source of drinking water. The groundwater exposure scenario is not applicable to Tax Lot 14 given the current high density urban land use, the reasonably anticipated land use at Tax Lot 14, and the prohibition on groundwater use by New York City code.

An exposure pathway describes the means by which an individual may be exposed to contaminants on a site. An exposure pathway has five elements: (1) a contaminant source; (2) contaminant release and transport mechanisms; (3) a receptor population; (4) a point of exposure; and (5) a route of exposure. The following paragraphs provide an overview discussion of exposure pathways that may potentially exist associated with Tax Lot 14.

4.1 Contaminant Sources

The predominant source of contamination was the creosote discharge in and around the central processing and storage area on BCP Site A in the 1950s. Impacts by chlorinated compounds to soil and groundwater arose most likely from ancillary cleaning, storage, and small-scale manufacture of janitorial products. Additional sources may have included petroleum releases from storage tanks. The contaminant source is predominantly on the southernmost edge of Lot 14 and at least 9 feet below grade or near the soil bedrock contact which ranges from 11 to 27 feet below grade.

4.2 Contaminant Release and Transport Mechanisms

The contaminants at the BCP Sites and Tax Lot 14 exist principally in the form of residual material adsorbed to soil particles and within the soil pores in the saturated zones and compounds dissolved in groundwater. The leaching of contaminants from soil serves as an ongoing source of contamination to groundwater beneath portions of the BCP Sites and Tax Lot 14. In addition, some VOCs are migrating through volatilization of compounds from soil and groundwater into soil vapor.

4.3 Receptor Population

The potential on-site receptors include occupational workers, construction/remediation workers, visitors, or trespassers. Future on-site receptors are expected to also include workers, residents, and guests based on the potential future use of the property. The potential off-site receptors include off-site workers, visitors, residents, and trespassers.

4.4 Potential Points and Routes of Exposure

Contaminated soil is encountered at depths below the immediate surface as indicated by subsurface and surficial soil samples collected as part of the RI. However, there is the potential for direct exposure to contaminated soil by anyone digging in the contaminated areas.

Tax Lot 14 and the surrounding community are supplied by public sources of drinking water, which meets all State and Federal standards for drinking water quality. As such, there is no potential for exposure to Tax Lot 14 contaminants from the public sources of drinking water. The use of groundwater as a drinking water source is prohibited by the City of New York.

VOCs have been documented by soil vapor measurements collected at Tax Lot 14. There is a potential for vapor intrusion into newly constructed buildings with the concentrations of soil vapors measured. The development plan will include an active SSDS in the area of the proposed building at Tax Lot 14. All floor slabs and basement walls will also be protected with a waterproofing/vapor barrier preventing vapor intrusion. Remediation and installation of engineering controls during construction will ensure there will be neither a source nor pathways for migration. During construction, site workers could be exposed to contaminants via the air inhalation route of exposure, which is addressed in a Site Health & Safety Plan.

The following matrix summarizes the media, human health exposure pathways, controls, and status of exposure pathways during the pre- and post-development phases.

Summary of Human Health Exposure Pathways by Media and Site Operation

Medium	Exposure Pathway	Construction	Post Development
Soil	Dermal Contact	Pathway complete but controlled by Health & Safety Plan procedures.	Pathway incomplete: Contaminated soil removed and residual soils covered by concrete slab or two feet of clean material.
	Inhalation	Pathway complete but controlled by Health & Safety Plan procedures.	Pathway incomplete: Contaminated soil removed and/or residual soils covered by concrete slab or two feet of clean material.
	Ingestion	Pathway complete but controlled by Health & Safety Plan procedures.	Pathway incomplete: All soils covered by concrete slab or clean material.
Soil Vapor	Dermal Contact	Not Applicable	Not Applicable
	Inhalation	Pathway complete but controlled by air monitoring.	Pathway incomplete: Active SSDS installed in new building and vapor barrier in place around and under foundation.
	Ingestion	Not Applicable	Not Applicable
Groundwater	Dermal Contact	Pathway complete but controlled by Health & Safety Plan procedures.	Pathway incomplete: Groundwater contact prevented by concrete slab and waterproofing around and under foundation and prohibition on use of groundwater as an institutional control.
	Inhalation	Pathway complete but controlled by air monitoring.	Pathway incomplete: Vapor barrier in place around foundation and SSDS in place beneath building on Lot 14.
	Ingestion	Pathway complete but controlled by Health & Safety Plan procedures.	Pathway incomplete: Groundwater use prohibited by local ordinances. Public water supply serves community.

In conclusion, complete exposure pathways will exist during the remediation and construction phases. These pathways will be controlled by air monitoring and implementing the procedures in the Health & Safety Plan and Community Air Monitoring Plan. Following construction and development, all exposure pathways will be incomplete or eliminated. Engineering controls in the form of the concrete slab, clean material cap, and vapor barrier will add an additional level of protection in that they ensure there are no complete human health exposure pathways. A site-specific prohibition on groundwater use will eliminate this potential exposure pathway. Following remediation and development, there will be no complete human health exposure pathways. The engineering and institutional controls planned for Tax Lot 14 will ensure there are no complete exposure pathways.

5.0 REMEDIAL ACTION OBJECTIVES

The following Remedial Action Objectives ("RAOs") have been defined for Tax Lot 14.

Groundwater

RAOs for Public Health Protection

- Prevent ingestion of groundwater containing contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of, volatiles emanating from contaminated groundwater.

RAOs for Environmental Protection

- Restore groundwater aquifer, to the extent practicable, to pre-disposal/pre-release conditions.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

Soil

RAOs for Public Health Protection

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of, or exposure to, contaminants volatilizing from contaminated soil.

RAOs for Environmental Protection

- Prevent migration of contaminants that would result in groundwater or surface water contamination.
- Prevent impacts to biota due to ingestion/direct contact with contaminated soil that would cause toxicity or bioaccumulation through the terrestrial food chain.

Soil Vapor

RAOs for Environmental Protection

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into the buildings at the site.

6.0 DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

Remedial investigations have determined that soil, groundwater and soil vapor at Tax Lot 14 have been impacted by the contamination at the adjacent BCP Sites. As previously discussed, soil vapor intrusion will be mitigated via engineering controls including an active SSDS in the building and a vapor barrier/waterproofing around and beneath foundation walls. The following sections describe potential remedial alternatives and evaluate each alternative with respect to the RAOs and the following criteria:

- Overall protectiveness of public health and environment
- Standards, criteria, and guidance
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume of contamination
- Short-term impacts and effectiveness
- Implementability
- Cost effectiveness
- Land use
- Community acceptance

6.1 No Action with Institutional and Engineering Controls

One remedial alternative is no further treatment at all. The location, end use, and urban setting make this alternative attractive, as it is consistent with the end use, urban setting, and remedy on the adjacent BCP Site A, but it does not reduce the toxicity, mobility, or volume of contamination in place. While no action will allow the contamination to remain in place, it does not compromise overall remedy effectiveness because the public will not be exposed. The contaminant will be covered by a building and engineered cap and therefore remain inaccessible. A sub-slab depressurization system and vapor barrier will also be in place that will eliminate the vapor migration pathway. Likewise, New York City law prohibits the use of groundwater, so there will be no exposure to this medium. Thus, engineering and institutional controls will already be in place to address the relatively small mass of contaminant found at depth and will prevent any exposure pathway from becoming complete.

The no action remedy does not meet the Remedial Action Objectives, since it leaves grossly contaminated soil in place. While not impossible to excavate Lot 14, it is highly impracticable because of the need for extensive SOE, equipment limitations, excessive cost, and additional NYCT restrictions and requirements.

No action has no bearing on long-term or short-term effectiveness in that nothing changes. Toxicity will remain unchanged, but the engineering and institutional controls will ensure no pathway is complete, so there is no risk associated with contamination allowed to remain in place.

No action is easily implemented by taking no further action. It is by definition cost effective. It will have no adverse effect on land use as a building will be placed on Lot 14, which is the same building as will be on Site A and on the surrounding urban areas.

Despite the implementability, lack of exposure and cost effectiveness, the No Action alternative would not reduce groundwater contamination, prevent groundwater migration or remove source material present at depth at Lot 14. Therefore, it would not achieve the RAOs with respect to environmental protection.

6.2 Excavation

One potential remedial alternative is excavation. Excavation of the impacted area to bedrock is a complete remedy that will meet all RAOs, but it isn’t cost effective and has severe restrictions on implementability due to NYCT review and approval. In terms of protectiveness, excavation is completely protective of public health and the environment as it removes all contaminated material. Removal of source material will insure that all material exceeding the SCOs will be removed. Excavation conforms to all remedial criteria.

Excavation yields an effective long-term remedy by means of complete removal of contaminated media. Complete removal naturally yields a total reduction in toxicity. It is effective in the short term in that excavation is relatively quick and toxicity is lowered with each volume of soil removed. Most short-term impacts are in the form of increased traffic, disruption of traffic patterns, noise, potential odors from impacted soils, and redirection of pedestrian traffic.

Excavation is readily accepted by the community. This is a common form of remediation and is also inherent in construction of new buildings that takes place at numerous locations in and near Lot 14. This remedy is consistent with land use. Lot 14 is in New York City, a highly urbanized location that has experienced numerous types of excavation throughout its history. There are no sensitive environmental receptors that would be adversely affected by excavation.

While excavation is a very positive alternative in many respects, two factors seriously detract from its feasibility: implementability and cost. Excavation on Lot 14 is subject to NYCT review and approval to protect vital New York City infrastructure. At a minimum, extensive SOE structures would have to be installed along with detailed engineered plans to construct the SOE. The design and installation of the SOE would add considerably to the cost. Even in the best case, some contamination would have to remain as there is a minimum three-foot setback from NYCT structures. Typically, NYCT would prohibit deep excavation altogether as it is very close to their structures and poses a threat to the structural integrity of their infrastructure. A critical limitation of excavation is that the required excavation depths would result in more settlement of the NYCT substation. A letter from the geotechnical engineer, Mueser Rutledge Consulting Engineers, documenting the concerns with excavation and NYCT review is provided in Appendix C.

At a cost of several million dollars to remove less than approximately 1,450 pounds of contaminant mass in the saturated zone, and allowing some contamination to remain due to NYCT excavation restrictions, it appears that excavation is not a cost effective alternative, and is one with severe restrictions on implementability.

6.3 Containment: Drilled Grout Cut-Off Wall and Capping

Installation of a drilled grout cut-off wall and surficial concrete cap is a means of containing the contamination and preventing any further migration. Containment would be achieved by the installation and grouting of a cut-off wall encircling Lot 14 from the southwest corner to approximately 59 feet north of this point, then east to within three feet of the NYCT Substation and then south to connect with the existing secant wall along the southern side. However, additional soil samples will be collected to determine the final northern extent of the eastern and western sides of cut-off wall. A soil sampling plan will be submitted to the NYSDEC for approval prior to implementation. Based on the soil results, the northern extent of the cut-off wall may be reduced following NYSDEC approval. Except for a small segment that extends the existing secant wall along the southern side, the grout cut-off wall would be constructed of 14-inch-diameter borings drilled a minimum of three inches into bedrock on 12-inch centers and filled with grout consisting of Type II cement with a small percentage of bentonite. The small segment extending the south secant wall to the southwest corner of Lot 14 will be completed with a poured grout wall. The cut-off wall would form a continuous, secant wall-type barrier preventing groundwater flow. Every other boring would be installed first, allowed to harden, and then the next set of borings would be drilled to seal the openings. The cut-off wall would be five feet from the inside of the SOE on the western side of Lot 14.

A concrete cap installed over the ground surface extending to all four sides of the perimeter grout cut-off wall would encapsulate the site, preventing infiltration of rainwater and off-site groundwater migration.

This proposed containment mechanism would effectively isolate the existing contamination at Lot 14 and reduce the mobility of contaminants, therefore preventing any further migration of material back onto the previously remediated BCP Sites, but it does not reduce toxicity or volume as a stand-alone remedy. Containment would be protective of public health since engineering and institutional controls will be in place as part of the design and New York City requirements. It would be semi-protective of the environment by preventing any further migration; however, the contamination would still be left in place at the site without any reduction in volume or toxicity. Therefore, it would not be appropriate as a stand-alone remedy, but could be used in conjunction with a remedy that reduces toxicity and volume.

Based on the proposed future use of the site, the applicable SCOs would be the Restricted Residential SCOs. Since the remedial investigation found a few contaminants exceeding the

Restricted Residential SCOs, containment would not conform to all of the applicable criteria and standards. Furthermore, containment would not address the existing contamination in groundwater that exceeds TOGS AWQSGVs.

Containment would be effective in the long term in preventing any off-site migration of contaminants but would not address the existing contamination at Lot 14. The short-term impacts would be relatively minimal and would include drilling required to install the cut-off wall and the associated noise and odor nuisances.

The community is likely to accept this contaminant remedy since drilling is already being performed on-site for construction purposes. The remedy would be consistent with land-use and there are no sensitive environmental receptors that would be adversely affected by the drilling activities.

The proposed containment method is implementable through readily available drilling technologies. While this method is relatively cost effective compared to other alternatives such as full excavation or thermal treatment, the installation of the grout cut-off wall is still costly compared to the no action alternative. Furthermore, containment alone would not achieve the RAOs with respect to protection of the environment since contamination toxicity and volume in Lot 14 soil and groundwater would not be fully addressed.

There are some risks and uncertainties associated with the proposed drilling method when installing the cut-off wall to depths since the borehole diameters must be relatively small and may bend or break during installation. If there is slight eccentricity with the small diameter borings, it is possible that the wall may have unknown gaps at the bottom. The small-diameter boreholes could also be susceptible to breakage when the intervening and overlapping second set of borings are installed. This would jeopardize the desired effect of a continuous impervious layer. Another risk is that the prolonged extensive drilling and use of heavy equipment may damage the structural features already present at both Tax Lot 14 and the adjacent BCP Site A. Measures can be taken to mitigate these risks such as installing a guide wall to maintain vertical orientation of the drill stem as well as checking the drill stem for vertical alignment during drilling.

6.4 Treatment: *In Situ* Chemical Oxidation

In situ chemical oxidation ("ISCO") is a means of destroying the contamination in place by injecting chemicals (oxidants) that break down the contaminant.

Overall protectiveness of public health and the environment is very high with this approach, but its feasibility is impacted by NYCT review and approval. Most of the contaminant mass can be destroyed in place and past experience with this approach and similar contaminant has achieved a high level of contaminant mass destruction. The small, low level contaminant mass remaining following treatment will be inaccessible to the public and pose no adverse hazard. A bench-scale treatability study was completed to verify treatment effectiveness and that the cleanup goals can be achieved. The bench-scale test took into account site-specific factors that could influence chemical treatment. The bench scale test results are provided in Appendix D.

This treatment is effective in the long term because it destroys contaminant mass, resulting in a permanent cleanup. Chemical treatment results in a large reduction in toxicity; this reduction occurs in place and does not expose the public to any contaminant (as opposed to excavation). The treatment takes a relatively short time to achieve cleanup, so it is very effective in the short term. In the short term, there can be increases in dissolved metals, PAHs, and other compounds as chemical oxidation strongly desorbs these contaminants from the soil surfaces (the same is true for excavation). This can result in a temporary increase in groundwater concentrations that is typically followed by a very sharp decrease in concentration after the chemical reaction is completed.

This type of remedy is readily accepted by the community as it results in no disruption. It does not require many vehicles or personnel to implement. Past experience in high density areas has shown no complaints over extended injection periods. This remedy is consistent with land use as it does not jeopardize land use for other purposes, nor does it impact sensitive receptors.

This remedy is easily implemented and can accurately target the contaminant by strategically placing the injection wells. The injection wells were already installed as it was necessary to install them when access was available. Because injection would occur next to the NYCT structures, NYCT review of the plans and acceptance is required. NYCT may limit the type and dosage of oxidant to protect their structures and could impose restrictions that would render *in situ* chemical injection infeasible. If this were the case, mitigating measures may be adopted such as stopping the reaction after time and/or adding an amendment to remove sulfate from solution. Due to past experience involving NYCT's review and concern with the concentration and composition of ISCO compounds applied adjacent to their structures, the feasibility of getting ISCO approved as a stand-alone remedy without a perimeter cut-off wall is unlikely, thereby negatively impacting its implementability.

This method is cost effective in that the injection wells have been installed and implementation requires only a small number of personnel to mix and inject the chemical. A typical treatment of this sort generally requires one to two weeks of site work. The end products would be water, carbon dioxide, and sulfate.

This alternative in conjunction with the engineering and institutional controls meets all RAOs. There is no public health exposure to soil, groundwater, or soil vapor. The contamination will not impact organisms or environmental receptors. This alternative will substantially improve groundwater water quality by resulting in a reduction of the concentration of VOCs and SVOCs in the groundwater.

6.5 Limited Source Removal Via Drilling

Although full excavation of contaminant source material at Lot 14 is infeasible due to the proximity of the NYCT substation building and the depth of excavation that would be required, limited source removal via drilling is feasible. Drilling as a method of source removal could be accomplished with readily available drilling equipment. This remedy is not cost effective for source removal across the entire site, but limited implementation could be used to reduce contaminant mass. Borings could be installed only in the most heavily contaminated areas of Lot 14 to reduce the costliness associated with extensive drilling. Soil removal via auger drilling would consist of the installation of overlapping 14-inch diameter bore holes within the southern five feet of Tax Lot 14 extending to the existing adjacent secant wall where the majority of source material has been identified. It is unlikely that equipment capable of drilling larger diameter boreholes would be able to access the site.

As with the other alternatives, protection of public health is addressed through the implementation of institutional and engineering controls. Overall protectiveness of the environment is partially achieved through this remedy by reducing contaminant mass as well as mobility and toxicity in groundwater. However, some contaminant mass would remain in place.

This remedy would be effective in the long term in reducing source material contact with groundwater and potentially reducing dissolved groundwater concentrations. Since implementation would require a large number of augured boreholes throughout the impacted area, it would require extensive drilling so short-term impacts would include those associated with the drilling activities. The drilling would be subject to NYCT review and approval. The community is likely to accept this remedy since drilling is already being performed on-site for construction purposes. The remedy would be consistent with land-use and there are no sensitive environmental receptors that would be adversely affected by the drilling activities. However, the source removal via drilling remedial option alone would not achieve all RAOs with respect to environmental protection since it is not a viable option for complete source removal.

6.6 Combination: Hydraulic Control via Containment Cut-Off Wall, Cap and Recovery Well, and *In situ* Chemical Oxidation with Institutional and Engineering Controls

The hydraulic control alternative combines installation of a drilled perimeter grout cut-off wall and concrete cap to isolate source material, and a groundwater recovery well and monitoring wells to establish and maintain hydraulic control. This is followed by subsequent ISCO injection(s) during the site management phase to reduce the contaminant mass. The principal benefits of this alternative are that it isolates the contamination on Tax Lot 14 south and west of the NYCT structures and provides a physical separation barrier between any injection chemical and NYCT structures. In addition, a groundwater recovery well installed within the confines of the perimeter grout cut-off wall enables control of water levels within Lot 14 to confirm and maintain hydraulic control. Hydraulic control would be confirmed by lowering ground water levels within the isolated perimeter grout cut-off wall to an elevation below the post-dewatering groundwater levels outside of the perimeter wall, such that groundwater could not migrate off-site or, by establishing that water is not migrating off the site by monitoring field parameters/tracer dye in paired monitoring wells located inside and outside of the perimeter grout cut-off wall. Hydraulic control confirmation would be performed after the perimeter grout cut-off wall is installed and the dewatering system has ceased operation, and prior to ISCO injections. If the perimeter grout cut-off wall and recovery well cannot confirm hydraulic control (a highly unlikely scenario), a contingency remedy of limited source removal via augered drilling would be performed to reduce the residual contaminant mass within the perimeter grout cut-off wall instead of applying ISCO. The limited source removal via drilling in the southern portion of Lot 14 would be feasible with the drilling equipment already on-site for the grout cut-off wall. The Lot 14 recovery well is feasible since the greater QPRD construction site will contain a proposed perimeter capture well network and groundwater treatment system, so the water recovered from Lot 14 could be conveyed to the QPRD groundwater treatment system for processing and off-site disposal.

The combination remedy is protective because of isolation, source material reduction, and chemical destruction of the contaminant thereby concurrently reducing mobility, volume and toxicity. It conforms to standards as all remedies are commonly used for this type of contamination. It is effective in both the short and long term in that the contamination is isolated, reduced and then destroyed in place in a very short time period. The remedy would be acceptable to the community as it causes no disruption other than typical construction nuisances and is compatible with land use in that it does not impact sensitive environmental receptors. It is consistent with the contemplated end use. The combined remedy reduces both the toxicity and contaminant mass, yielding a double measure of protection.

The remedy is implementable, although it requires NYCT review and comment. In terms of cost, the combination remedy is not particularly cost-effective at an estimated cost of $4,000,000, because three separate remedies are being combined where either one alone would likely be sufficient to address the contamination. It is an expensive means to address the approximate

1,450 pounds of contamination in the saturated zone, particularly when only a limited number of results exceed the Restricted Residential SCOs. However, it is cost effective when compared to other alternatives such as thermal treatment and excavation, and it is more likely to be both effective and approved by NYCT than any of the other remedies on their own.

This alternative meets all RAOs. There is no public health exposure to soil, groundwater, or soil vapor after the remedy has been implemented. The contamination would not impact organisms or environmental receptors. This alternative will substantially improve groundwater water quality by resulting in a reduction of the concentration of VOCs and SVOCs in the groundwater.

Since this alternative involves the installation of the grouted containment cut-off wall, there are similar risks associated with the effectiveness of the remedy (impermeable layer may not be achieved at depth) and potential to damage existing structural features with extensive use of heavy equipment.

6.7 Thermal Treatment

Thermal treatment consisting of electric resistance heating involves installing electrodes into the subsurface and adding electricity to heat soil and groundwater for prolonged periods to evaporate contaminants. Thermal treatment can be very successful in remediation of volatile organic contaminations; however, is less effective for heavier compounds including SVOCs. Since the contaminants of concern at Lot 14 are both VOCs and SVOCs, thermal treatment may not be overall as protective of the environment as other alternatives. It would be still be protective of public health since institutional and engineering controls will implemented.

Thermal treatment would remove volatile contaminants but would not likely remove all contaminants exceeding the regulatory criteria, standards, and guidelines. For the contamination removed, there will be a reduction in toxicity, mobility and volume; however it is unlikely to work for all compounds. The short term impacts would include drilling and associated noise nuisances, which are already occurring for construction purposes. The long-term effectiveness is unknown.

The community is likely to accept this contaminant remedy since drilling is already being performed on-site for construction purposes and the remedy is an *in situ* type that has negligible impact on the community. The remedy would be consistent with land-use and there are no sensitive environmental receptors that would be adversely affected by the drilling activities.

Other than overall protectiveness of the environment, there are two other factors that detract from the feasibility of thermal treatment for Lot 14: implementability and cost effectiveness. Lot 14 is immediately adjacent to a NYCT subway tunnel to the north and a NYCT substation to the east. Therefore any work at Lot 14 must be approved by the NYCT prior to implementation and there are concerns about stray current from the electrodes so close to the NYCT structures. One risk associated with thermal treatment is that in some instances, it can mobilize and spread contamination. Another risk is that heating the soil for extended periods could jeopardize the integrity of structural features such as piles and concrete, resulting in an unacceptable level of uncertainty for this type of remedy. Thermal treatment can be extremely expensive due to electrical infrastructure and electrical consumption during operation, and since it does not work on certain contaminants of concern, it is not nearly as cost effective as other alternatives.

6.8 *In Situ* Stabilization

In situ stabilization entails mixing a concrete and/or cement-like material with the contaminated soil, creating a solid block that has minimal contact with groundwater. This is achieved by using large augers to mix the material with the soil throughout the soil column and would require a large number of boreholes throughout Lot 14 to reach the desired effect. Another method of *in situ* stabilization is jet grouting which consists of overlapping columns formed in the ground by mixing grout introduced at high pressure. As with the other alternatives, protection of public health is addressed through the implementation of institutional and engineering controls. Overall protectiveness of the environment is achieved through this method by reducing mobility of contaminants and preventing dissolving of contaminants into groundwater. In this manner, it would also reduce toxicity in groundwater, but it does not reduce the volume of contamination.

In situ stabilization would reduce potential for contaminated soil to further impact groundwater but it would not fully address the existing soil and groundwater contaminant exceeding standards.

This remedy would be effective in the long term in preventing soil contact with groundwater, therefore reducing dissolved groundwater concentrations. Since implementation would require a large number of augered boreholes throughout the impacted area, it would require extensive drilling so short-term impacts would include those associated with the drilling activities. The drilling would be subject to NYCT review and approval.

The community is likely to accept this remedy since drilling is already being performed on-site for construction purposes. The remedy would be consistent with land-use and there are no sensitive environmental receptors that would be adversely affected by the drilling activities.

In situ stabilization would require installation of many borings throughout the impacted area similar to the source removal via drilling alternative. *In situ* stabilization would not remove any source material from Tax Lot 14, whereas the soil removal via drilling method would remove some of the contaminant mass. Therefore, the effectiveness of the *in situ* stabilization remedy is less than that of the limited source removal via drilling while using the same drilling technology. Considering the cost, complexity, and lack of source removal, *in situ* stabilization is not believed a practicable remedial alternative.

7.0 RECOMMENDATIONS

Eight remedial alternatives have been evaluated to address contamination at Tax Lot 14. Each has been examined for its merits according to the nine criteria set forth in DER-10 in conjunction with the mass of contamination, the surrounding land use, and the site limitations and restrictions unique to Lot 14. Because of the adjacent infrastructure, each remedy is subject to NYCT review to protect vital transportation infrastructure. The NYCT set back restrictions mean that no matter what remedy is selected; some contamination will remain in place.

The remedial option that most effectively meets the RAOs, is most likely to be accepted by the MTA, and yields the most protectiveness for the least cost is the Combination: Hydraulic Control via Containment Cut-Off Wall, Cap and Recovery Well, and In Situ Chemical Oxidation with Institutional and Engineering Controls.

8.0 PROPOSED REMEDY

This RAWP describes the proposed remedy for Tax Lot 14. The Hydraulic Control remedy consists of the following:

- installation of a perimeter containment grout cut-off wall and overlying concrete cap to isolate contamination on-site; and
- installation of a recovery well within the perimeter containment grout cut-off wall and paired monitoring wells located inside and outside of the perimeter grout cut-off wall to confirm hydraulic control and to control and observe groundwater levels within Lot 14.

ISCO treatment is proposed during the site management phase following implementation of the Hydraulic Control remedy to address and treat residual soil and groundwater contamination within the isolated grout wall perimeter.

Limited source removal via augered drilling in the southern portion of Tax Lot 14 would only be implemented as a contingency alternative to ISCO if hydraulic control isn't confirmed via the proposed remedy noted above.

The Tax Lot 14 remedy does not include grout wall drilling, source removal drilling or *in situ* chemical oxidation on the northern portion of Tax Lot 14 under the Tower A footprint since this area of the site contains very little contaminated media per the findings of the Remedial Investigation (Section 3.0) and these remedies are subject to NYCT review and approval due to proximity of the underlying and adjacent subway tunnel. The northern portion of Tax Lot 14 under the proposed building footprint extends 56 feet south of Jackson Avenue and currently contains building foundation elements in place, which would preclude any deep remedial work in this portion of the site.

The northern portion of Tax Lot 14 will contain a vapor barrier and SSDS common to both BCP Site A and under the proposed building footprint on Tax Lot 14 to prevent soil vapor intrusion into the proposed building. The SSDS is described in greater detail in the BCP Site A RAWP and FLS' letter "Re: Clarification on Implementation of BCP Site A RAWP (Sub-Slab Depressurization System)", dated August 26, 2015. The SSDS will be managed under the site management plan for the adjacent BCP Site A. Provided below is a description of means and methods to implement the proposed remedy.

8.1 Site Preparation

8.1.1 Sediment and Erosion Control Measures

Due to the site location within the greater QPRD construction site and surface topography on Tax Lot 14, surface stormwater currently percolates down to bedrock and flows northwest/west from Tax Lot 14 onto the adjacent BCP Site A. Surface water does not flow north off-site to Jackson Avenue because Tax Lot 14 is at a lower elevation than the sidewalk north of Tax Lot 14.

Stormwater containment devices, including sumps and perforated stormwater collection piping will be installed on Tax Lot 14 to contain surface stormwater and prevent water coming through the soldier pile and lagging SOE during the grout wall drilling process. Contained wastewater will be submitted through the greater QPRD site-wide dewatering system to prevent flooding on Tax Lot 14 or on adjacent lower elevations of BCP Site A.

Sediment and erosion control measures previously installed per the adjacent BCP Site A and Site B Storm water Pollution Prevention Plans (“SPPPs”) will be maintained to prevent off-site migration. Erosion and sediment control measures from Site A and Site B SPPPs will be available options to implement on Tax Lot 14 to control and prevent environmental pollution arising from storm water during remediation and construction. The control measures will include a berm, or hay bales around the site perimeter and routine maintenance and street cleaning. Appendix E describes the specific measures in detail.

8.1.2 Grading

Structural materials consisting of gravel, recycled concrete aggregate (“RCA”) and Track 2 approved backfill will be brought on Tax Lot 14 for remediation. Prior demolition of the five-story building on Tax Lot 14 lowered the site below sidewalk grade before remediation began. Ground surface elevations may require import of gravel for leveling for installation of the drill rigs and for surface water containment/sump construction.

Any imported backfill required for grading will either be certified virgin material or non-virgin material that has been tested and meets the 6 NYCRR Part 375 Soil Cleanup Objectives for Restricted Residential Use consistent with the intended future use of Lot 14, or is otherwise acceptable to the Department. Alternatively, RCA, a commercial product, may be used as imported backfill without testing if it originates from a DEC registered facility.

8.1.3 Permits/Notifications

All necessary permits will be obtained prior to commencing the remediation work. The permits that may be required include:

- A New York City Department of Environmental Protection (NYCDEP) sewer connection permit (15 RCNY Chapter 19) for the discharge of the groundwater from dewatering operations to the city sanitary sewer and remediated groundwater after dewatering ceases.
- Drilling approvals issued by the NYCT for ground intrusive activities (e.g., drilled grout cut off wall, augered source removal and chemical injections) within the off-set of NYCT structures (stamped drawings).
- USEPA Underground Injection Control notification for ISCO injections (permit by rule, requires notification only).

Prior to shipping to the site, XDD Environmental will notify the New York City Fire Department (FDNY) and New York City Department of Transportation (DOT) of the types and quantities of chemicals (i.e., Klozur® persulfate and sodium hydroxide) that will be transported for use during the ISCO injection program.

8.2 Soil Removal

The following sections describe the remedial excavation methods and procedures.

8.2.1 Extent Of Soil Removal Via Drilling

Soils will be removed via auger drilling to extract grossly contaminated source material and to install the grout cut-off wall for hydraulic containment. The cut-off wall will consist of overlapping, 14-inch-diameter borings drilled with casings a minimum of three inches into bedrock and grouted to grade. The borings will be drilled on 12-inch centers such that the borings overlap and form a continuous, impermeable barrier between Lot 14 and BCP Site A from bedrock to ground surface. The cut-off wall will extend from the southwest corner of Lot 14 northward for approximately 59 feet along the property line (final dimensions pending results of the soil sampling plan and NYSDEC approval as discussed in Section 6.3), and then will turn 90 degrees and run east approximately 20 feet to within 3 to 5 feet of the adjacent NYCT building. Once adjacent to the NYCT building, the grout wall will run south to the secant wall, with the final dimensions of the cut-off wall pending results of the soil sampling plan and NYSDEC approval as discussed in Section 6.3, to key into the secant wall present on the southern border of Tax Lot 14. To complete the grout cut off wall on the southern boundary of Tax Lot 14, a grout wall will be poured to extend the current secant wall to the southwest corner of Tax Lot 14. Figures 5 and 6 show the layout and cross-section, respectively, of the proposed grout cut-off wall.

8.2.1.1 Estimated Mass Removal

As noted in Section 3.0, the estimated mass in the source zone is 663.2 kg (1,459 lbs). Source zone mass removal by means of coring the perimeter wall will remove an estimated 44 kg (96.7 lbs). This equates to approximately 6.6% of the contaminant mass in the source areas.

For ISCO, the estimated contaminant mass in the source zone is approximately 1,450 pounds. The dosing for this mass will be approximately 110% of the contaminant mass. The goal is to destroy all the contaminant mass in the ISCO zone.

Open cut excavation will not be performed on Tax Lot 14 since it is not feasible due to site constraints associated with SOE installation and NYCT approval.

The goal is to remove or destroy source material to the extent feasible including heavily impacted soil directly overlying the bedrock surface.

8.2.2 Soil Disposal

Soil cuttings generated during drilling will require off-site disposal. The method is to temporarily stockpile drill cuttings and load soil (and debris) into trucks or roll-off containers for disposal at off-Site facilities. If there is insufficient space to routinely stockpile and segregate soil cuttings on Tax Lot 14, then drilled soil cuttings may be containerized in drums or stockpiled on plastic sheeting lined and covered stockpiles located on BCP Site A or BCP Site B for future loading and off-site disposal by the Remedial Contractor. Soil will be removed from Lot 14 and placed onto BCP Site A and/or BCP Site B using appropriate or otherwise suitable excavation equipment.

Any soil stockpiled will be placed upon plastic sheeting and covered with plastic sheeting at the end of each day. All soil will be characterized and disposed in accordance with an approved waste profile from the disposal facility.

8.3 Construction Dewatering

Dewatering is currently being used on the greater QPRD construction site to complete the work and excavate to the desired depths on BCP Sites A and B. Groundwater and drilling wastewater may be lowered and removed using wells and/or sumps placed to dewater for construction purposes. The dewatering system will remove and treat Tax Lot 14 groundwater and drilling fluids, and prevent recontamination of BCP Sites A and/or B as well as treat the BCP Sites A and B groundwater in the surrounding area to well below development depth, to the bottom of the remediation zone, and/or to the bedrock surface depending on field conditions.

The dewatering system will operate throughout the remediation phase as necessary. The extracted groundwater will be properly treated by being pumped through a treatment suite consisting of settling tanks to remove suspended solids, a separator to remove any free product, and granular activated charcoal (“GAC”) units to remove dissolved organic contaminants, as required. From there the water will be discharged to the New York City Combined Sewer system through a sewer connection to the existing sewer line on Orchard Street. Discharge will be performed under a NYCDEP groundwater discharge permit meeting the NYCDEP requirements for treatment. No dewatering liquids or sediments will be discharged back into the excavation. See Appendix E for the Storm water Pollution Prevention Plan. Contaminated soil will be amended to be as dry as possible, if necessary, prior to loading.

8.4 Trucking and Disposal

All trucks used for disposal will be permitted as licensed waste transporters as required by NYCRR Part 364. Trucks will be covered with solid and/or tight fitting sealable or otherwise appropriate covers to minimize the release of odors during transport (no mesh covers will be used). Petroleum or creosote-contaminated soils will be transported in trucks with gasketed rear gates to prevent any liquid discharge during transit.

Tax Lot 14 is currently inaccessible for vehicular truck traffic. Therefore, trucks required for disposal will access the greater QPRD construction site via BCP Site A or BCP Site B. However, if a portion of Tax Lot 14 is made accessible for vehicular truck traffic for disposal purposes, each truck will be inspected before exiting onto Jackson Avenue and any soil accumulations on the truck tires and sides will be brushed off on-site, if necessary.

A decontamination pad placed at the exit of BCP Site A and BCP Site B will be used. Before exiting, soil will be brushed or washed off the trucks' exterior and undercarriage and the wash water collected and treated before disposal to the city sanitary sewer. On-site truck roads will be covered with stone to minimize dust and mud entering public roads. Truck transport routes have been previously provided to the NYSDEC.

8.5 Transportation Specifications

The following sections describes the furnishing of labor, materials and equipment, and performing all operations required for the proper management, off-Site transportation, and disposal of waste materials and waste liquids generated during implementation of the remedial action.

<u>Disposal Facilities and Submittals</u>

Disposal facilities will be identified for each anticipated waste stream. All required analytical data will be provided to the disposal facilities for approval. Disposal facilities will be designated and submitted for each anticipated waste stream. Additionally, copies of all waste manifests, bills of lading, and certified weight slips from a scale approved for the use of all disposed materials as well as the Part 364 Permits for all waste transporters will be submitted to the NYSDEC.

Vehicle Requirements and Odor Suppressant

All license plates on the trucks will be properly affixed and visible at all times; proper placards will be displayed and extraneous or incorrect placards will be covered and/or removed prior to the truck departing the site. All required permits will be properly displayed or readily available for verification by the NYSDEC. Drivers will remain in the truck at all times unless they are wearing the correct personal protective equipment required for the site. Standing on the back of the truck will be prohibited and ladders or scaffolding will be used when securing tarps and/or covers. Vehicles and containers used to store and/or transport materials will provided with solid and/or tight fitting sealable or otherwise appropriate covers to minimize the release of odors during transport (no mesh covers will be used). The NYSDEC has the right to reject vehicles that are not properly equipped and/or arrive to the site in a dirty condition. Odor and dust suppressing foam will be available as needed to supplement covers, or if requested by the NYSDEC.

Execution

Traffic control at the site entry will ensure a smooth flow of traffic and minimize congestion at the site entrance. At a minimum, the traffic control will include the usage of flaggers and proper signage, where required. Trucks containing excavated material will be properly covered prior to exiting the site to prevent vapor and fugitive dust emissions during transport. The covers will be supplemented with odor suppressant foam or solvent as needed. Gross vehicle truck weights shall conform to the most current DOT regulations for the Federal, State, and local level. All work in and around trucks will be performed in appropriate personal protective equipment in conformance with the Site Specific Constructions HASP.

Prior to leaving the site, material transport vehicles and containers will be inspected for evidence of contamination (including inside of wheels and undercarriage). All trucks leaving the site will proceed to a decontamination station for cleaning prior to exiting onto public roads. Trucks and equipment will be cleaned using a broom and/or brushes within the excavation area prior to moving to the decontamination pads to decrease the amount of particulates leaving the remediation area. If necessary, at the decontamination pad, all heavy equipment will be pressure washed before leaving the site. All equipment leaving the site will be decontaminated as per these guidelines. In addition, any equipment previously utilized to excavate impacted material will be decontaminated prior to use in backfilling (e.g., excavator bucket). Decontamination pads will be sized to ensure that the largest piece of contractor equipment can be adequately decontaminated and provisions will be made to control overspray at the decontamination pads. All waste water from decontamination will be collected and pumped into frac tanks. Wastewater will be transported from the site by a properly licensed liquid waste hauler or will be discharged in the approved dewatering system. Soils collected from the decontamination pads will be bulked with the impacted material and sent to the properly licensed approved disposal facility, as necessary.

Trucks will proceed directly to the designated disposal facility after leaving the Site and will not be pre-loaded with material for overnight storage. Clean up of any material spilled or leaked in transit, or mud or dirt tracked off-Site will be performed in accordance with all applicable Federal, State, and local regulations. Material from the Site will not be combined with any other material.

Volunteer and/or Volunteer's agent will sign transport bills of lading or manifests. Volunteer will provide a hazardous waste generator number, if required. Maintain copies of all documents involving transportation of materials from the Site. Copies of these records shall be submitted to the NYSDEC at a frequency agreed to by Arnold F. Fleming, Remedial Engineer, and Volunteer. All records shall be turned over to the Volunteer at the completion of the Work. It will be ensured that all transport vehicles are properly secured, labeled, and placarded prior to exiting the site.

8.6 Air/Odor Monitoring

Air monitoring onsite and in the work zone is described in the site-specific HASP in Appendix G. Air monitoring around the site perimeter and within the community is described in the Community Air Monitoring Plan (CAMP) described in Appendix H. In addition to CAMP monitoring, daily monitoring of downwind odor levels will take place at the site perimeter. The downwind perimeter will be checked for odors a minimum of once per day and more frequently, if required. Use of measures such as odor suppressant foam or spray, covering of soils will be used as necessary to mitigate odors, if required. Air monitoring will be performed during drilling activities, but will not be implemented during ISCO injections.

The Volunteer is responsible for compliance with odor control requirements. This odor control plan is capable of controlling emissions of nuisance odors off-site. Specific odor control methods to be used on a routine basis will include all reasonable and necessary means as described in the following paragraph.

If nuisance odors are identified by Volunteer at the site boundary, or if odor complaints are received, work will be halted and the source of odors will be identified and corrected. Work will not resume until all nuisance odors have been abated. The NYSDEC, NYSDOH, and Volunteer will be notified of all odor events and of any other complaints about the project. Implementation of all odor controls, including the halt of work, is the responsibility of the Remedial Engineer, and any measures that are implemented will be discussed with NYSDEC. All reasonable and necessary means will be employed to prevent on- and off-site nuisances. At a minimum, these measures will include: (a) limiting the area of open excavations and size of soil stockpiles; (b) shrouding open excavations with tarps and other covers; and (c) using foams to cover exposed odorous soils. If odors develop and cannot be otherwise controlled, additional means to eliminate odor nuisances will include: (d) direct load-out of soils to trucks for off-site disposal; (e) use of chemical odorants in spray or misting systems; and, (f) use of staff to monitor odors in surrounding neighborhoods.

8.7 Underground Storage Tanks

No underground storage tanks (“USTs”) are expected on Tax Lot 14 based on prior demolition and investigations conducted on-site. If encountered, USTs and ancillary piping uncovered during drilling/excavation will be emptied of their contents, if applicable, and the tanks/piping removed for disposal (or scrap metal). The USTs will be registered under the Petroleum Bulk

Storage requirements if eligible. The USTs will also be registered with FDNY as required by local regulations.

8.8 Groundwater Remediation

8.8.1 Hydraulic Control

A groundwater recovery well will be installed on Lot 14 inside the perimeter grout cut-off wall to control water levels and confirm hydraulic control within the remediation zone. This recovery well shall supplement the perimeter grout cut-off wall to provide an additional means of controlling groundwater flow and prevent off-site migration from Lot 14. The recovery well will be installed in accordance with the QPRD site's perimeter capture well system design (Appendix I). Extracted groundwater from the recovery well will be conveyed to the capture well groundwater treatment system located within the off-site amenity building on the adjacent BCP Site B during full scale operation.

The continuous grout cut-off wall will key three inches into bedrock around the remediation zone perimeter and the entire remediation zone will be covered with a concrete cap. This will serve to limit groundwater and surface water infiltration into the isolated remediation zone. The recovery well is not expected to yield significant water production due to a lack of recharge. The exact model, capacity and depth of the recovery well pump within the recovery well will be determined in the field to maintain hydraulic control following well installation and monitoring of water levels. By decreasing the groundwater elevation inside the remediation zone below the elevation of groundwater outside of the perimeter containment wall via a float system, hydraulic control will be maintained and groundwater levels within the remediation zone can be controlled to prevent off-site migration in the improbable event of a breach to the perimeter grout cut-off wall.

Hydraulic control will be confirmed by monitoring both groundwater elevations and/or groundwater field parameters in monitoring wells located both inside and outside of the remediation zone. Groundwater monitoring to confirm hydraulic control will be performed after the perimeter grout cut-off wall is installed, site-wide dewatering system operation is ceased, and prior to commencing ISCO injections. Once hydraulic control is established, operation of the recovery well inside the cut-off wall will continue during and after ISCO injections to maintain hydraulic control. The proposed recovery well and monitoring well locations are shown in Figure 7. The locations of the recovery well and monitoring wells are subject to change based on the final extent of the northern portion in the grout cut-off wall, as discussed in Section 6.3.

8.8.1.1 Hydraulic Control Procedures

Paired monitoring wells (interior monitoring wells within the perimeter grout cut-off wall and corresponding monitoring wells located directly outside of the perimeter grout cut-off wall) will be installed immediately following completion of the grout cut-off wall to monitor groundwater levels inside and outside of the grout cut-off wall. A total of three paired monitoring wells (MW-4/IW-5, MW-5/MW-3, and MW-6/MW-7) will be installed on either side of the perimeter of the grout cut-off wall. Existing injection well, IW-5, will be used as the paired well with proposed monitoring well MW-4. The proposed monitoring well locations are shown on Figure 7.

Each monitoring well will be constructed with approximately 20 feet of two-inch diameter, 0.010 feet slotted PVC well screen installed to span the water column (i.e., from the top of bedrock to two feet above the water column). Actual screen lengths will be determined in the field based on water levels and the depth to bedrock at each location.

Hydraulic control will be established via management of water levels inside and outside of the grout cut-off wall to prevent off-site migration, by the operation of a recovery well within Lot 14. Groundwater will be pumped from the recovery well using a submersible pump at a rate determined in the field that will lower the groundwater level within the grout cut-off wall to a stable elevation below the groundwater elevation outside of the grout cut-off wall. If groundwater levels within the Lot 14 grout cut-off wall are maintained consistently below the elevation of groundwater outside of Lot 14 for a period of one day (24 hours), hydraulic control will be confirmed. The 24 hour period to confirm hydraulic control will not begin until groundwater levels in all paired wells inside the cutoff wall are several inches below their corresponding well outside the cutoff wall. The extraction rate and recovery well pump cycle frequency required to maintain hydraulic control may be modified pending groundwater elevation fluctuations in the monitoring wells. Interior and exterior grout cut-off wall groundwater levels will be monitored via the paired groundwater monitoring wells as well as any viable, existing monitoring and/or injection well. The proposed recovery well location is shown on the Figure 7.

Prior to recovery well installation, an evaluation of the soil grain size and physical property analyses will be conducted via a recovery well trial boring to facilitate the design of the recovery well. Design plans for the recovery well will be submitted to the NYSDEC, under separate cover, following the evaluation of the soil sieve and physical property analyses. The design plans will include specifications for the well screen slot size and gravel filter pack type as well as drawings showing the proposed layout of piping and supporting well control infrastructure. Upon completion of the recovery well installation activities, the well screen interval will be developed to increase porosity in the near-well formation. The recovery well will be developed using the mechanical surging method. The groundwater will be pumped from the recovery well into holding tanks/drums to allow for settlement of fine-grained sediment and free-product, if present, before being treated by the BCP Site A perimeter capture well treatment system.

The BCP Sites' perimeter capture well and treatment system may not be operational at the time of hydraulic control testing. If this is the case, groundwater recovered during the hydraulic control testing and thereafter will be run through the site-wide dewatering system or a temporary groundwater treatment system until the perimeter capture well and treatment system is fully operational.

8.8.2 Groundwater Treatment via ISCO and Dewatering

Groundwater will be remediated by means of an ISCO injection program, construction dewatering and operation of the recovery well. Residual contamination within the perimeter cut-off wall will be destroyed via ISCO treatment. Post-remedial conditions for material not destroyed by ISCO are expected to yield geochemical conditions favorable for monitored natural attenuation ("MNA"). Construction dewatering during remedial excavation of the adjacent BCP Sites will also serve as pump-and-treat remediation for groundwater.

8.8.2.1 ISCO Injection Program

An ISCO injection program will be performed to reduce contaminant mass within the treatment zone. Based on a bench scale treatability study performed by XDD Environmental on site soil and groundwater samples (Appendix D), alkaline activated persulfate is proposed as the oxidant, subject to NYCT approval, for the following reasons:

- Oxidant stability over the bench scale study period was acceptable;
- Soil oxidant demand/total oxidant demand (SOD/TOD) were within typical ranges observed at other sites; and
- The technology was effective in treating the contaminants of concern at the site and field treatment will result in a longer contact period than used in the bench scale study testing.

In addition to oxidizing the contaminant directly, persulfate adds a source of sulfate that promotes natural degradation of the contaminant once the oxidant has been expended. A product brochure of Klozur® persulfate is provided in Appendix J.

The chemical oxidant will be injected into three existing injection wells (IW-4, IW-5 and IW-6). The injections will occur at a depth of approximately eight to 13 feet below ground surface in IW-5, nine to 18 feet below ground surface in IW-6 and 23 to 28 feet below ground surface in IW-4. All injections will take place below the water table. The locations of the injection wells are shown on Figure 7. The injection wells construction details are provided in Table 1. Injection well construction logs are provided in Appendix A.

The oxidant will be administered via pressure pulsing technology, using Wavefront Technology Solutions Sidewinder tool or equivalent to create subsurface pressure waves that cause the soil pores to open, thus altering the water-bearing zone properties to promote remediation. Pulsing has the advantage of getting much more even oxidant dispersion than conventional gravity or pumped injection. Pulsing has successfully injected oxidant into formations having conductivities between 10^{-4} centimeters per second (cm/sec) and 10^{-5} cm/sec. The source zone is expected to have conductivities within this range and should allow injection of oxidant.

The number and position of the three injection wells were based on the boring logs, observations of NAPL staining, and analytical results. The injection wells were positioned to target the source zone areas. Two wells (IW-4 and IW-5) have 5-foot-long well screens and the injection well near MW-6 (IW-6) has a 9-ft-log well screen. Thus the wells have been positioned to pinpoint the elevations where contamination was observed during the prior RI sampling. Each well is constructed of 2-inch-diameter, Schedule 80, 0.02 ft machine-slotted polyvinyl chloride (“PVC”) well screen that was installed to bedrock with the solid casing grouted into place.

Treatment calls for injection of 24,244 pounds of sodium persulfate and 8,900 pounds of sodium hydroxide in order to reduce the overall concentration of VOCs and SVOCs in groundwater. A second injection of equal oxidant mass may be required, but will be determined by post-injection groundwater monitoring. The chemical loadings are based on the mass of contaminant identified in the Remedial Investigation, the non-target oxidant demand, and the buffering capacity of the soil as determined by the site investigation and Bench Scale Treatability Study.

The persulfate is the oxidant that destroys the contaminant; the sodium hydroxide is the activator. Sodium hydroxide raises and maintains the injection solution at a pH equal to or greater than 10.5, which is the optimal pH for activating persulfate. Activating the persulfate generates free radicals. This chemical species is among the most aggressive in breaking down contaminant.

Sodium hydroxide will be delivered as 50 percent solution in 300-gallon polyethylene totes. There would be 5 totes needed for the first injection. Persulfate will be delivered in 2,200 pound supersacks. Eleven sacks would be needed for the first injection. All chemicals are stored in secondary containment. The oxidant will be batched in 1,000-gallon or 1,200-gallon polyethylene tanks as close to the injection areas as possible. It is initially batched at 350 g/L to account for the water in the 50 percent sodium hydroxide solution, which reduces to 320 g/L in the final injection solution.

The persulfate is mechanically mixed and tested to ensure the proper concentration. The design concentration for Lot 14 is 320 g/Liter (32 percent solution by weight). Sodium hydroxide is then added to the mixture to raise the pH to 10.5 or higher. The ratio of persulfate to sodium hydroxide to maintain the optimal pH is 2 moles of hydroxide per mole of persulfate; in addition, sufficient hydroxide is added to overcome the bench-test-determined buffering capacity of the site-specific soils. Typically, the persulfate to hydroxide ratio on a weight basis ranges from 3 to 8; for this site the ratio is approximately 3 to 5 depending on whether a second polishing application is required. After mixing is complete and the oxidant concentration and pH are balanced, the mixture is pumped to the wellhead via double-diaphragm pneumatic pumps where it will be injected (pulsed in) using Wavefront's Sidewinder tool. The target injection rate is 5 gallons/minute for each injection point, but this may vary due to formation response and parameter conditions in the monitoring wells while the injections are ongoing. Typical injection monitoring parameters include pumping rate, pH, ORP, water levels, input and output pressure, and persulfate concentration.

The plan for Lot 14 is to use two Sidewinder tools simultaneously. One tool would probably be positioned at IW-4 and the other at either IW-5 or IW-6. The injection tools will be moved around as necessary to keep oxidant entering the formation and prevent overloading of a particular location. The decision when and where to locate or move the tools is based on field conditions. The injection interval will be isolated in each injection well using a mechanical packer so that the material is injected into the target interval. IW-4 and IW-5 have 5-foot-long target intervals; IW-6 has a 9-foot-long injection interval. Injections in IW-6 may be separated by the packer to isolate different depth intervals.

To inject 24,244 pounds of sodium persulfate using two Sidewinder tools at 5 gallons per minute per well, it is estimated to require approximately 18 hours of injection time to introduce this oxidant mass. This time period could increase due to tool malfunction, weather, or formation response. The first injection will likely require five days for set up, calibration, injection, and demobilization. The mass of persulfate will be administered via injection of approximately 8,890 gallons of oxidant mixture. Approximately 2,080 gallons will be injected into IW-4 and approximately 6,810 gallons will be injected into IW-5 and IW-6. Of the 6,810 gallons, approximately 4,560 gallons will be injected into IW-6 and the balance, 2,250 gallons, into IW-5.

Periodic sampling of the monitoring wells will take place beginning one month following the end of the first injection and then each month thereafter for the first quarter. Subsequent sampling will take place quarterly. The goal of the ISCO injection is to effect an overall reduction in the concentration of VOCs and SVOCs.

RemMetrik® Process Description

The ISCO treatment will be conducted using the RemMetrik® process. RemMetrik® (U.S. Patent No. 8,739,867 B2), an alternative to conventional chemical injection, was first introduced in 2011. The alternative employs a natural process that overcomes many of the serious obstacles facing conventional injection such as ensuring oxidant distribution at targeted boring-specific contaminant elevations. RemMetrik® combines contaminant mass targeting with subsurface pressure waves to optimize in situ treatment of soil and groundwater. Using the RemMetrik® process, the first step is to obtain an accurate estimate of the contaminant mass and identify its 3-D position beneath the site. This is accomplished using statistical analysis of site data to create representative concentrations of the source zone. The second step is to treat the contaminant mass using subsurface pressure waves that deliver the treatment chemical laterally into the soil pore spaces at elevations that contain most of the contaminant. It is this residual contamination, the pollutant trapped within the small pore spaces that is targeted for the remediation to be effective. RemMetrik® treats the residual contamination by incorporating depth based targeting and treatment into a specialized, proprietary and patented process.

In adopting the RemMetrik® process, the total contaminant mass and the location of the contaminant mass was estimated using the concentration of Total Petroleum Hydrocarbons to define the impacted areas within the saturated zone along with the Part 375 compound concentrations. Once the impacted areas were identified, the contaminant mass estimates were then prepared using the TPH concentrations, the bulk density and the dimensions of the impacted areas. The overall contaminant mass estimate was broken down into the SB-5 and SB-6 area and a separate SB-4 area. The depth intervals and associated contaminant mass for each area were estimated for the purpose of targeting the injections wells. Using this approach, the injection wells were placed as close as feasible to the contaminant source areas in order to optimize contact between the contaminant and the oxidant and to establish a concentration gradient between the contaminant and the oxidant such that the oxidant will “seek out” the contaminant over time (as long as there is an oxidant that remains effective for a period of time, persulfate meets this requirement). The RemMetrik® statistical analysis is provided in Appendix K.

Contaminant mass is a more accurate and effective metric for designing treatment. Contaminant mass identifies the bulk of the contaminant, so treatment focuses on where impacts are greatest, as opposed to using concentration only, where a high concentration, but small contaminant mass, can bias treatment towards areas with a small amount of overall contaminant.

8.8.2.2 Groundwater Monitoring

To assess the performance of the ISCO injections, a groundwater monitoring program will be established. The groundwater monitoring program will include two components: baseline sampling and performance monitoring. The sampling, sample handling, decontamination, and field instrument calibration procedures will be performed in accordance with established procedures for the site.

<u>Groundwater Monitoring Well Installations</u>

Prior to implementation of the ISCO injection program, a total of three monitoring wells (MW-1, MW-2 and MW-3) will be installed to monitor the performance of the ISCO injection program. The location of the proposed monitoring wells is shown on Figure 7. The existing monitoring wells (MW-5 and MW-6) may be rendered unusable during grout cut-off wall installation. Proposed construction details (i.e., screen length and depth) for monitoring wells MW-1, MW-2, and MW-3 will be determined with NYSDEC approval prior to installation. A No. 1 Morie Sand or equivalent filter pack will be placed into the annular space between the well screen and the borehole and one to two feet above the top of the well screen. A minimum one-foot-thick bentonite seal will be installed above the sand filter pack. The bentonite seal will be hydrated with potable water and allowed to expand for a minimum of one-half hour before filling the overlying annular space with a Portland cement mix. The wells will be completed with a locking, flush-mounted, water-tight manhole, concreted at grade.

Following installation, each well will be developed with a submersible pump until the purge water is free of fines or demonstrated no further improvements in turbidity.

Baseline Sampling

Following one week after well development, MW-1, MW-2 and MW-3 will be sampled using low-flow sampling methods. The groundwater samples will be analyzed for the following parameters:

- TCL VOCs by USEPA Method 8260;
- TCL SVOCs by USEPA Method 8270;
- TAL metals by USEPA Method 6010/7000;
- Basic groundwater quality parameters: pH, alkalinity, methane, carbon dioxide, chloride, sulfate, sulfide, ammonia nitrogen;
- Iron II, dissolved iron; and
- Total Petroleum Hydrocarbons.

The results of the initial sampling round will be used as baseline sampling data for the ISCO injection performance monitoring. Two rounds of baseline groundwater sampling will be completed prior to soil removal and injections in order to establish baseline conditions.

Performance Monitoring

The goal of the ISCO injection program is to reduce VOC and SVOC concentrations in groundwater. Following the completion of the ISCO injection program, performance monitoring samples will be collected from MW-1, MW-2 and MW-3. The monitoring wells will be sampled for field parameters every two weeks for one month following the completion of the ISCO injection program. The wells will be sampled for the same set of parameters that were analyzed during the baseline sampling at one month and two months following the injection event and then quarterly thereafter for a period of 1-year following the initial injection event. The post-treatment groundwater samples will be field tested for persulfate and ascorbic acid, if necessary, to stop any reaction in transit to the laboratory. Additional ISCO injection events may be required by NYSDEC pending the results of post-injection groundwater performance monitoring. NYSDEC will make the final determination when groundwater performance monitoring is no longer required or if remediation is complete.

The operation of the on-site recovery well will be required until either groundwater quality on Lot 14 meets the TOGS AWQSGVs or, NYSDEC approves ceasing operation of the on-site recovery well.

8.8.3 Data Evaluation and Reporting

After the one year ISCO performance monitoring period has been completed, the results of the ISCO injection program will be evaluated to determine the effectiveness of the oxidant at reducing the contamination in the groundwater. The evaluation and recommended course of action, including additional injection or monitoring events as necessary, will be summarized in a report to NYSDEC.

8.9 Contingency Remedy

In the unlikely event hydraulic control cannot be established via the cut-off wall, a contingency remedy to reduce contaminant mass by auger drilling will be completed within the contingency interior auger zone (southern portion of Lot 14) shown on Figures 5 and 6. The interior augering will include overlapping borings in the southernmost five feet of Lot 14 and on BCP Site A extending to the secant wall, to the extent feasible. Once completed, each borehole will be grouted to grade with the same material as the cut-off wall. The total number of interior augered bore holes and location within the southern portion of Tax Lot 14 may be altered based on field conditions and accessibility, in consultation with NYSDEC.

If internal augering is performed to reduce contaminant mass inside the southern portion of Lot 14, this will remove an additional 146 kg (321 lbs) or 22% of the contaminant mass.

8.10 Restoration

8.10.1 Backfill Material

Any imported backfill required for grading will either be certified virgin material or non-virgin material that has been tested and meets the 6 NYCRR Part 375 Soil Cleanup Objectives for Restricted Residential Use and applicable Protection of Groundwater Standards consistent with the intended future use of Lot 14, or is otherwise acceptable to the NYSDEC. RCA may be used as imported backfill without testing if it originates from a DEC registered facility and meeting the conditions of DER-10-5.4. The backfill will be used to bring the site up to final grade as necessary.

8.10.2 Backfilling

The excavations may be backfilled to within approximately 2 feet below street level with certified clean fill or reusable soils from Tax Lot 14. Backfill will be placed in loose lifts no thicker than 12 inches and compacted in accordance with the developer's requirements. Excavated and filled areas and adjacent transition areas shall be reasonably smooth, compacted, and free from irregular surface changes.

8.11 Engineering Controls

8.11.1 Water Proofing, SSDS and Vapor Barrier

A waterproofing/vapor barrier and SSDS will be installed beneath the footprint of Tower A on the northern portion of the site. The Final Engineering Report will document the materials installed per the remedy. Operation of the Tower A SSDS will be performed in accordance with the Site Management Plan for the adjacent BCP Site A SMP (Site C241105).

8.11.2 Engineered Cap

An engineered cap consisting of an impervious concrete surficial cover will be installed across the Tax Lot 14 remediation area footprint that will remain open-air space following construction. A separate design plan will be submitted to NYSDEC to specify the details of the engineered cap. All monitoring, injection, and recovery wells will be installed through the engineered cap to enable monitoring, additional ISCO injections (if necessary) and extraction of groundwater. The Final Engineering Report will document the engineered cap per the remedy.

8.12 Nuisance Control

8.12.1 Rodent Control

The potential for rats and other rodents will be addressed by placing traps around the periphery of the site. No food will be stored onsite for the duration of remedial activities, and all refuse generated by site activities will be promptly containerized in covered dumpsters or roll-offs.

These measures will reduce the possibility of attracting rodents. Rodent traps will be inspected and replaced at a minimum of once every month. Additional traps will be placed, if warranted.

8.12.2 Noise Control

Appropriate measures will be taken to ensure that noise levels conform to New York City and local regulations, and to the latest OSHA standards for worker protection. Noise control measures will ensure that on-site work does not pose a nuisance to surrounding businesses. Equipment and vehicles used on-site will be outfitted with appropriate noise control devices.

8.13 Citizen Participation

Citizen participation will be performed throughout the project in accordance with the approved Citizen Participation Plan. Project fact sheets will be distributed to the public throughout the project, and will include the following:

- Site description
- Remedial objectives and selected remedial alternative
- Project schedule
- Sources of additional information

The NYSDEC-approved fact sheet will be provided to persons on the project mailing list (included in Appendix L) prior to the start of remedial activities.

8.14 Notification and Reporting

8.14.1 Notification

The following parties will be notified of significant events or developments during the course of the remedial program, and will be notified a minimum of one week in advance of the start of remediation. The listed individuals will receive copies of all reports, plans, and relevant specifications and correspondence.

Name	Agency	Address	Phone	Role
Michael Haggerty	NYSDEC	Div. of Environmental Remediation 625 Broadway Albany, New York 12233-7016	518-402-9688	Project Manager
Chris Doroski	NYSDOH	NYSDOH Corning Tower Empire State Plaza, Albany, NY 12237	518-402-7880	Health Dept. Liaison

8.14.2 Daily Reports

Daily reports will be provided to the NYSDEC project manager during excavation activities (via e-mail or facsimile). The daily reports will provide a summary of daily activities, a site map, results of air monitoring, a discussion of any odor or dust problems, and any corrective actions implemented to counter noise, odor, or dust. Any time-sensitive information will be communicated directly to the NYSDEC project manager ahead of the daily reports.

8.14.3 Record Keeping

A project logbook will be kept on-site during all remedial activities, and will be available for NYSDEC inspection. At a minimum, the following information will be recorded in the project logbook:

- Date, weather, and BCP Site conditions
- Names and affiliations of all on-site personnel
- Calibration records for all monitoring equipment
- A record of trucks transporting excavated material to or from Lot 14
- Daily summary of work, issues, decisions, delays, resolution of issues
- Safety incidents and their resolution
- Waste manifests for material removed from Lot 14 will be kept with the project file

8.14.4 Environmental Easement

An Environmental Easement, as defined in Article 71 Title 36 of the Environmental Conservation Law, is required when residual contamination is left on-site after the Remedial Action is complete. If the site will have residual contamination after completion of all Remedial Actions than an Environmental Easement is required. As part of this remedy, an Environmental Easement approved by NYSDEC will be filed and recorded with the New York County Clerk. The Environmental Easement will be submitted as part of the Final Remediation Report.

The Environmental Easement renders the site a Controlled Property. The Environmental Easement must be recorded with the Queens County Clerk before the Certificate of Completion can be issued by NYSDEC. A series of Institutional Controls are required under this remedy to implement, maintain and monitor these Engineering Control systems, prevent future exposure to residual contamination by controlling disturbances of the subsurface soil and restricting the use of the site to residential use(s) only. These Institutional Controls are requirements or restrictions placed on the site that are listed in, and required by, the Environmental Easement. Institutional Controls can, generally, be subdivided between controls that support Engineering Controls, and those that place general restrictions on site usage or other requirements. Institutional Controls in both of these groups are closely integrated with the Site Management Plan (SMP), which provides all of the methods and procedures to be followed to comply with this remedy.

The Institutional Controls that support Engineering Controls are:

- Compliance with the Environmental Easement by the Grantee and the Grantee's successors and adherence of all elements of the SMP is required;
- All Engineering Controls must be operated and maintained as specified in this SMP;
- All Engineering Controls on the Controlled Property must be inspected and certified at a frequency and in a manner defined in the SMP;
- Groundwater and other environmental or public health monitoring must be performed as defined in the SMP;
- Data and information pertinent to Site Management for the Controlled Property must be reported at the frequency and in a manner defined in the SMP;

- On-site environmental monitoring devices, including but not limited to groundwater monitor wells, must be protected and replaced as necessary to ensure proper functioning in the manner specified in the SMP; and
- Engineering Controls may not be discontinued without an amendment or extinguishment of the Environmental Easement.

Adherence to these Institutional Controls for the site is mandated by the Environmental Easement and will be implemented under the SMP. The Controlled Property (Site) will also have a series of Institutional Controls in the form of Site restrictions and requirements. The Site restrictions that apply to the Controlled Property are:

- Vegetable gardens and farming on the Controlled Property are prohibited.
- Use of groundwater underlying the Controlled Property is prohibited without treatment rendering it safe for intended purpose.
- All future activities on the Controlled Property that will disturb residual contaminated material are prohibited unless they are conducted in accordance with the soil management provisions in the SMP.
- The Controlled Property may be used for restricted residential use, provided the long-term Engineering and Institutional Controls included in the SMP are employed;
- The Controlled Property may not be used for a higher level of use, such as unrestricted use without an amendment or extinguishment of this Environmental Easement.
- Grantor agrees to submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the Controlled Property are unchanged from the previous certification or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP. NYSDEC retains the right to access such Controlled Property at any time in order to evaluate the continued maintenance of any and all controls. This certification shall be submitted annually, or an alternate period of time that NYSDEC may allow. This annual statement must be certified by an expert that the NYSDEC finds acceptable.

8.14.5 Site Management Plan

Site Management is the last phase of remediation and begins with the approval of the Final Engineering Report and issuance of the Certificate of Completion (COC) for the Remedial Action. The SMP will be submitted as part of the FER but will be written in a manner that allows its removal and use as a complete and independent document. Site Management continues in perpetuity or until released in writing by NYSDEC. The property owner is responsible to ensure that all Site Management responsibilities defined in the Environmental Easement and the SMP are performed.

The SMP is intended to provide a detailed description of the procedures required to manage residual contamination left in place at the site following completion of the Remedial Action in accordance with the Consent Order with the NYSDEC. This includes: (1) development, implementation, and management of all Engineering and Institutional Controls; (2) development and implementation of monitoring systems and a Monitoring Plan; (3) development of a plan to operate and maintain any treatment, collection, containment, or recovery systems (including, where appropriate, preparation of an Operation and Maintenance Manual); (4) submittal of Site Management Reports, performance of inspections and certification of results, and demonstration of proper communication of site information to NYSDEC; and (5) defining criteria for termination of treatment system operation.

To address these needs, this SMP will include four plans: (1) an Engineering and Institutional Control Plan for implementation and management of EC/ICs; (2) a Monitoring Plan for implementation of Site Monitoring; (3) an Operation and Maintenance Plan for implementation of remedial collection, containment, treatment, and recovery systems; and (4) a Site Management Reporting Plan for submittal of data, information, recommendations, and certifications to NYSDEC. The SMP will be prepared in accordance with the requirements in NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation, dated May 2010 (DER-10), and the guidelines provided by NYSDEC.

Site management activities, reporting, and EC/IC certification will be scheduled on a certification period basis. The certification period will be annually, unless otherwise approved by the NYSDEC. The SMP will be based on a calendar year and will be due for submission to NYSDEC by March 1 of the year following the reporting period.

The SMP may include a monitoring plan for groundwater to evaluate site-wide performance of the Remedy.

All handling of residual contaminated material will be subject to provisions contained in the SMP.

8.14.6 Final Engineering Report

Upon completion of the perimeter grout cut-off wall, installation of the recovery well, monitoring wells, and surface cap as well as confirmation of hydraulic control with NYSDEC, a Final Engineering Report (FER) will be submitted to NYSDEC. The FER will be submitted prior to conducting ISCO injections for source removal as that will be summarized in a separate summary report under the SMP. If contingency interior augering is necessary, this work will be performed prior to submitting the FER. The FER will comply with the requirements of DER-10 and include as a minimum the following:

- Photographs of remedial activities
- As-built drawings for all constructed elements (e.g., grout cut off wall, recover well, cap)
- Groundwater monitoring and Hydraulic control test results
- Waste manifests and bills of lading for all material removed from the site
- A drawing depicting the source areas of contamination encountered during remedial activities
- Documentation of environmental quality for imported backfill

The FER will be certified by the professional engineer of record.

8.15 Schedule

Remedial actions will be performed during NYCDOB permissible work hours. The current estimate for the duration of the remedial part of construction is 9 months starting in December 2015 – August 2016. An approximate schedule is as follows:

Lot 14 Site Remediation Schedule

Item	Duration/Date
Submit Proposed RAWP	11/25/15
NYSDEC/NYSDOH Reviews RAWP	2 weeks, 12/9/15
NYSDEC Approves RAWP and Starts Public Comment Period	12/14/15
RAWP Public Comment Period	45 Days
RAWP Public Comment Period Ends	1/27/16
NYSDEC Issues Notice to Proceed	2/5/16
Begin In-Ground Remediation/Construction *Grout wall approved 10/30/15 for installation under separate submission	**December 2015***
Cease On-Site Dewatering	March 2016
Submit Draft SMP and Easement for Review	March 2016
Complete Perimeter Cut-Off Wall	May 2016
Install Wells and Test Hydraulic Control	June 2016
Install Surface Cap	July 2016
End Remediation per RAWP begin Site Management Phase	**July 2016**
Submit FER	August 2016
Finalize SMP and Record Easement	August 2016
Conduct ISCO Injection	August 2016
Receive NYSDEC Approval of FER and COC	September 2016
Conduct post-ISCO injection Groundwater Monitoring	August – October 2016
Document post-ISCO injection groundwater results	November 2016

9.0 REFERENCES

1. *Queens Plaza Site Investigation*, AKRF, 1988
2. *Outlet City Soil and Groundwater Sampling Results*, AKRF, 1990
3. *Outlet City Property*, Supplemental Site Assessment/Remedial Investigation, AKRF, 1998.
4. *Site Investigation*, AKRF, 2002
5. *Soil and Groundwater Sampling and Analysis*, ELM, 2001
6. *Remedial Investigation Report,* Fleming Lee-Shue, Inc., March 2007
7. *Geotechnical Summary Report, Queens Plaza Project – Site A, Long Island City, Queens, New York, Mueser Rutledge, April 20, 2007*
8. *Geotechnical Summary Report, Gotham Center – Tower B-2 – Long Island City, Queens, New York, Mueser Rutledge,* February 15, 2008
9. Approved FLS *Queens Plaza Residential Development* [Site A], *Brownfield Cleanup Program (BCP) C241105, Long Island City,* August 2007
10. SCS Engineers sampling event April 2013
11. An Introduction to Geotechnical Engineering, Holtz & Kovacs, Prentice-Hall Inc., 1981

TABLE

1. Injection Well Construction Details

Table 1. Injection Well Construction Details – Queens Plaza Residential Development (Tax Lot 14)

Injection Well	Injection Well Material	Injection Well Diameter	Screen Length (ft)	Screen Interval (ft-bg)	Screen Interval (ft-NAVD88)
IW-4	SS	2	5	23 — 28	(12.12) — (17.12)
IW-5	SS	2	5	8 — 13	4.57 — (0.43)
IW-6	SS	2	9	9 — 18	3.25 — (5.75)

ft – Feet
ft-bg – Feet below ground
ft-NAVD88 – Feet in North American Vertical Datum of 1988
SS – Stainless steel
() – Negative elevation

FIGURES

SOURCE:
BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.

Title:

SITE LAYOUT

QUEENS PLAZA RESIDENTIAL DEVELOPMENT
BLOCK 264, TAX LOT 14
28-18 JACKSON AVENUE, LONG ISLAND CITY, NY

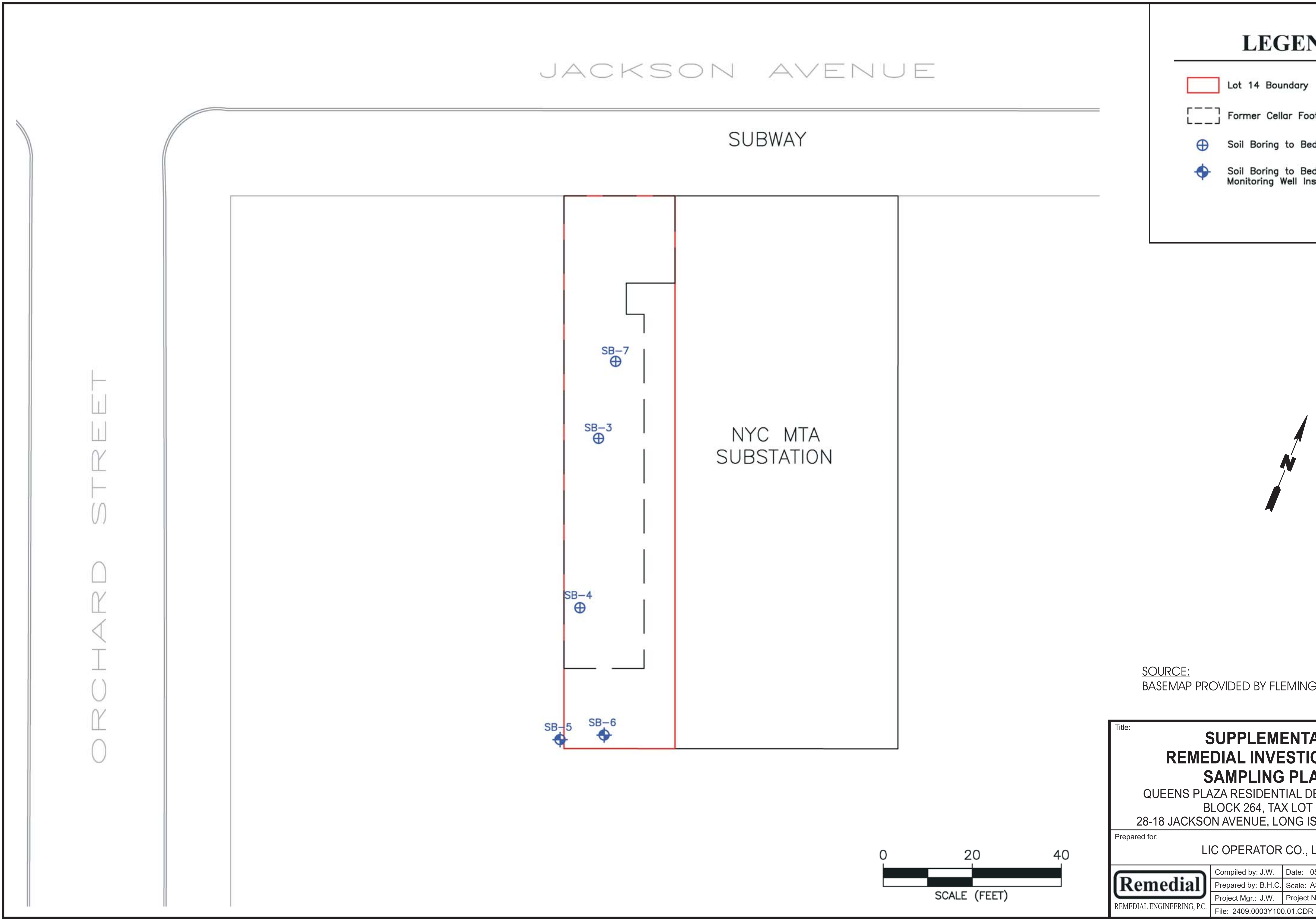
Prepared for:

LIC OPERATOR CO., L.P.

Remedial
REMEDIAL ENGINEERING, P.C.

Compiled by: J.W.	Date: 05OCT15	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	1
Project Mgr.: J.W.	Project No.: 2409.0003Y000	
File: 2409.0003Y100.01.CDR		

\2409Y\0003Y\100\2409.0003Y100.01.CDR



LEGEND

🟥	Lot 14 Boundary
⬚	Former Cellar Footprint
⊕	Soil Boring to Bedrock (2015)
⌖	Soil Boring to Bedrock (2015) Monitoring Well Installed

SOURCE:
BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.

Title:

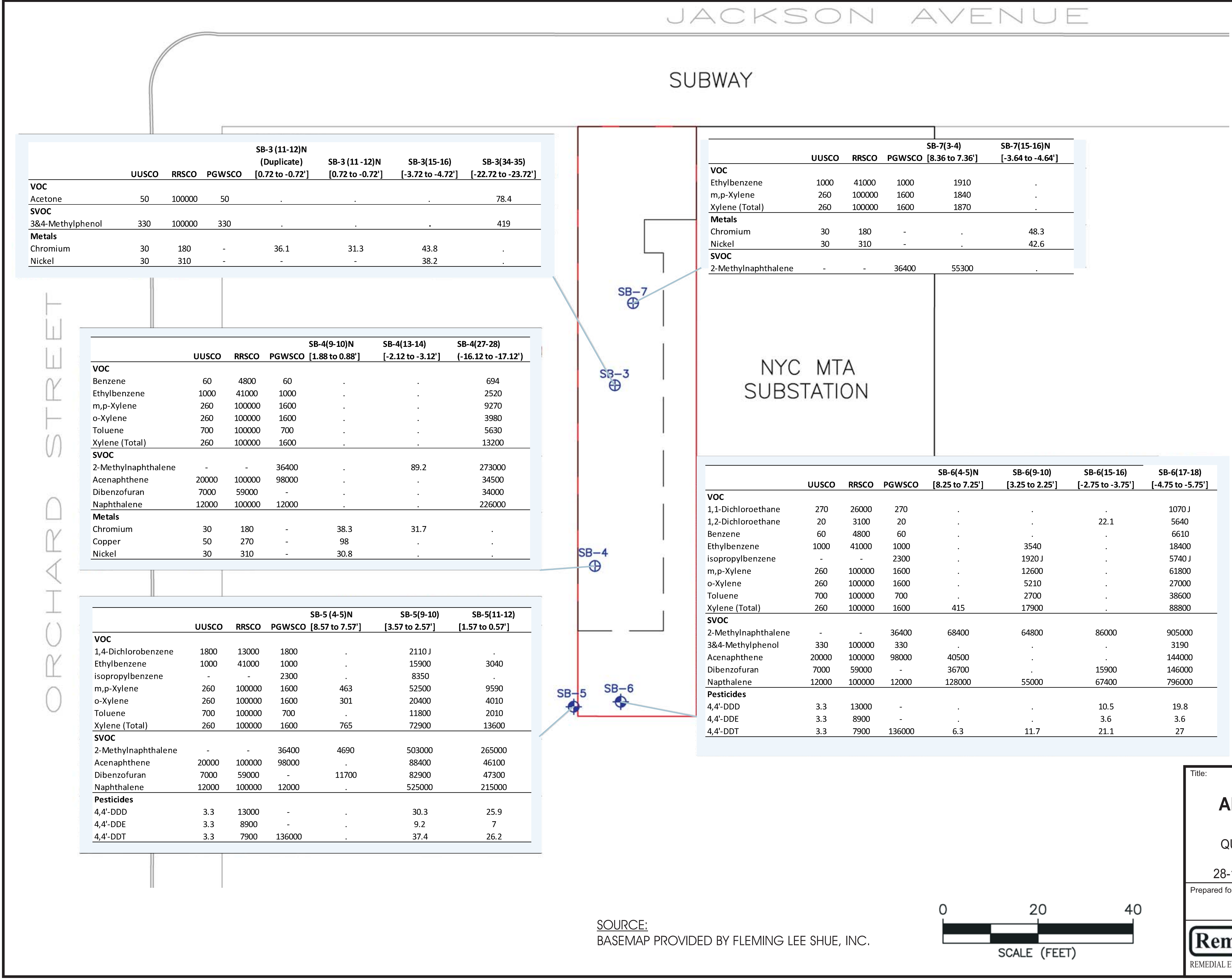
SUPPLEMENTAL
REMEDIAL INVESTIGATION
SAMPLING PLAN
QUEENS PLAZA RESIDENTIAL DEVELOPMENT
BLOCK 264, TAX LOT 14
28-18 JACKSON AVENUE, LONG ISLAND CITY, NY

Prepared for:

LIC OPERATOR CO., L.P.

Remedial
REMEDIAL ENGINEERING, P.C.

Compiled by: J.W.	Date: 05OCT15	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	2
Project Mgr.: J.W.	Project No.: 2409.0003Y000	
File: 2409.0003Y100.01.CDR		



	UUSCO	RRSCO	PGWSCO	SB-3 (11-12)N (Duplicate) [0.72 to -0.72']	SB-3 (11 -12)N [0.72 to -0.72']	SB-3(15-16) [-3.72 to -4.72']	SB-3(34-35) [-22.72 to -23.72']
VOC							
Acetone	50	100000	50	.	.	.	78.4
SVOC							
3&4-Methylphenol	330	100000	330	.	.	.	419
Metals							
Chromium	30	180	-	36.1	31.3	43.8	.
Nickel	30	310	-	-	-	38.2	.

	UUSCO	RRSCO	PGWSCO	SB-7(3-4) [8.36 to 7.36']	SB-7(15-16)N [-3.64 to -4.64']
VOC					
Ethylbenzene	1000	41000	1000	1910	.
m,p-Xylene	260	100000	1600	1840	.
Xylene (Total)	260	100000	1600	1870	.
Metals					
Chromium	30	180	-	.	48.3
Nickel	30	310	-	.	42.6
SVOC					
2-Methylnaphthalene	-	-	36400	55300	.

	UUSCO	RRSCO	PGWSCO	SB-4(9-10)N [1.88 to 0.88']	SB-4(13-14) [-2.12 to -3.12']	SB-4(27-28) (-16.12 to -17.12')
VOC						
Benzene	60	4800	60	.	.	694
Ethylbenzene	1000	41000	1000	.	.	2520
m,p-Xylene	260	100000	1600	.	.	9270
o-Xylene	260	100000	1600	.	.	3980
Toluene	700	100000	700	.	.	5630
Xylene (Total)	260	100000	1600	.	.	13200
SVOC						
2-Methylnaphthalene	-	-	36400	.	89.2	273000
Acenaphthene	20000	100000	98000	.	.	34500
Dibenzofuran	7000	59000	-	.	.	34000
Naphthalene	12000	100000	12000	.	.	226000
Metals						
Chromium	30	180	-	38.3	31.7	.
Copper	50	270	-	98	.	.
Nickel	30	310	-	30.8	.	.

	UUSCO	RRSCO	PGWSCO	SB-6(4-5)N [8.25 to 7.25']	SB-6(9-10) [3.25 to 2.25']	SB-6(15-16) [-2.75 to -3.75']	SB-6(17-18) [-4.75 to -5.75']
VOC							
1,1-Dichloroethane	270	26000	270	.	.	.	1070 J
1,2-Dichloroethane	20	3100	20	.	.	22.1	5640
Benzene	60	4800	60	.	.	.	6610
Ethylbenzene	1000	41000	1000	.	3540	.	18400
isopropylbenzene	-	-	2300	.	1920 J	.	5740 J
m,p-Xylene	260	100000	1600	.	12600	.	61800
o-Xylene	260	100000	1600	.	5210	.	27000
Toluene	700	100000	700	.	2700	.	38600
Xylene (Total)	260	100000	1600	415	17900	.	88800
SVOC							
2-Methylnaphthalene	-	-	36400	68400	64800	86000	905000
3&4-Methylphenol	330	100000	330	.	.	.	3190
Acenaphthene	20000	100000	98000	40500	.	.	144000
Dibenzofuran	7000	59000	-	36700	.	15900	146000
Napthalene	12000	100000	12000	128000	55000	67400	796000
Pesticides							
4,4'-DDD	3.3	13000	-	.	.	10.5	19.8
4,4'-DDE	3.3	8900	-	.	.	3.6	3.6
4,4'-DDT	3.3	7900	136000	6.3	11.7	21.1	27

	UUSCO	RRSCO	PGWSCO	SB-5 (4-5)N [8.57 to 7.57']	SB-5(9-10) [3.57 to 2.57']	SB-5(11-12) [1.57 to 0.57']
VOC						
1,4-Dichlorobenzene	1800	13000	1800	.	2110 J	.
Ethylbenzene	1000	41000	1000	.	15900	3040
isopropylbenzene	-	-	2300	.	8350	.
m,p-Xylene	260	100000	1600	463	52500	9590
o-Xylene	260	100000	1600	301	20400	4010
Toluene	700	100000	700	.	11800	2010
Xylene (Total)	260	100000	1600	765	72900	13600
SVOC						
2-Methylnaphthalene	-	-	36400	4690	503000	265000
Acenaphthene	20000	100000	98000	.	88400	46100
Dibenzofuran	7000	59000	-	11700	82900	47300
Naphthalene	12000	100000	12000	.	525000	215000
Pesticides						
4,4'-DDD	3.3	13000	-	.	30.3	25.9
4,4'-DDE	3.3	8900	-	.	9.2	7
4,4'-DDT	3.3	7900	136000	.	37.4	26.2

LEGEND

🟥	Lot 14 Boundary
⬚	Former Cellar Footprint
⊕	Soil Boring to Bedrock (2015)
●	Soil Boring to Bedrock (2015) Monitoring Well Installed

Notes:

SB-6 (17–18)	Sample ID (Feet Below Grade)
[–4.75 TO –5.75']	Sample Elevation [NAVD88]
UUSCO	Unrestricted Use Soil Cleanup Objectives (6 NYCRR Part 375 6.8)
RRSCO	Restricted Residential Soil Cleanup Objectives (6 NYCRR Part 375 6.8)
PGWSCO	Applicable Protection of Groundwater Soil Cleanup Objectives (6 NYCRR Part 375 6.8)
J	Estimated Analytical Result
–	No Applicable SCO
.	Result Below SCO

*All Results and Standards Reported in Micrograms Per Kilogram, Except Metals Which are Reported in Milligrams Per Kilogram

SOURCE:
BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.

Title:

SOIL RESULTS ABOVE PART 375 SOIL CLEANUP OBJECTIVES

QUEENS PLAZA RESIDENTIAL DEVELOPMENT
BLOCK 264, TAX LOT 14
28-18 JACKSON AVENUE, LONG ISLAND CITY, NY

Prepared for:
LIC OPERATOR CO., L.P.

Remedial
REMEDIAL ENGINEERING, P.C.

Compiled by: J.W.	Date: 05OCT15	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	3
Project Mgr.: J.W.	Project No.: 2409.0003Y000	
File: 2409.0003Y100.01.CDR		

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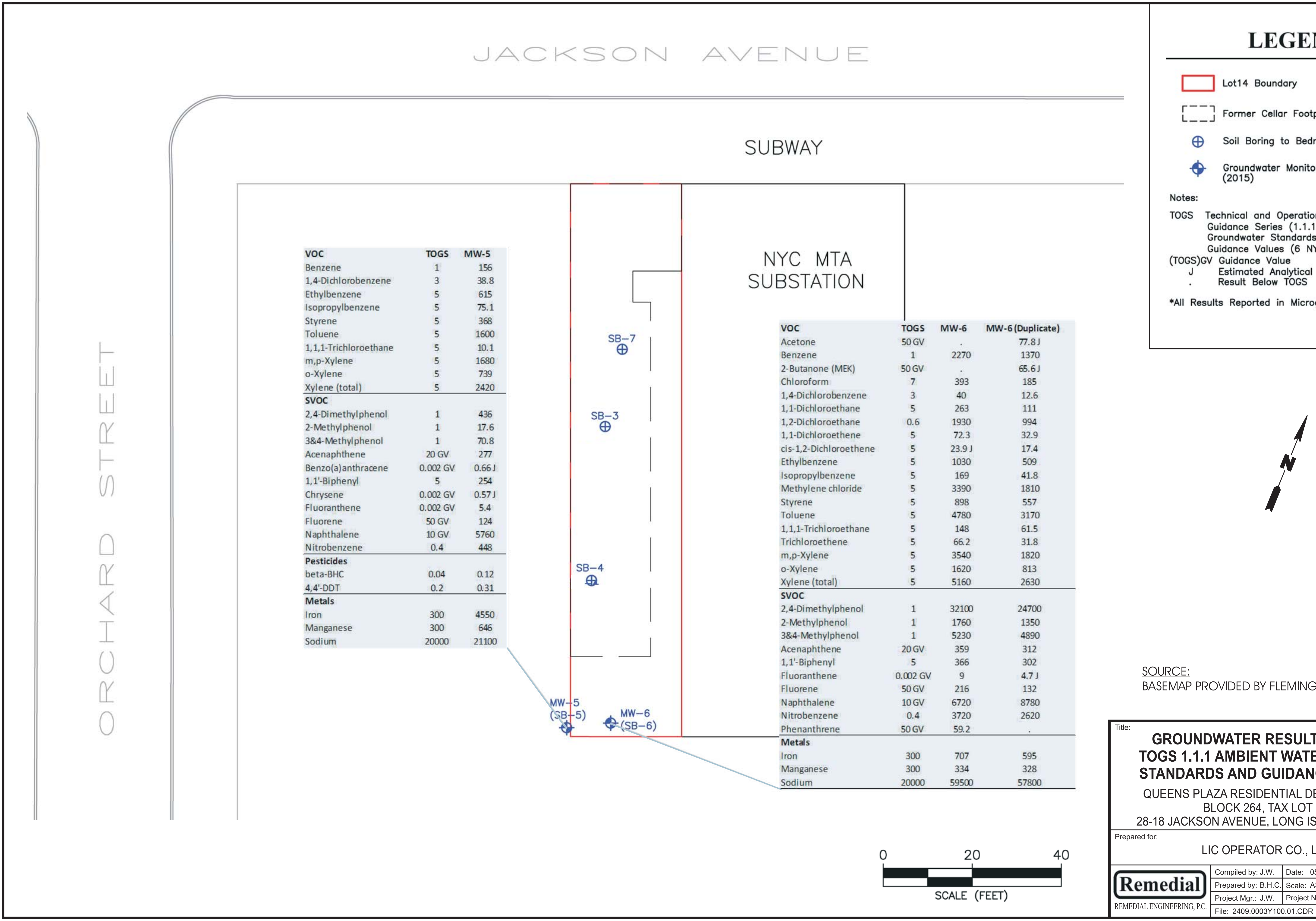

VOC	TOGS	MW-5
Benzene	1	156
1,4-Dichlorobenzene	3	38.8
Ethylbenzene	5	615
Isopropylbenzene	5	75.1
Styrene	5	368
Toluene	5	1600
1,1,1-Trichloroethane	5	10.1
m,p-Xylene	5	1680
o-Xylene	5	739
Xylene (total)	5	2420
SVOC		
2,4-Dimethylphenol	1	436
2-Methylphenol	1	17.6
3&4-Methylphenol	1	70.8
Acenaphthene	20 GV	277
Benzo(a)anthracene	0.002 GV	0.66 J
1,1'-Biphenyl	5	254
Chrysene	0.002 GV	0.57 J
Fluoranthene	0.002 GV	5.4
Fluorene	50 GV	124
Naphthalene	10 GV	5760
Nitrobenzene	0.4	448
Pesticides		
beta-BHC	0.04	0.12
4,4'-DDT	0.2	0.31
Metals		
Iron	300	4550
Manganese	300	646
Sodium	20000	21100

VOC	TOGS	MW-6	MW-6 (Duplicate)
Acetone	50 GV	.	77.8 J
Benzene	1	2270	1370
2-Butanone (MEK)	50 GV	.	65.6 J
Chloroform	7	393	185
1,4-Dichlorobenzene	3	40	12.6
1,1-Dichloroethane	5	263	111
1,2-Dichloroethane	0.6	1930	994
1,1-Dichloroethene	5	72.3	32.9
cis-1,2-Dichloroethene	5	23.9 J	17.4
Ethylbenzene	5	1030	509
Isopropylbenzene	5	169	41.8
Methylene chloride	5	3390	1810
Styrene	5	898	557
Toluene	5	4780	3170
1,1,1-Trichloroethane	5	148	61.5
Trichloroethene	5	66.2	31.8
m,p-Xylene	5	3540	1820
o-Xylene	5	1620	813
Xylene (total)	5	5160	2630
SVOC			
2,4-Dimethylphenol	1	32100	24700
2-Methylphenol	1	1760	1350
3&4-Methylphenol	1	5230	4890
Acenaphthene	20 GV	359	312
1,1'-Biphenyl	5	366	302
Fluoranthene	0.002 GV	9	4.7 J
Fluorene	50 GV	216	132
Naphthalene	10 GV	6720	8780
Nitrobenzene	0.4	3720	2620
Phenanthrene	50 GV	59.2	.
Metals			
Iron	300	707	595
Manganese	300	334	328
Sodium	20000	59500	57800

LEGEND

🟥	Lot14 Boundary
⬚	Former Cellar Footprint
⊕	Soil Boring to Bedrock (2015)
⌖	Groundwater Monitoring Well (2015)

Notes:

TOGS	Technical and Operational Guidance Series (1.1.1) Class GA Groundwater Standards and Guidance Values (6 NYCRR 703.5)
(TOGS)GV	Guidance Value
J	Estimated Analytical Result
.	Result Below TOGS

*All Results Reported in Micrograms Per Liter

SOURCE:
BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.

Title:

GROUNDWATER RESULTS ABOVE TOGS 1.1.1 AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES

QUEENS PLAZA RESIDENTIAL DEVELOPMENT
BLOCK 264, TAX LOT 14
28-18 JACKSON AVENUE, LONG ISLAND CITY, NY

Prepared for:
LIC OPERATOR CO., L.P.

Remedial
REMEDIAL ENGINEERING, P.C.

Compiled by: J.W.	Date: 05OCT15	FIGURE
Prepared by: B.H.C.	Scale: AS SHOWN	4
Project Mgr.: J.W.	Project No.: 2409.0003Y000	
File: 2409.0003Y100.01.CDR		

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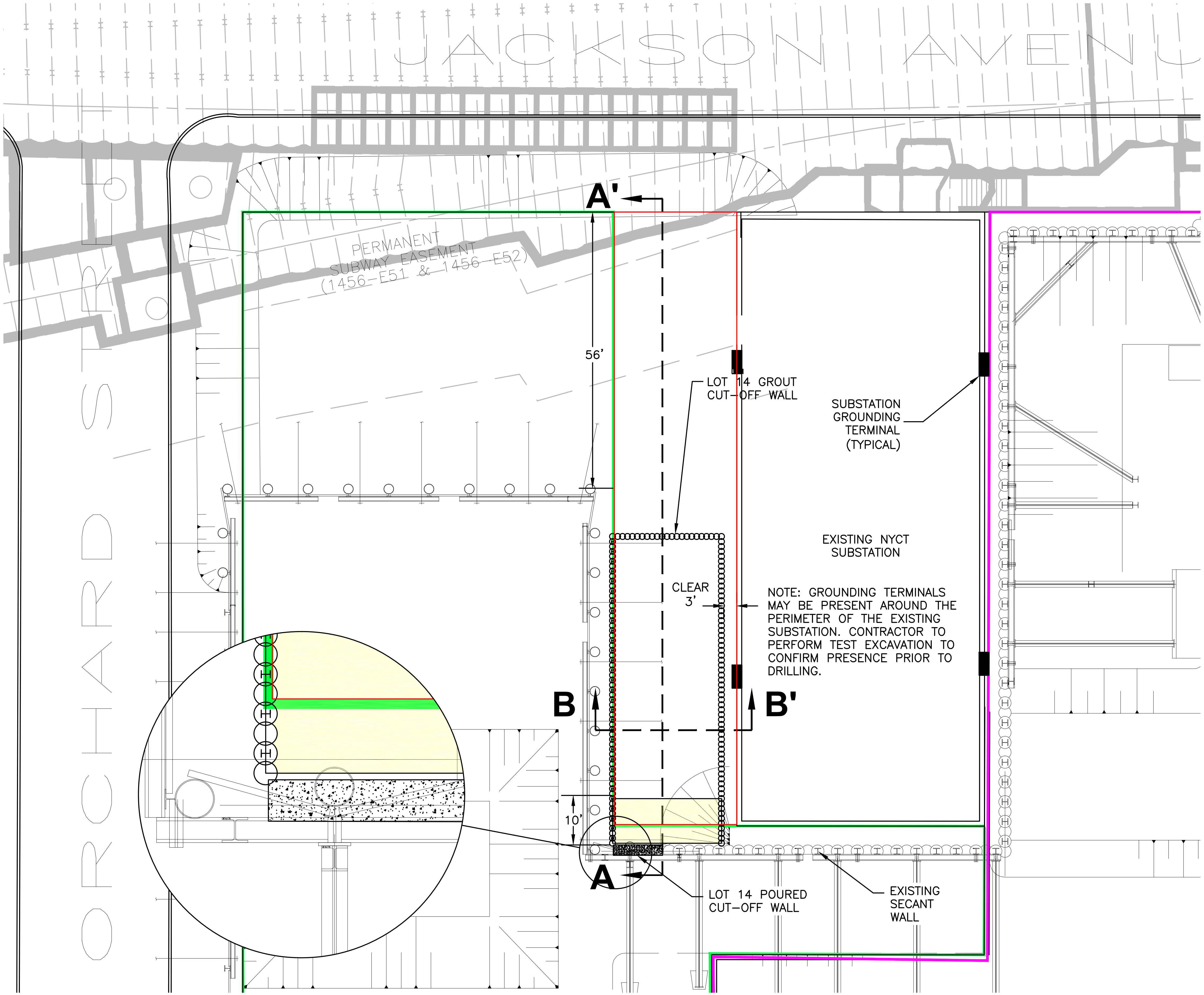

LEGEND

- 🟩 BCP SITE A (C241105)
- 🟪 BCP SITE B (C241151)
- 🟥 LOT 14
- 🟨 CONTINGENCY INTERIOR AUGERING ZONE
- ○○○○ GROUT CUT-OFF WALL

SOURCE

BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.

20' 0 20'

Title:

LAYOUT OF PROPOSED GROUT CUT-OFF WALL AND CONTINGENCY INTERIOR AUGERING ZONE

QUEENS PLAZA RESIDENTIAL DEVELOPMENT –
BLOCK 264, TAX LOT 14
28–18 JACKSON AVENUE, LONG ISLAND CITY, NEW YORK

Prepared For:

LIC OPERATOR CO., L.P.

Remedial
REMEDIAL ENGINEERING, P.C.
ENVIRONMENTAL ENGINEERS

Compiled by: J.W.	Date: 13NOV15	FIGURE 5
Prepared by: G.M.	Scale: AS SHOWN	
Project Mgr: J.W.	Project: 2409.0003Y000	
File: 2409.0003Y100.02.DWG		

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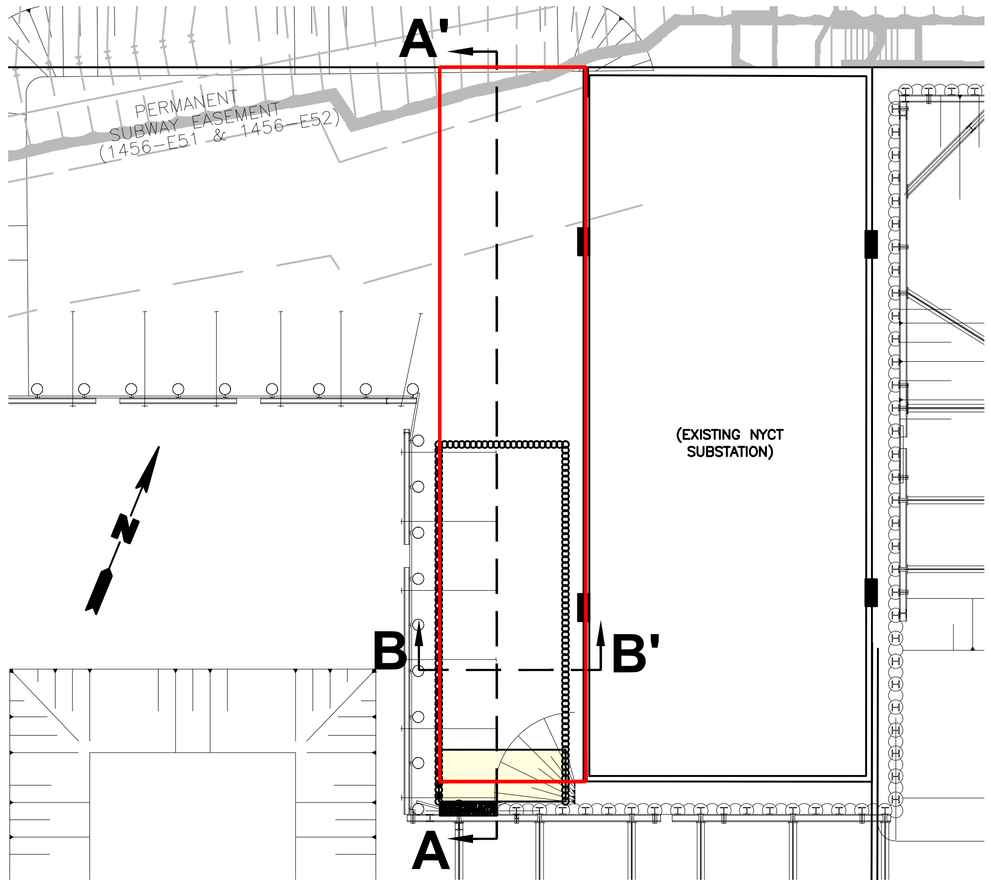


MATERIAL AND TESTING NOTES:

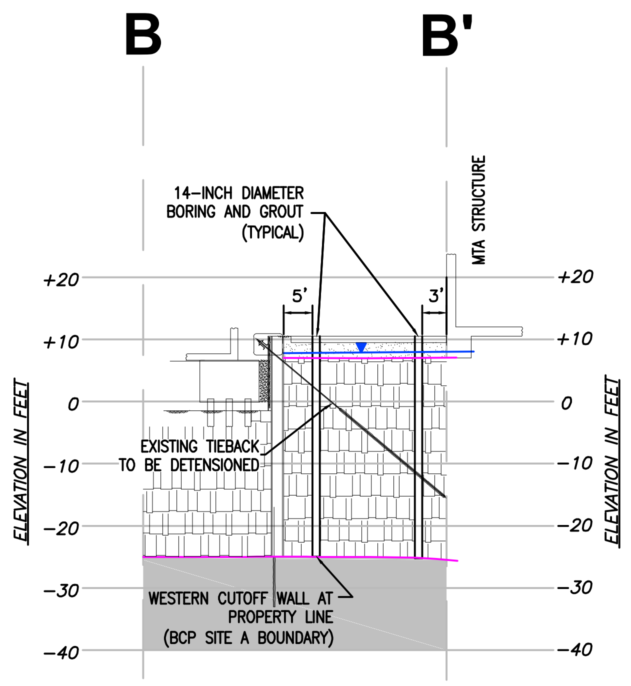
1. GROUT MIX SHALL CONSIST OF SAND, TYPE 2 PORTLAND CEMENT, WATER AND ADMIXTURES THAT RESULT IN A GROUT THAT HAS A MINIMUM COMPRESSIVE STRENGTH OF 2000 PSI AT 28 DAYS.
2. PER EVERY SECOND DAY GROUTING IS PERFORMED, A TESTING LAB SHALL TAKE A SET OF SIX GROUT CUBES.
3. TWO CUBES SHALL BE TESTED AT 14 DAYS. IF THE 14 DAY TESTS SHOWS SPECIFIED DESIGN STRENGTH IS MET, THE 4 REMAINING SAMPLES NEED NOT BE TESTED, OTHERWISE TEST 2 MORE CUBES AT 28 DAYS. THE REMAINING 2 CUBES CAN BE TESTED LATER AT 56 DAYS IF THE 28 DAY REQUIRED STRENGTH IS NOT MET.
4. ALL STRUCTURAL STEEL FOR BRACING SHALL CONFORM TO ASTM A992, WITH A MINIMUM YIELD STRENGTH OF F_y = 50 KSI.

PILE CUT–OFF WALL INSTALLATION PROCEDURE:

1. STAKE OUT PILE LOCATIONS BY SURVEY WITH 12–INCH SPACING ON CENTER (ESTIMATED 170 PILES OVER 200 LINEAR FEET).
    A. GROUT CUT–OFF WALL PILES WILL COMPRISE OF 13.375–INCH DIAMETER SECANT PILES TO ROCK.
    B, EVERY OTHER HOLE ON THE WESTERN CUT–OFF WALL WILL RECEIVE A W6 X 15 CORE BEAM.
2. INSTALL PILE DRILLING GUIDE TEMPLATE IF REQUIRED TO HOLD PILE ALIGNMENT.
3. ADVANCE A TEMPORARY STEEL DRILL CASING THROUGH THE SOIL OVERBURDEN TO TOP OF SOUND ROCK AS FOLLOWS:
    C. SOILS SHALL BE REMOVED FROM WITHIN THE CASING USING A ROLLER BIT AND FLUSHING WITH WATER.
    B, ROLLER BIT SHALL NOT ADVANCE AHEAD OF THE CASING. MAINTAIN THE WASH WATER RETURN INTERNAL TO THE CASING.
    C. FLUSHING THAT RESULTS IN CIRCULATION OUTSIDE OF THE CASING SHALL NOT BE PERMITTED. USE OF FORCED AIR WILL NOT BE PERMITTED EXCEPT FOR DRILLING THROUGH OBSTRUCTIONS WHICH CANNOT BE PENETRATED BY THE ROLLER BIT AFTER 30 MINUTES OF CONTINUOUS DRILLING WITH LESS THAN 3 INCHES OF PROGRESS.
5. CLEANING – PLACE A TREMIE PIPE TO THE BOTTOM OF THE CASING. INJECT WATER THROUGH THE TREMIE PIPE, FLUSHING OUT THE SEDIMENTS TRAPPED IN THE CASING. CONTINUE PUMPING WATER UNTIL CLEAN WATER IS NOTED RETURNING TO THE TOP OF THE CASING.
6. INSERT STEEL CORE BEAM INTO THE CASING.
7. FILL THE INSIDE OF THE CASING WITH TREMIE GROUT. CONTINUE PUMPING GROUT UNTIL GOOD GROUT RETURN IS NOTED FROM THE TOP OF THE CASING.
8. EXTRACT THE DRILL CASING KEEPING THE PILE TOPPED OFF WITH GROUT.
9. REPEAT THE ABOVE PROCEDURE FOR THE NEXT PILE BUT DO NOT DRILL A NEW PILE WITHIN 10 FEET OF A GROUTED PILE THAT IS LESS THAN 24 HOURS OLD.

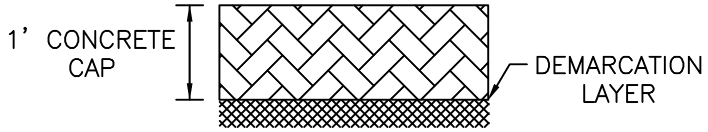
NOTE: VIBRATION MONITORING PROGRAM WILL CONTINUE AS INDICATED IN SOE–003.

NOTE: PILES WITHIN CUT–OFF WALL WILL BE INSTALLED WITH 3–FOOT SPACING ON CENTER; INSTALLATION PROCEDURES FOR THE INTERIOR PILES ARE TO BE THE SAME AS PILE CUT–OFF WALL INSTALLATION WITH THE EXCEPTION OF CORE BEAM.



TYPICAL CROSS SECTION

30' 0 30'

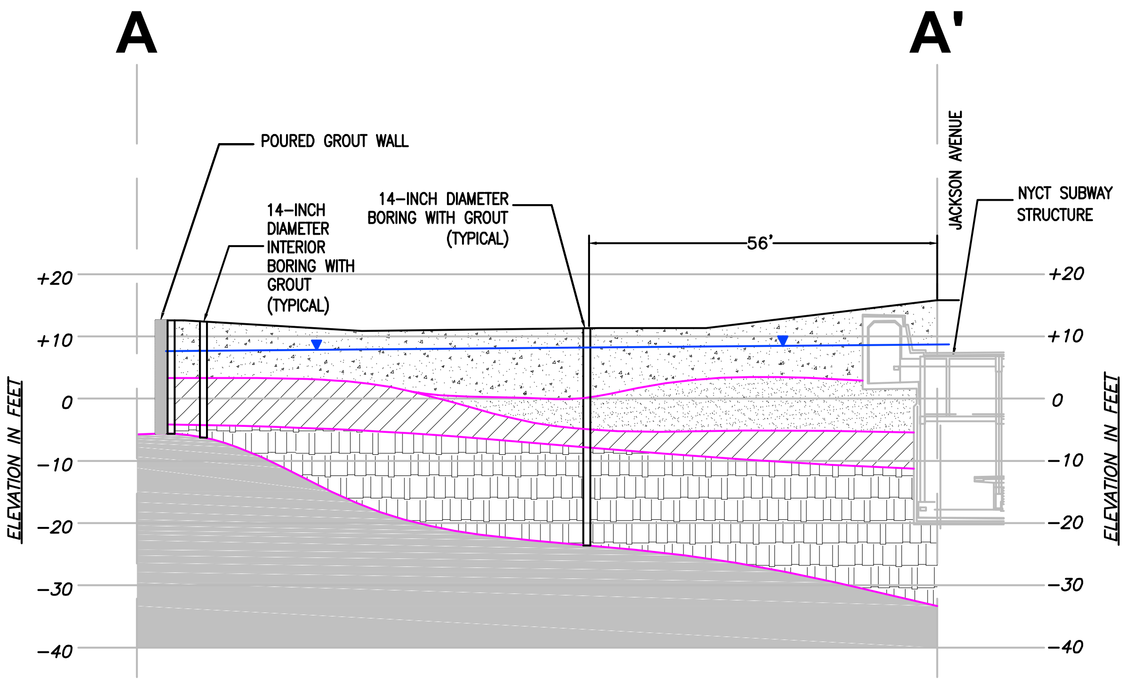


CONCRETE CAP DETAIL

NOT TO SCALE

SOURCE

BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.



TYPICAL CROSS SECTION

30' 0 30'

LEGEND

▨ FILL
▨ SAND
▨ VARVED SILT AND CLAY
▨ GLACIAL TILL
▨ BEDROCK
▼ APPROXIMATE STATIC GROUNDWATER SURFACE
— LOT 14 BOUNDARY

Title: **CROSS SECTIONS AND DETAILS OF PROPOSED GROUT CUT-OFF WALL, SOURCE REMOVAL BORING AND CONCRETE CAP**

QUEENS PLAZA RESIDENTIAL DEVELOPMENT
BLOCK 264, TAX LOT 14
28–18 JACKSON AVENUE, LONG ISLAND CITY, NEW YORK

Prepared For:

LIC OPERATOR CO., L.P.

Remedial REMEDIAL ENGINEERING, P.C. *ENVIRONMENTAL ENGINEERS*	Compiled by: J.W.	Date: 13NOV15	FIGURE 6
	Prepared by: G.M.	Scale: AS SHOWN	
	Project Mgr: J.W.	Project: 2409.0003Y000	
	File: 2409.0003Y100.03.DWG		

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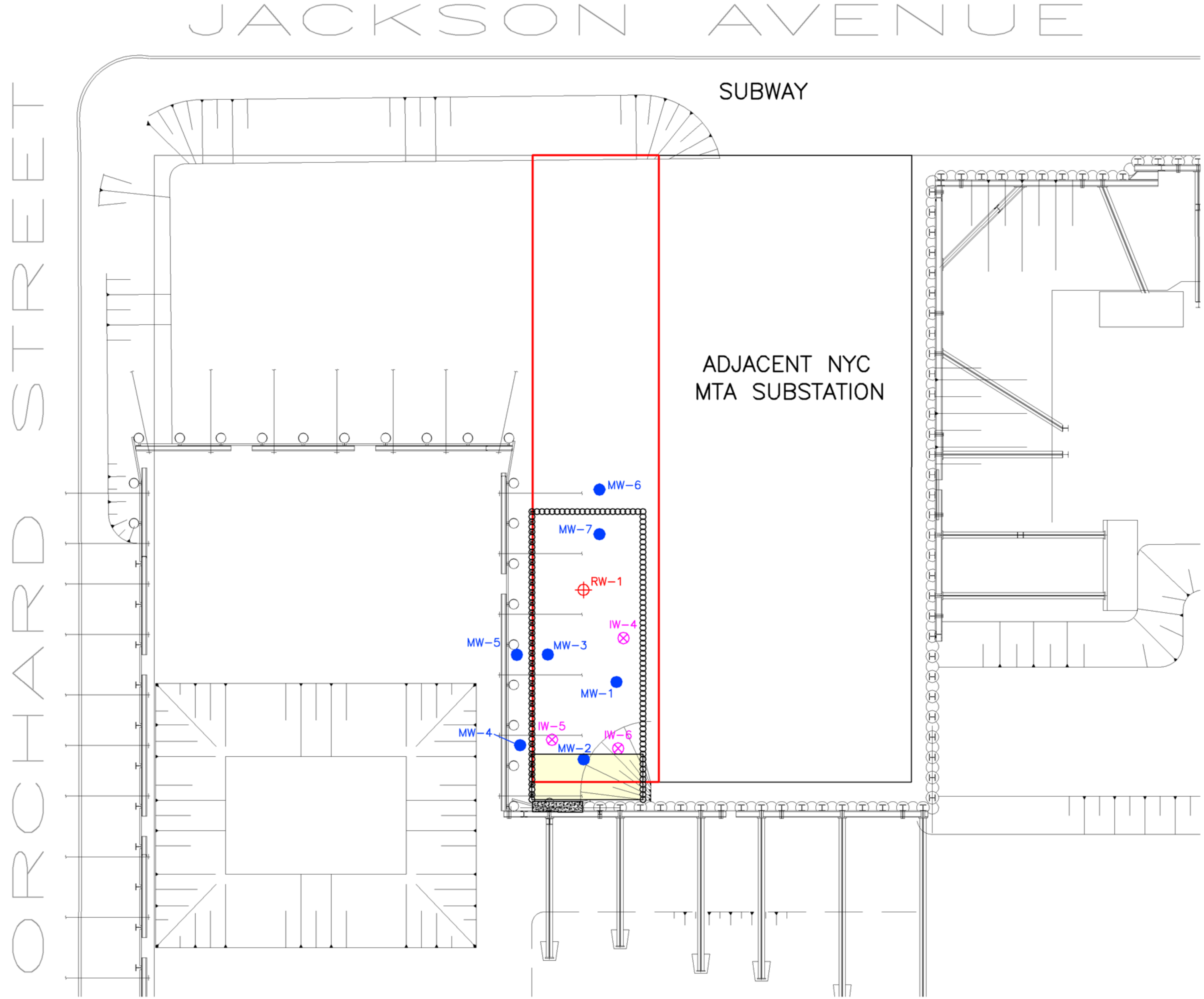

LEGEND

🟥 LOT 14 BOUNDARY

⊗ INJECTION WELL

● PROPOSED MONITORING WELL

⊕ PROPOSED RECOVERY WELL

🟨 CONTINGENCY INTERIOR AUGERING ZONE

SOURCE

BASEMAP PROVIDED BY FLEMING LEE SHUE, INC.

20' 0 20'

Title:

INJECTION AND MONITORING WELL LAYOUT

QUEENS PLAZA RESIDENTIAL DEVELOPMENT
BLOCK 264, TAX LOT 14
28-18 JACKSON AVENUE, LONG ISLAND CITY, NEW YORK

Prepared For:

LIC OPERATOR CO., L.P.

Remedial
REMEDIAL ENGINEERING, P.C.
ENVIRONMENTAL ENGINEERS

Compiled by: J.W.	Date: 13NOV15	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	7
Project Mgr: J.W.	Project: 2409.0003Y000	
File: 2409.0003Y108.01.DWG		

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APPENDICES

A. Soil Boring and Well Construction Logs
B. Source Zone Contaminant Mass Calculations and Analytical Results
C. Evaluation of Excavation Support Systems for Removal of Contaminated Soil, Mueser Rutledge, MRCE File No. 10608D, September 15, 2015
D. Bench Scale Treatability Study
E. Stormwater Pollution Prevention Plan
F. Quality Assurance/Quality Control (QA/QC) Plan
G. Health and Safety Plan
H. Community Air Monitoring Plan
I. QPRD Capture Well Design Details
J. Proposed Oxidant Brochure: Klozur® persulfate
K. RemMetrik® statistical analysis
L. Citizen Participation Plan

APPENDIX A

Soil Boring and Well Construction Logs

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting
& Management

209 Shafter Street
Islandia, NY 11749
Telephone: (631) 232-2600
Fax: (631) 232-9898

Page **1** of **1**

SOIL BORING LOG

WELL NO. **SB-3**	NORTHING **Not Measured**	EASTING **Not Measured**
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**	
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**

DRILL BIT DIAMETER/TYPE **3-in. / Sonic**	BOREHOLE DIAMETER **3-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **7/30/15-8/5/15**
LAND SURFACE ELEVATION **Not Measured**	DEPTH TO WATER **Not Measured**	BACKFILL **Bentonite**		

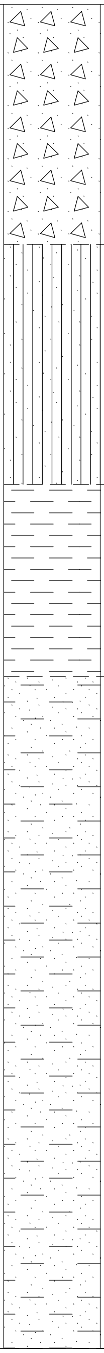
Depth, feet	Graphic Log	Visual Description	Blow Counts per 6"		PID Values (ppm)	REMARKS
		FILL (Brown, fine SAND, some medium Sand, little Silt, trace coarse sand, gravel, concrete and brick; moist).		G	454	Hand cleared to 5 ft bls.
5					672	3.5 ft recovery. Sample SB-3 (6-7) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis.
		Brown, fine SAND, some Silt, little medium Sand, trace coarse sand and gravel; moist			2.4	Sample SB-3 (9-10) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis .
10		Grey, SILT, little fine Sand, trace medium sand; moist			0.8	4 ft recovery. Sample SB-3 (11-12) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis.
15		Grey, SILT, some Clay, trace fine to medium sand; very moist			0.0	3 ft recovery. Sample SB-3 (15-16) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/ GRO analysis.
20		Grey, fine to medium SAND, little Silt, trace coarse sand; wet			0.0	4.8 ft recovery. Water table observed at approximately 20 ft bls.
25					8.7	2 ft recovery
					17.4	
30					97.5	
					29	Sample SB-3 (34-35) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis. Bedrock at 35 ft bls.
35						

ROUX ASSOCIATES, INC.
Environmental Consulting
& Management

209 Shafter Street
Islandia, NY 11749
Telephone: (631) 232-2600
Fax: (631) 232-9898

SOIL BORING LOG

WELL NO. **SB-4**	NORTHING **Not Measured**	EASTING **Not Measured**		
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**		
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**			
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**		
DRILL BIT DIAMETER/TYPE **3-in. / Sonic**	BOREHOLE DIAMETER **3-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **7/30/15-8/4/15**
LAND SURFACE ELEVATION **Not Measured**	DEPTH TO WATER **Not Measured**	BACKFILL **Bentonite**		



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0	FILL (Brown, fine SAND and SILT, little medium Sand, trace coarse sand and gravel; moist)		397	Hand cleared to 5 ft bls. Odor observed.
5	Brown, SILT, little fine Sand, trace medium sand; moist		5.4	2.5 ft recovery.
9				Sample SB-4 (9-10) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis. 4 ft recovery.
10	Grey, SILT, trace fine sand; moist		3.7	
13				Sample SB-4 (9-10) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals, TPH DRO/GRO, Bulk Density and Grain Size analysis. 4 ft recovery. Odor observed. Sample SB-4 (15-16) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis .
14	Greyish brown, medium SAND, some fine Sand, little Silt, trace coarse sand and gravel; moist		17.2	
15			41.4	
20			547	4.5 ft recovery.
25			10000	3 ft recovery. Odor observed. Sample SB-4 (27-28) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals, TPH DRO/GRO, Bulk Density and Grain Size analysis. Bedrock at 28 ft bls.

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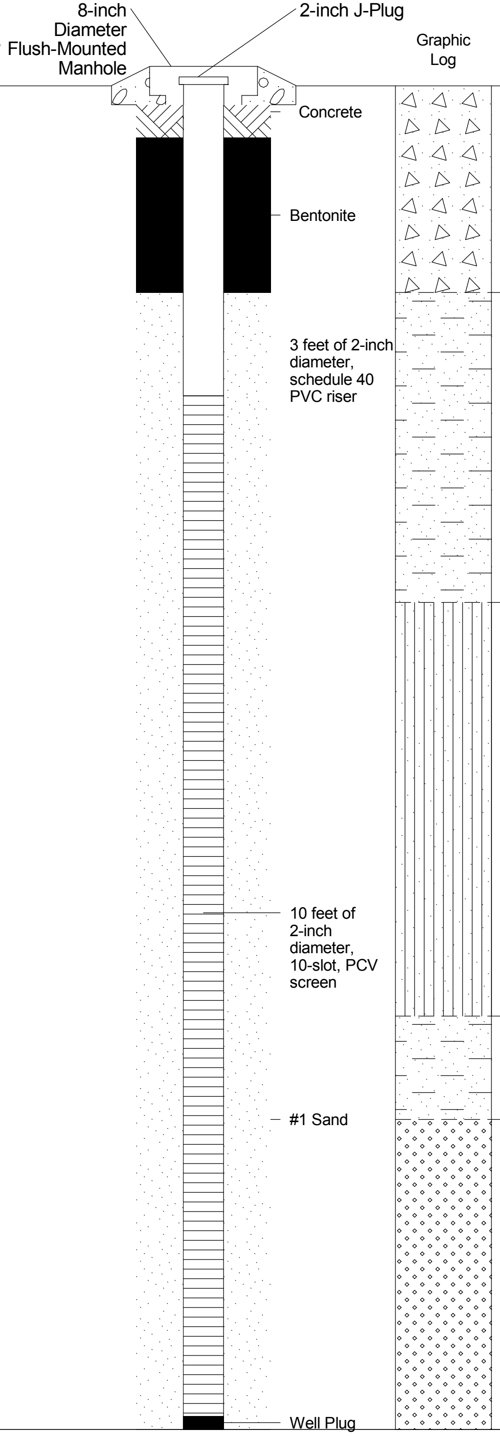
WELL CONSTRUCTION LOG

WELL NO. **SB-5/MW-5**	NORTHING **Not Measured**	EASTING **Not Measured**		
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**		
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**			
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**		
DRILL BIT DIAMETER/TYPE **5-in. / Sonic**	BOREHOLE DIAMETER **5-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **7/31/15-8/4/15**
CASING MAT./DIA. **PVC / 2-inch**	SCREEN: TYPE **Slotted**	MAT. **PVC** TOTAL LENGTH **10.0**ft	DIA. **2-inch**	SLOT SIZE **10-Slot**
ELEVATION OF: (Feet)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN **/**	GRAVEL PACK SIZES **#1**



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0–2	FILL (Brown, fine SAND some Silt, little medium Sand, trace coarse sand, gravel, concrete and brick; moist)		342	Hand cleared to 5 feet bls.
2–5	Grey to dark grey, fine SAND, some Silt, little medium Sand, trace coarse sand; moist		1729	Odor observed. Sample SB-5 (4-5) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis.
5–9	Greyish brown, SILT, some fine Sand, trace medium sand; moist		3533	3.5 ft recovery. Staining and odor observed.
9–10	Greyish brown, fine SAND, some medium Sand, little Silt, trace coarse sand; moist			Sample SB-5 (9-10) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis.
10–13	Greyish brown, fine to medium SAND, little coarse Sand, trace gravel; very moist		1500	2 ft recovery. Staining and odor observed. Sample SB-5 (11-12) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals, TPH DRO/GRO, Bulk Density and Grain Size analysis. Bedrock at 13 ft bls.

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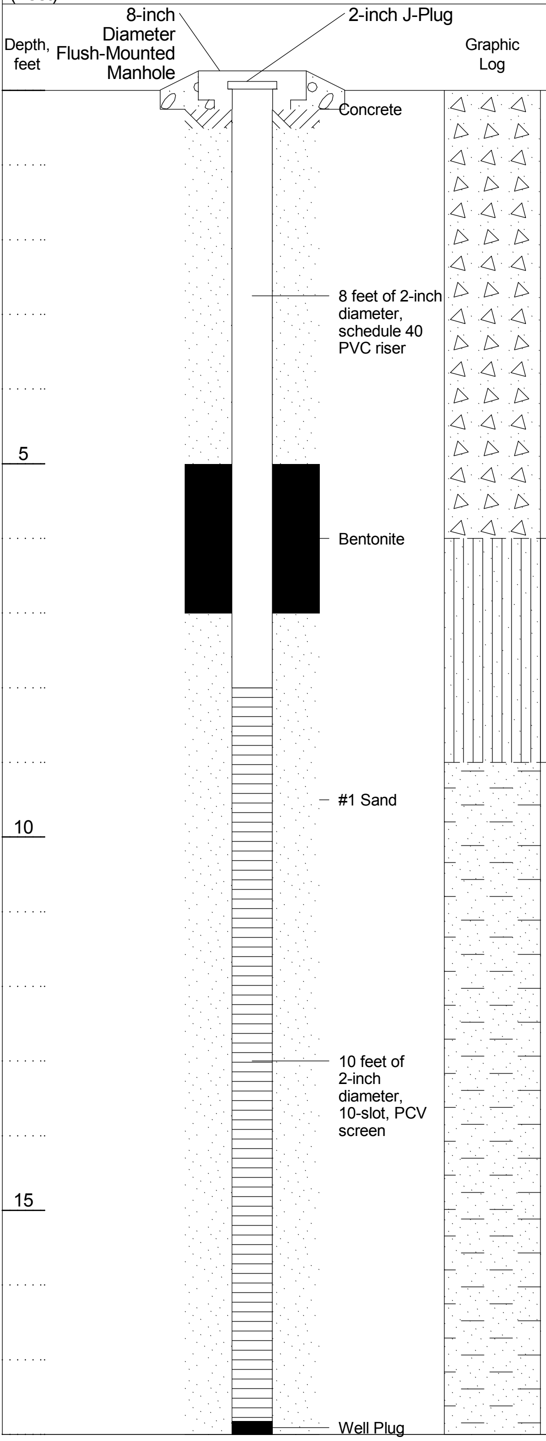
Page **1** of **1**

WELL CONSTRUCTION LOG

WELL NO. **SB-6/MW-6**	NORTHING **Not Measured**	EASTING **Not Measured**		
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**		
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**			
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**		
DRILL BIT DIAMETER/TYPE **5-in. / Sonic**	BOREHOLE DIAMETER **5-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **7/31/15-8/4/15**
CASING MAT./DIA. **PVC / 2-inch**	SCREEN: TYPE **Slotted**	MAT. **PVC**	TOTAL LENGTH **10.0**ft DIA. **2-inch**	SLOT SIZE **10-Slot**
ELEVATION OF: (Feet)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN /	GRAVEL PACK SIZES **#1**



Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
FILL (Brown to dark brown, fine SAND and SILT, little medium Sand, trace gravel, concrete and brick; moist)		5098	Hand cleared to 5 ft bls. Staining and odor observed.
			Sample SB-5 (4-5) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals, TPH DRO/GRO, Bulk Density and Grain Size analysis. 3.5 ft recovery. Staining and odor observed.
Greyish brown, SILT, little fine Sand; moist		15000	
Brown, fine SAND, some medium Sand, little Silt, trace coarse sand; moist		15000	Sample SB-6 (9-10) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis. 3 ft recovery. Staining and odor observed.
Greyish brown, fine SAND, some Silt, little medium Sand, trace coarse sand; moist			
Greyish brown, medium SAND, some fine Sand, little Silt, trace coarse sand and gravel; moist		301	
			3 ft recovery. Free-product, staining and odor observed. Sample SB-6 (15-16) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis.
Greyish brown, medium SAND, some fine Sand, little Silt, trace coarse sand and gravel; wet		15000	Sample SB-6 (17-18) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals, TPH DRO/GRO, Bulk Density and Grain Size analysis. Bedrock at 18 ft bls.

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SOIL BORING LOG

WELL NO. **SB-7**	NORTHING **Not Measured**	EASTING **Not Measured**		
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**		
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**			
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**		
DRILL BIT DIAMETER/TYPE **3-in. / Sonic**	BOREHOLE DIAMETER **3-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **7/31/15-8/5/15**
LAND SURFACE ELEVATION **Not Measured**	DEPTH TO WATER **Not Measured**	BACKFILL **Bentonite**		

Depth, feet	Graphic Log	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
		FILL (Dark brown, fine SAND, some medium Sand, little Silt, trace coarse sand, gravel, concrete andbrick; moist)	G	722	Hand cleared to 5 ft bls. Odor observed.
					Sample SB-7 (3-4) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis. 3.8 ft recovery.
5				361	
		Brown, fine SAND, some Silt, little medium Sand, tracea coarse sand and gravel; moist		6.7	Odor observed.
					Sample SB-7 (9-10) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis. 2.5 ft recovery.
10		Greyish brown, SILT, some fine Sand, little medium Sand, trace coarse and gravel; moist		0.0	
15		Greyish brown, SILT, trace fine sand; very moist		5.4	4.5 ft recovery. Sample SB-7 (15-16) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis.
		Greyish brown, medium SAND, some fine Sand, little Silt, trace coarse sand and gravel; wet		13.1	Water table observed at approximately 19 ft bls.
20				0.7	4 ft recovery.
25				0.2	4 ft recovery.
30				7.9	3.6 ft recovery.
35				95.7	2 ft recovery. Sample SB-7 (36-37) collected for TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, TAL Metals and TPH DRO/GRO analysis. Bedrock at 37 ft bls.

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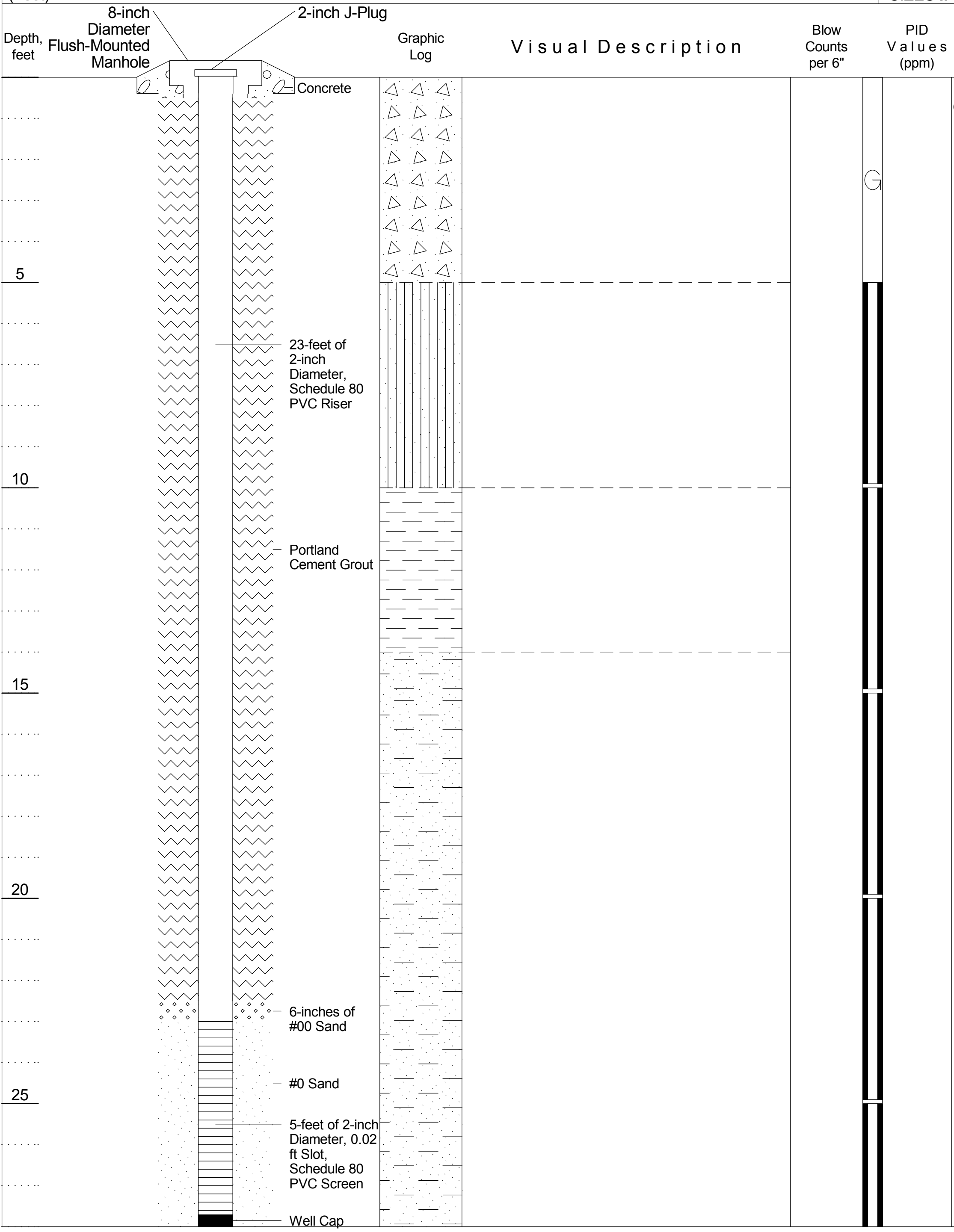
WELL CONSTRUCTION LOG

WELL NO. **IW-4**	NORTHING **Not Measured**	EASTING **Not Measured**		
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**		
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**			
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**		
DRILL BIT DIAMETER/TYPE **3-in. / Sonic**	BOREHOLE DIAMETER **5-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **9/3/15-9/8/15**
CASING MAT./DIA. **SCH 80 PVC / 2-inch**	SCREEN: TYPE **Slotted**	MAT. **SCH 80 PVC** TOTAL LENGTH **5.0** ft	DIA. **2-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (Feet)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN /	GRAVEL PACK SIZES **#0**



REMARKS

Hand cleared to 5 ft bls. Odor observed.

Bedrock at ~28 ft bls.

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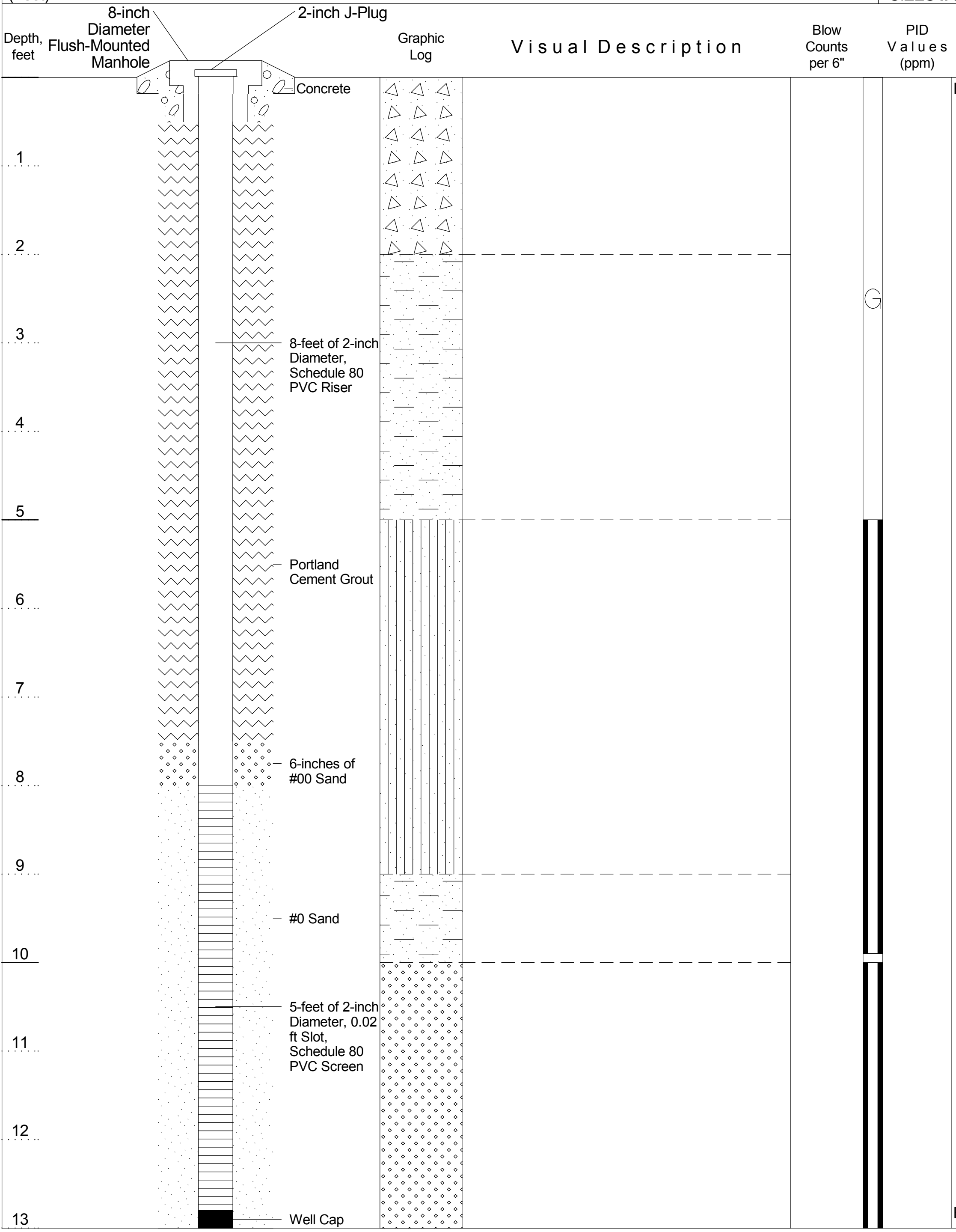
WELL CONSTRUCTION LOG

WELL NO. **IW-5**	NORTHING **Not Measured**	EASTING **Not Measured**
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**	
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**

DRILL BIT DIAMETER/TYPE **3-in. / Sonic**	BOREHOLE DIAMETER **5-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **9/3/15-9/8/15**

CASING MAT./DIA. **SCH 80 PVC / 2-inch**
SCREEN: TYPE **Slotted** MAT. **SCH 80 PVC** TOTAL LENGTH **5.0** ft DIA. **2-inch** SLOT SIZE **20-Slot**

ELEVATION OF: (Feet) GROUND SURFACE TOP OF WELL CASING TOP & BOTTOM SCREEN /
GRAVEL PACK SIZES **#0**



REMARKS

Hand cleared to 5 feet bls.

Bedrock at ~13 ft bls.

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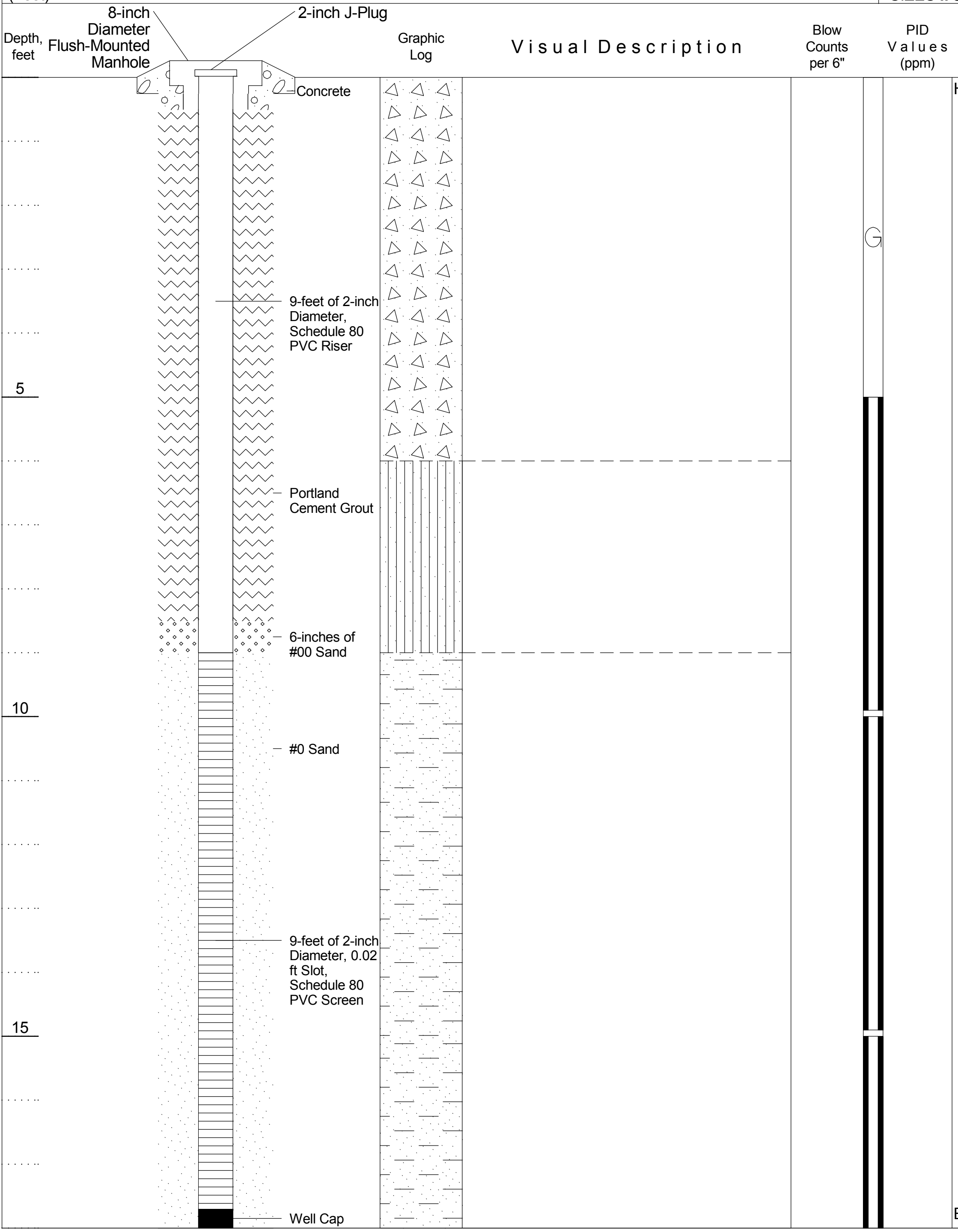
Page **1** of **1**

WELL CONSTRUCTION LOG

WELL NO. **IW-6**	NORTHING **Not Measured**	EASTING **Not Measured**		
PROJECT NO./NAME **2409.0001Y000 / Queens Plaza Lot 14**		LOCATION **28-18 Jackson Avenue** **Long Island City, New York**		
APPROVED BY **J.Wills**	LOGGED BY **R.Crockett**			
DRILLING CONTRACTOR/DRILLER **Aquifer Drilling and Testing / German Torres**		GEOGRAPHIC AREA **Tax Lot 14**		
DRILL BIT DIAMETER/TYPE **3-in. / Sonic**	BOREHOLE DIAMETER **5-inches**	DRILLING EQUIPMENT/METHOD **Minisonic / Sonic**	SAMPLING METHOD **Sonic Sampler**	START-FINISH DATE **9/3/15-9/8/15**
CASING MAT./DIA. **SCH 80 PVC / 2-inch**	SCREEN: TYPE **Slotted**	MAT. **SCH 80 PVC** TOTAL LENGTH **9.0** ft	DIA. **2-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (Feet)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN /	GRAVEL PACK SIZES **#0**



REMARKS

Hand cleared to 5 ft bls.

Bedrock at ~18 ft bls.

BORING/FEET 2409.0001Y000 (LOT14).GPJ ROUX.GDT 10/27/15

APPENDIX B

Source Zone Contaminant Mass Calculations and Analytical Results

Estimated Contaminant Mass Calcualtions
Tax Lot 14, 28-18 Jackson Avenue, Long Island City, New York

Boring	**Length**	**Width**	**Thickness**	**Volume (ft3)**	**Volume (m^3)**
SB-6	18	12.5	10	2,250	63.7
SB-5	18	12.5	7.5	1,688	47.8
SB-4	17	25	5	2,125	60.2
Total	35	25		6,063	172

Source Zone Area	**Avg. Contam. Conc., (mg/kg)**	**Bulk Density (kg/m^3)**	**Soil Volume (m^3)**	**Contam. Mass (kg)**	**Contam Mass (lbs)**	**Percent Contam. Mass (%)**
SB-5 & SB-6	2,946	1,600	111.5	525.6	1156	79.2
SB-4	1,429	1,600	60.2	137.6	303	20.8
Total	--	--	171.7	663.2	1,459	100
				74.9	165	

Notes:

1. The average value is the Minimum Variance Unbiased estimator calculated by converting the values to logarithms and adjusting for variance, from Gilbert, 1987, Section 13.1.1., p. 165.
2. Gilbert, 1987. Statistical Methods for Environmental Pollution Monitoring
3. The bulk density was obtained from measurements. There were eight bulk density measurements, which averaged 1.44 g/mL. A conservative value of 1.6 g/mL was used.
4. The Source Zone Area is taken to be the volume of soil containing creosote and/or petroleum hydrocarbons that are the principal source of contaminants affecting soil, groundwater, and soil vapor (Lundegard and Johnson 2006, p. 93, No. II).
5. The Source Zone Area is also the soil volume that can be treated in situ

Contingency Remedy Estimated Contaminant Mass Removal Calculations
Tax Lot 14, 28-18 Jackson Avenue, Long Island City, New York

Site Area	Length (ft)	width (ft)	Area (ft^2)	Average Depth (ft)	Area Volume (ft^3)	Area Volume (m^3)	1-inch Core Overlap (ft^2)	Effective Boring area (ft^2)	No. Cores	Volume/ Core (ft^3)	Volume Removed (ft^3)
5-ft-wide area	25	5	125	8.75	1,094	31.0	-	-	-	-	-
14-inch boring	-	-	1.069	8.75	-		0.001	1.068	117	9.3	1,094

Source Zone Area	Avg. Contam. Conc., (mg/kg)	Bulk Density (kg/m^3)	Soil Volume (m^3)	Contam. Mass (kg)	Contam Mass (lbs)	Percent Contam. Mass	
SB-5 & SB-6	2,946	1,600	31.0	146.0	321.2	**22**	% removed by coring of source zone

APPENDIX C

Evaluation of Excavation Support Systems for Removal of Contaminated Soil

Mueser Rutledge, MRCE File No. 10608D,
September 15, 2015

Mueser Rutledge
Consulting Engineers
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www.mrce.com

September 17, 2015

Fleming Lee Shue, Inc.
158 West 29th St., 9th Floor
New York, NY 10001

Attention: Mr. Arnold Fleming

Re: Long Island City Block 264, Lot 14
Evaluation of Impacts on Adjacent Structures
due to Proposed Soil Remediation Alternatives
MRCE File No. 10608D

Dear Mr. Fleming,

Based on our discussions, Fleming Lee Shue (FLS), is studying the following soil remediation alternatives for the referenced site which may have structural impacts on adjacent structures:

1. Complete excavation of contaminated soil to top of rock.

2. In-situ stabilization using soil-mixing / jet-grouting techniques.

3. Containing the contamination within a cutoff wall installed around the perimeter of the area to be remediated, with and/or without in-situ chemical treatment.

As shown on Attachment A, Site Plan, the proposed remediation on Lot 14 is limited to the southern part of the site and measures approximately 69 feet by 25 feet. We understand the remediation is to extend from existing grade (+10, NAVD88) to top of rock, which varies between elevation -8 at the south end to about elevation -25 at the north (see Attachment B for top of rock elevation). The remediation is located between the existing Support of Excavation (SOE) wall for Building A foundation construction on the west boundary and the NYCT Substation foundation on the east. On the south side, the excavation footprint also abuts the existing Building A SOE. The north boundary is approximately 56 feet from the existing NYCT Subway Tunnel on Jackson Avenue.

This letter presents Mueser Rutledge Consulting Engineers' (MRCE) evaluation of the proposed alternatives with respect to potential impacts on the adjacent NYCT Substation and the existing construction for Building A.

Alternative 1: Complete Excavation of Contaminated Soil

Attachment B is an enlarged plan of the proposed excavation. The complete excavation of the soil to top of rock will require the installation of new excavation support walls along three sides of the excavation: the NYCT Substation on the east; adjacent to the existing Building A SOE wall on the west; and along the northern remediation boundary. The wall along the Substation must be located 3 feet clear of the western edge of the spread footing foundation in order to comply with NYCT requirements. A new SOE wall is required along the western edge of Tax Lot 14 because the existing soldier pile and lagging wall is inadequate to support the new loading conditions. In addition, since the existing western soldier pile and lagging wall is not continuous, it will not provide the groundwater cutoff required to excavate to top of rock. The existing SOE wall along the south boundary, with minor modifications, can be utilized for support of the new excavation.

Attachment C is a cross-section through the proposed excavation. The proposed excavation will extend as deep as 32 feet below the bottom of the existing NYCT Substation spread footing foundation and the bottom of the Building A basement slab on grade.

Due to the excavation's close proximity to the existing foundations, the installation method for the SOE wall must prevent soil disturbance below the existing foundations which would result in immediate settlement of the structures. Further, the SOE wall must be designed for the high surcharge loads imposed on it by the existing spread footing foundations. The wall must also be sufficiently rigid so that the deflection of the wall that occurs as excavation progresses to top of rock does not result in soil disturbance below the foundations, which will result in additional settlement.

Based on our experience with similar conditions at other projects we have designed, a very stiff two feet minimum diameter secant pile wall, internally supported by multiple brace levels, will be required to adequately support the excavation and limit settlement of the existing structures (see Attachment C). Even with such a stiff system, settlement of the existing structures should be expected. For the excavation depths at Lot 14 required to remove the contaminated soil to top of rock, we would expect settlement of the NYCT Substation to be on the order of ½ to 1 inch (assuming no soil loss during wall installation) for a two foot diameter secant pile wall; settlement would be significantly greater if smaller diameter wall elements would be used. These estimated settlements greatly exceed the ¼ inch maximum value normally accepted by NYCT. NYCT approval for this work would not be expected to be granted.

The installation of a secant pile wall is also restricted because of the size of the site, limited access and the size of the equipment required. Secant pile walls are typically installed using a Bauer BG rig as shown on the attached catalog sheet, which requires about a 30 foot minimum width for the rig to operate. The rig size exceeds the 25ft width of Lot 14. The secant pile rig will not physically fit on Lot 14 and the existing soldier pile and lagging wall just west of Lot 14 is not designed to support the load imposed by a secant pile rig resting on the wall.

Alternative 2: In-situ Stabilization

In-situ stabilization consists of mixing cement and water with the in-situ soil to form a "solid" mass. The mixing is accomplished using soil mixing or jet grouting methods.

Soil-mixing utilizes a single or multiple auger assembly to mix cement and water with the in-situ soil. The cement and water is injected through the auger(s) at relatively low pressures. Because of the existing foundations and other obstructions at the site and the presence of cobbles and boulders in the soils, soil mixing with an auger system is not feasible.

Jet grouting is a system consisting of overlapping columns formed in the ground by mixing grout introduced at high pressures with the in-situ soil. The individual columns remain fluid until the grout sets. This system will displace a significant amount of contaminated soil from the ground which must be disposed of.

Because of the high pressures introduced into the ground and the large amount of in-situ soil displaced, there are many documented instances where the use of this system has resulted in significant settlement of adjacent structures. We do not believe this system is appropriate for use along the NYCT Substation or along the recently completed Building A foundations due to the potential risk of damaging existing structures.

Alternative 3: Containment within a Cutoff Wall

Containment/treatment of the contaminated soil within a cutoff wall also requires the installation of a new wall around the remediation area as shown on Attachment B (similar to Alternative 1). However, since this scheme does not require excavation of site soils, the wall would not have to support excavation and building loads and can be thinner and less stiff than for Alternative 1.

The cutoff wall for this alternative can consist of 8 to 12 inch diameter overlapping grout filled holes which can be drilled with a smaller rig (similar to that used to install mini-piles).

The installation of this wall type is feasible at Lot 14 with limited impact to Building A work. The wall installation methods will not impact the adjacent Building A or Substation foundations and approval of the system should be granted by NYCT.

Conclusions and Recommendations

FLS has investigated several soil remediation methods of which the three discussed in this letter would have some impact on adjacent structures.

Both Alternative 1, Complete Soil Excavation and Alternative 2, In-Situ Stabilization, present significant risks of settlement and/or damage to the adjacent NYCT Substation and Building A foundations and most likely would not be approved by NYCT. We do not recommend they be pursued.

Alternative 3, Containment within a Cutoff Wall, offers the least risk to adjacent structures and can be installed with equipment which can operate within the limited lot width. We believe NYCT will grant approval for this system.

Please do not hesitate to contact us should you have any questions.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS

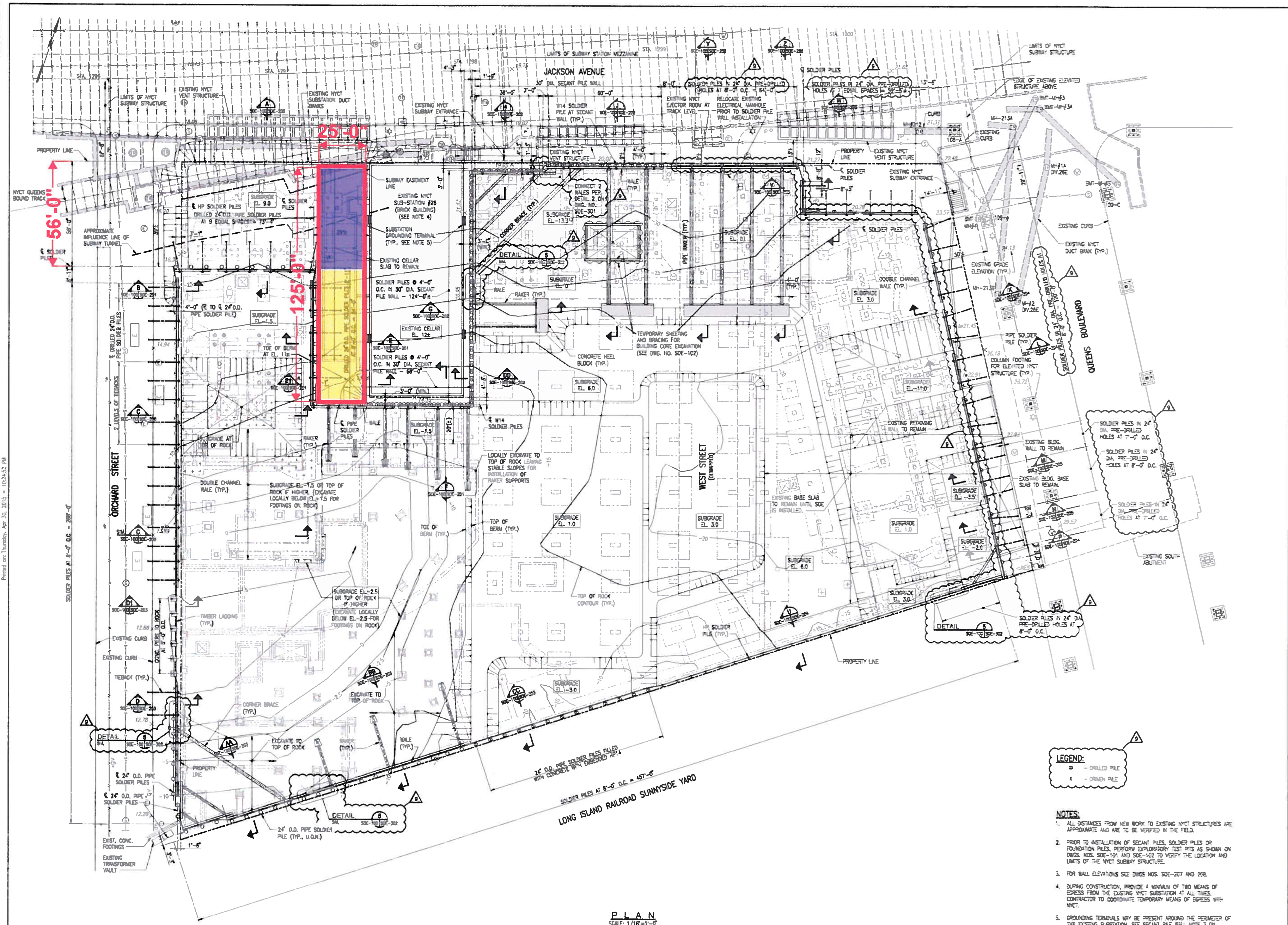
By: ______________________________
David M. Cac[illegible] P.E.

No. 073500

NYCT concurs with MRCE assessments

____
Mr. Rajen Udeshi Date
NYCT Outside Projects

DMC:f\106\10608\10608D\Soil Remediation Alternatives.docx



LEGEND:

⊕ - DRILLED PILE

x - DRIVEN PILE

NOTES:

1. ALL DISTANCES FROM NEW WORK TO EXISTING NYCT STRUCTURES ARE APPROXIMATE AND ARE TO BE VERIFIED IN THE FIELD.
2. PRIOR TO INSTALLATION OF SECANT PILES, SOLDIER PILES OR FOUNDATION PILES, PERFORM EXPLORATORY TEST PITS AS SHOWN ON DWGS. NOS. SOE-101 AND SOE-102 TO VERIFY THE LOCATION AND LIMITS OF THE NYCT SUBWAY STRUCTURE.
3. FOR WALL ELEVATIONS SEE DWGS NOS. SOE-207 AND 208.
4. DURING CONSTRUCTION, PROVIDE A MINIMUM OF TWO MEANS OF EGRESS FROM THE EXISTING NYCT SUBSTATION AT ALL TIMES. CONTRACTOR TO COORDINATE TEMPORARY MEANS OF EGRESS WITH NYCT.
5. GROUNDING TERMINALS MAY BE PRESENT AROUND THE PERIMETER OF THE EXISTING SUBSTATION. SEE SECANT PILE WALL NOTE 3 ON DRAWING NO. SOE-001.
6. PRIOR TO PERFORMING THE WORK, THE CONTRACTOR SHALL SUBMIT TO THE ENGINEER AND THE NYCT FOR APPROVAL THE DEWATERING SYSTEM DESIGN DRAWINGS. SEE DEWATERING NOTE 4 ON DRAWING NO. SOE-001 FOR ADDITIONAL INFORMATION.

LEGEND

🟥 TAX LOT 14

🟨 AREA TO BE REMEDIATED

🟪 REMEDIATION SATISFIED

ATTACHMENT A: SITE PLAN

NOTES

No.	Date	Revision
9	05-01-15	ADDITIONAL TA COMMENTS
8	04-16-15	REVISED SUBGRADES AND UPDATED SOE PER FOUNDATION PLANS OF 04-14-15 INCORPORATED NYCT COMMENTS OF 04-01-15
7	03-16-15	REVISED SUBGRADES AND UPDATED SOE PER FOUNDATION PLANS OF 03-04-15
6	02-17-15	REVISED SUBGRADES AND SOE
5	02-05-15	REVISED DRILLED SOLDIER PILES
4	12-19-14	INCORPORATED NYCT COMMENTS OF 12-15-14
3	12-15-14	INCORPORATED NYCT COMMENTS OF 12-09-14 & 12-11-14, DELETED TIEBACKS AT LIRR
2	12-05-14	INCORPORATED ADDITIONAL NYCT COMMENTS AND UPDATED SOE PER DEMOLITION PLANS OF 10-24-14
1	11-19-14	INCORPORATED NYCT REVIEW COMMENTS-UPDATED SOE PER FOUNDATION PLANS OF 11-6-14

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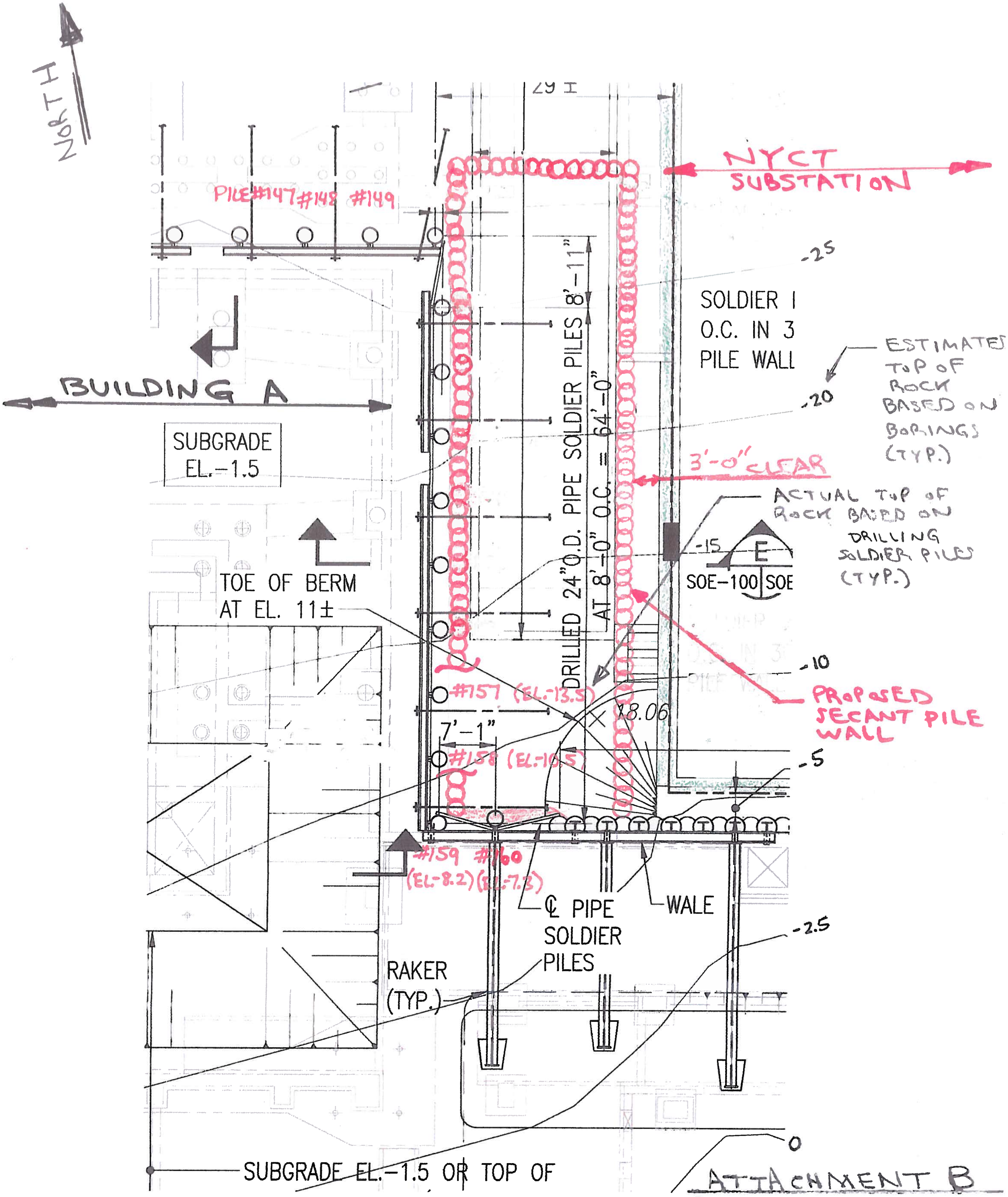
QPRD
LIC, NY 11231

SUPPORT OF EXCAVATION
GENERAL PLAN

SEAL & SIGNATURE

DATE 10-3-2014
SCALE AS NOTED
DRAWING BY B.B.
CHKD BY A.A.
DWG NO.
SOE-100

Printed on Thursday, Apr 30, 2015 - 10:24:52 PM



ATTACHMENT B

JOB#10608D

FROM SOE-100

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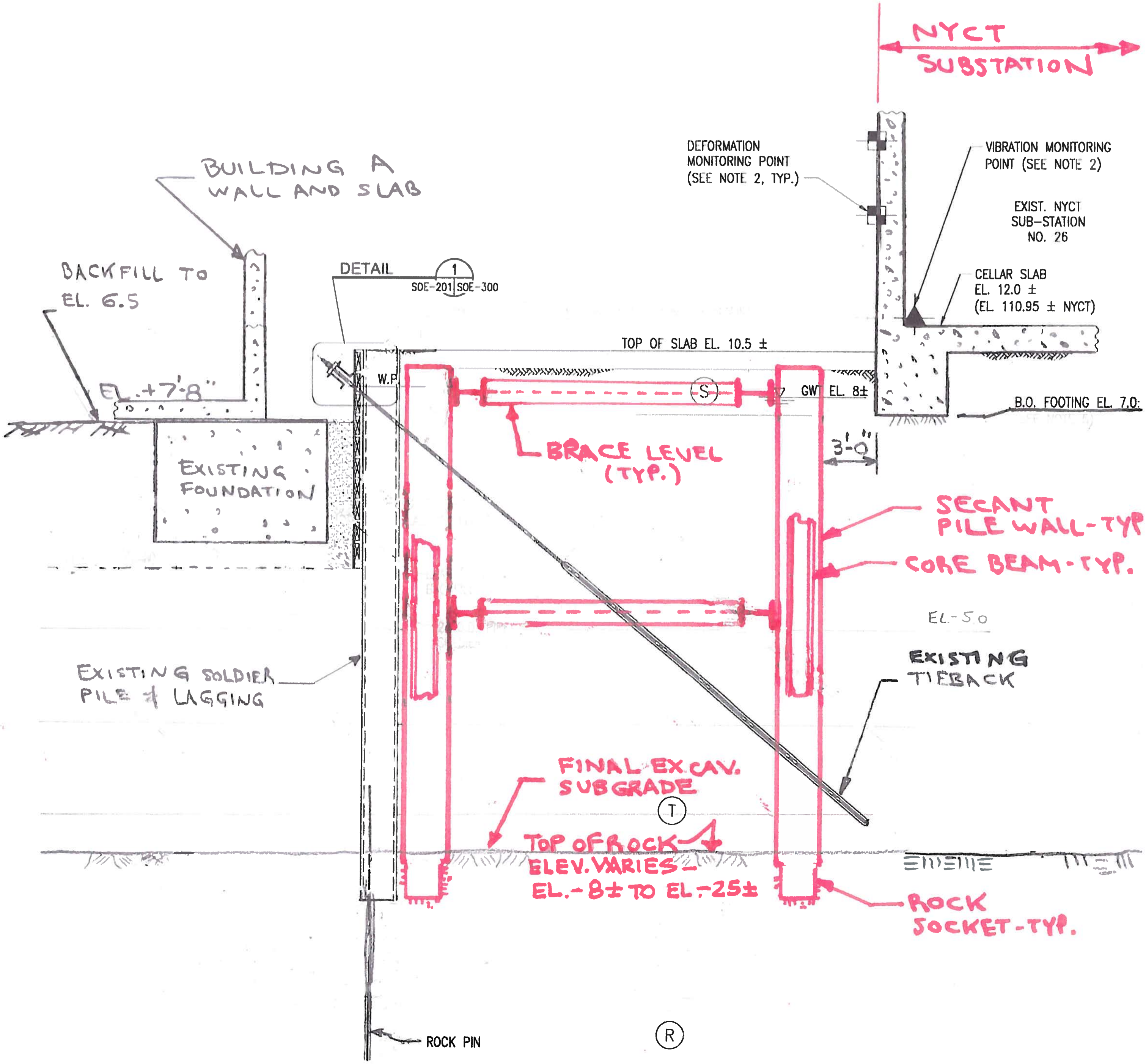


SECTION E
SCALE: 1/8"=1'-0"
SOE–100 SOE–101 | SOE–201

ATTACHMENT C
JOB #10608D
FROM SOE-201
SCALE: 1/8"=1'-0"

BAUER RIG

Abmessungen

Dimensions

Windenvorschub

Crowd winch type

Die **BG 28,** ein Gerät mit einem Einsatzgewicht von ca. 95 to und einem Drehmoment von 275 kNm dient zur Herstellung von

- verrohrten Bohrungen (Eindrehen des Bohrrohres mit dem Drehgetriebe oder mit angebauter Verrohrungsmaschine)
- unverrohrten, flüssigkeitsgestützten Bohrungen
- Bohrungen mit langer Hohlschnecke (SOB) - mit oder ohne Kellyverlängerung
- Sonderverfahren wie VdW-Bohren, Doppelkopfbohren ("verrohrtes SOB-Bohren"), Verdrängerbohrungen, Soil-Mixing Verfahren (SMW)

The **BG 28** rotary drilling rig has an operating weight of approx. 95 to and a torque of 275 kNm. It is ideally suited for:

- Drilling cased boreholes (installation of casing by rotary drive or optionally by hydraulic oscillator – both are powered by the drilling rig)
- Drilling uncased deep boreholes that are stabilised by drilling fluid
- Drilling boreholes with long hollow stem augers (CFA system), with or without kelly extensions
- Special drilling systems, such as FOW piles, double rotary head drilling ("cased CFA system"), displacement piles, soil mixing wall system (SMW)

Bohrverfahren mit Serienausstattung:

Kellybohren (ohne Verrohrungsmaschine)

SOB-Verfahren (hydraulisch und elektrisch vorgerüstet)

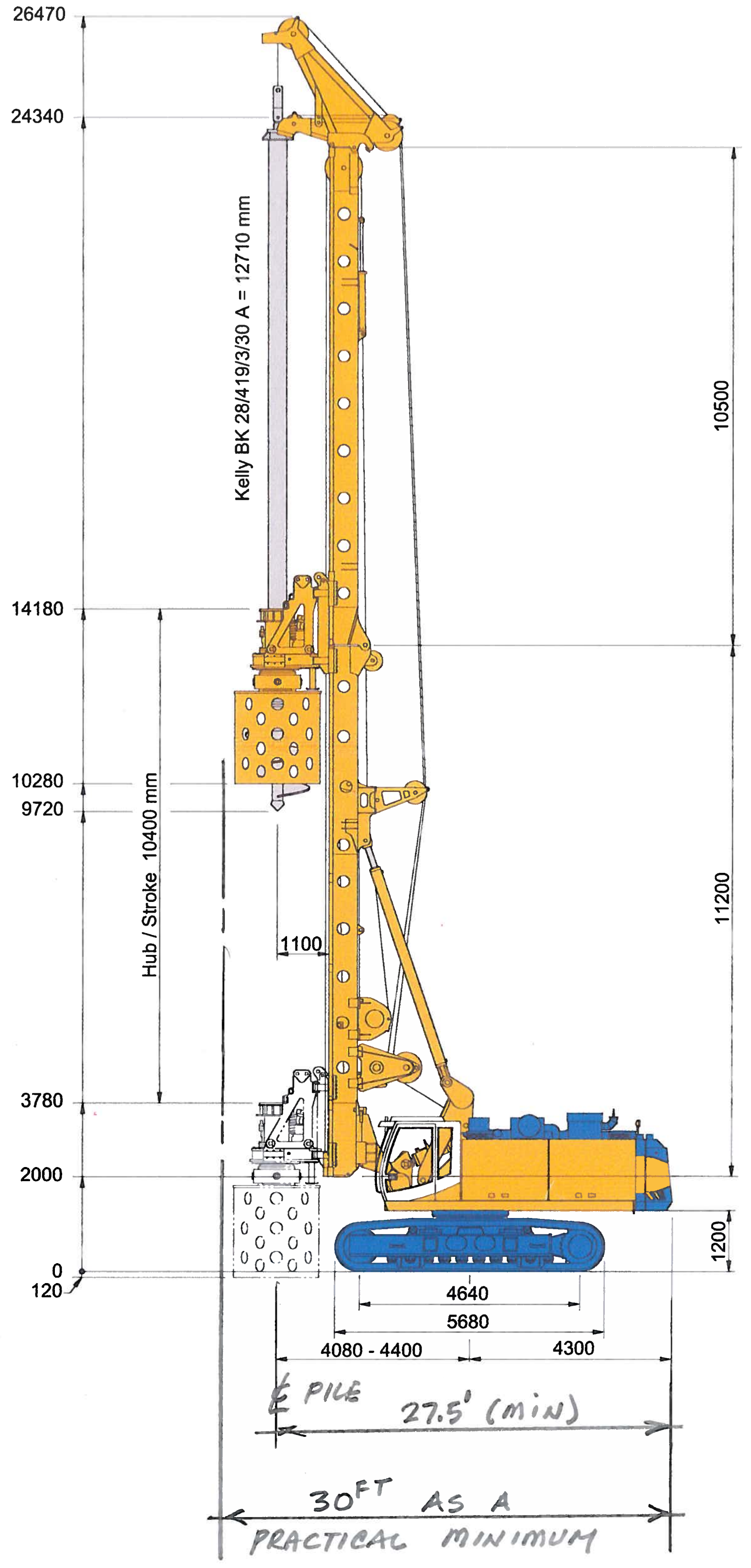
FDP Verdrängerbohren (hydraulisch und elektrisch vorgerüstet)

Drilling processes with standard equipment:

Kelly drilling (without casing oscillator)

CFA drilling (pre-equipped with hydraulic and electric installations)

FDP Full-Displacement-Piling (pre-equipped with hydraulic and electric installations)



℄ PILE

27.5' (MIN)

30 FT AS A PRACTICAL MINIMUM

APPENDIX D

Bench Scale Treatability Study

via E-Mail (steve@flemingleeshue.com)

October 20, 2015

Steven E. Panter, CGWP
Senior Consultant
Fleming-Lee Shue, Inc.
158 West 29th Street, 9th Floor
New York, NY 10001

RE: Bench-Scale ISCO Treatability Study Report
Queens Plaza Residential Development – Lot 14
Long Island City, Queens, New York

Dear Mr. Panter,

XDD Environmental (XDD) appreciates the opportunity to provide Fleming-Lee Shue, Inc. (FLS) with this report summarizing the results of the Bench-Scale In Situ Chemical Oxidation (ISCO) Treatability Study for the above referenced site. The bench testing is being performed in accordance with “Proposal for Bench Testing Services”, dated July 29, 2015.

If you have any questions regarding the information presented in this report, please do not hesitate to call me at 603.778.1100.

Sincerely,
XDD, LLC

Laurel Crawford

Laurel Crawford
Senior Scientist

cc: Michael Marley/XDD

Report

BENCH-SCALE IN SITU CHEMICAL OXIDATION TREATABILITY STUDY RESULTS

Queens Plaza Residential Development – Lot 14
Long Island City, Queens, New York

Prepared For:

FLEMING-LEE SHUE, INC.
158 West 29th Street, 9^{TH} FLOOR
NEW YORK, NY 10001

Prepared By:

22 MARIN WAY
STRATHAM, NEW HAMPSHIRE 03885
TEL: (603) 778-1100
FAX: (603) 778-2121

October 20, 2015

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1.0 INTRODUCTION

XDD, Environmental (XDD) was retained by Fleming-Lee Shue, Inc. (FLS) to perform a bench-scale evaluation of in situ chemical oxidation (ISCO) on soil and groundwater from the Queens Plaza Residential Development – Lot 14 located in Long Island City, Queens, New York (site). The bench scale tests are to evaluate the potential for select ISCO reagents to treat the impacted soil and groundwater at the site. Another goal of the bench testing was to identify an oxidant(s) that can be used near the existing building, infrastructure, and new foundation elements. XDD tested persulfate and hydrogen peroxide that have demonstrated compatibility as oxidants with nearby structures (i.e., concrete) at other sites.

The area targeted for treatment at the site covers an area of approximately 25 feet wide by 35 feet long. The target treatment area is impacted with creosote and petroleum in the saturated zone between 8 and 28 feet below ground surface (ft. bgs). Some chlorinated VOCs are also present. The soils consist of silty sandy fill material.

1.1 BENCH TEST APPROACH

XDD recommended that a phased bench scale test program be implemented to identify potential failure mechanisms via testing the site specific soil geochemistry and ISCO process chemistry. Phase 1 evaluated the stability and associated gas / heat evolution of hydrogen peroxide, and the soil oxidant demand (SOD) and stability of sodium persulfate. For activated persulfate, iron-chelate, alkaline-activated, and unactivated persulfate were evaluated during the Phase 1 tests. Based on the Phase 1 results, the preferred oxidant / reagent was selected for testing in Phase 2 to determine full-scale implementation design parameters. The addition of a surfactant to the oxidant of choice for the Phase 2 testing was also evaluated in the injection simulation testing.

2.0 EXPERIMENTAL PROCEDURE

The following contains a description of the general procedures followed for the tests conducted in this bench-scale evaluation.

2.1 SAMPLE HANDLING

The soil used in the ISCO bench tests was a composited sample from Lot 14 soil boring locations SB-4, SB-5, and SB-6. The groundwater samples were a composite of SB-5 / MW-5 and SB-6 / MW-6. All samples collected for treatability testing were stored at approximately 38 degrees Fahrenheit (°F) prior to use in the test reactors.

2.2 EXPERIMENTAL PROCEDURES

Unless otherwise specified, experiments were conducted at 70 °F in borosilicate-glass batch reactors. Approximately two pore volumes of reagent were applied to the soil unless otherwise noted. Aqueous phase residual oxidant concentrations for each ISCO technology were determined using iodometric titration. Geochemical parameters, such as pH, were determined using an ion selective probe.

2.2.1 EXPERIMENTAL PROCEDURES: ISCO PHASE 1

XDD evaluated the ISCO technologies in two phases to identify potential failure mechanisms via testing the site-specific soil geochemistry and ISCO process chemistry. The first phase, Phase 1, evaluated the acid buffering capacity, stability, and associated gas / heat evolution of hydrogen peroxide. Phase 1 also evaluated the SOD of persulfate, and the base buffering capacity of alkaline activated persulfate. Based on the Phase 1 results, the preferred oxidant, injection concentrations and buffering, catalyst, and/or stabilization agents are selected for testing in Phase 2 (i.e., injection simulation test) to aid in the determination of field implementation design parameters. The Phase 1 test procedures are discussed below.

2.2.1.1 Hydrogen Peroxide

For the hydrogen peroxide tests, XDD evaluated hydrogen peroxide and hydrogen peroxide stabilized with citric acid, as each method generates a unique chemistry that has been found to be advantageous under different site conditions. General procedures used for each test were as follows:

- ***Acid Buffering Capacity***: Various concentrations of sulfuric acid were added to separate duplicate vials containing 20 grams (g) of site soil. The concentrations varied from 0.1 grams per liter (g/L) to 20 g/L sulfuric acid. pH measurements were collected after 0, 3, 4, and 7 days of contact time between the sulfuric acid solutions and the soil. The quantity of acid required to lower and maintain the pH was assessed and calculated as grams of sulfuric acid per kilogram (Kg) of soil.
- ***Hydrogen Peroxide Stability***: The rate of decomposition of 7% hydrogen peroxide (w/w groundwater solution) with 30 g soil was assessed over 24 hours under different stabilizing and catalyzing conditions. Test conditions included three concentrations of citric acid (5 millimolar [mM], 20, mM, and 50 mM citric acid). In addition, duplicate control reactors using hydrogen peroxide and distilled water only (no soil) were evaluated as part of the hydrogen peroxide stability test. Residual hydrogen peroxide was monitored at several time points during the 24 hour test.

- ***Gas and Heat Evolution:*** Using the test conditions identified in the hydrogen peroxide stability tests, the rate of evolution of gas and heat during the decomposition of hydrogen peroxide was evaluated. Gas was collected and measured in a syringe.

2.2.1.2 Sodium Persulfate

For the persulfate tests, XDD evaluated unactivated, iron-chelate, and alkaline activation methods as each method generates a unique chemistry that has been found to be advantageous under different site conditions. The general procedures used for each test were as follows:

- ***Base Buffering Capacity***: Various concentrations of sodium hydroxide were added to separate vials containing 20 grams of soil. The concentrations varied from 0.1 g/L to 40 g/L sodium hydroxide. pH measurements were collected after 0, 3, 4, 7, and 14 days of contact time between the sodium hydroxide solutions and the soil. The quantity of base required to raise and maintain the pH above 10.5 was assessed (for alkaline activation of sodium persulfate) and calculated as g of sodium hydroxide per Kg of soil (mass loading).
- ***Persulfate Stability***: The stability of unactivated, alkaline activated, and iron activated sodium persulfate was evaluated by monitoring residual persulfate in duplicate reactors of two different concentrations of sodium persulfate (100 g/L and 200 g/L) dissolved into site groundwater in the presence of 30 g of soil. The decomposition of persulfate in the reactors was evaluated at time steps of 1, 7, and 14 days.
- ***Total and Soil Oxidant Demands***: SOD and total oxidant demand (TOD) were calculated using the data generated in the persulfate stability test by calculating the mass as g of oxidant consumed per Kg of soil in each reactor. TOD was considered to be the oxidant consumed in comparison to the baseline while SOD was the oxidant consumed in comparison to the control reactors containing activation chemicals.

2.2.2 EXPERIMENTAL PROCEDURES: ISCO PHASE 2

Following the completion of Phase 1 tests, the reagents and oxidant concentrations, including necessary stability and/or catalyst agents, were selected for the injection simulation tests conducted in Phase 2. As discussed in Section 3, alkaline activated persulfate was selected for the Phase 2 testing, based on the Phase 1 test results.

The injection simulation tests were set up in glass jars with site soil and groundwater with minimal headspace. The reactors, including the controls, were set up in duplicate. Two pore volumes of oxidant were tested at two concentrations (100 and 200 g/L). The test was designed to apply up to two doses of oxidant to the reactors. Each oxidant dose was allowed to contact the site soils and groundwater for approximately 10 days. For the “re-dose” test conditions, the residual oxidant was measured at the end of the single dose test duration and based on those measurements, a sufficient quantity of oxidant was added to bring the oxidant concentration in the reactors back up to the original starting concentration. The control reactors did not contain oxidant.

Two additional sets of the 200 g/L oxidant 10-day contact time reactors were set up: 1) one set including controls were submitted for quick turn-around time (TAT) laboratory analyses, and 2) a second set to test the addition of a surfactant, VeruSOL®, at 20 g/L. The set with the surfactant produced gas such that it had to be vented into a syringe to prevent breakage of the glass reactors. Therefore, a corresponding set of controls with attached syringe was set up (for VOCs analysis only). The Phase 2 test conditions are summarized in the table below.

Test Condition	**Soil Analyses**	**Groundwater Analyses**
<u>10-Day Test Period</u>		
Control	2	1
100 g/L Alkaline Activated Persulfate	2	1
200 g/L Alkaline Activated Persulfate	2	1
Control – Quick TAT*	2	1
200 g/L Alkaline Activated Persulfate – Quick TAT*	2	1
<u>20-Day Test Period</u>		
Control	2	1
100 g/L Alkaline Activated Persulfate Re-Dose	2	1
Control - Surfactant**	2	1
200 g/L Alkaline Activated Persulfate Re-Dose	2	1
200 g/L Alkaline Activated Persulfate – with VeruSOL®**	2	1
TOTAL	**20**	**10**

*At the request of FLS, a quick turn-around time (TAT) test condition with controls was submitted for laboratory analyses. ** Due to the amount of gas produced, a syringe was attached through the septum of the VOCs reactors to prevent breakage.

Baseline conditions were evaluated by FLS in site groundwater and soil prior to developing the injection simulation test setup. For each test condition, duplicate soil and single groundwater samples were submitted for laboratory analysis of the following:

- volatile organic compounds (VOCs) using United States Environmental Protection Agency (EPA) Target Compound List (TCL) Method 8260
- semi-volatile organic compounds (SVOCs) using EPA TCL Method 8270

- total petroleum hydrocarbons (TPH) diesel range organics (DRO) by EPA Method 8015

Absolute Resource Associates (ARA) located in Portsmouth, NH performed the analyses associated with the 10-day test conditions. As a result of the availability for TAT and at the request of FLS, Accutest Laboratories (Accutest), located in Dayton, NJ performed the analyses for the surfactant and 20-day test conditions.

3.0 RESULTS AND DISCUSSION

The results of Phase 1 and Phase 2 bench scale tests are presented and discussed in this section.

3.1 ISCO PHASE 1 TESTS

The ISCO Phase 1 tests are intended to evaluate the effects of the site geochemistry on the ISCO process technology. XDD evaluated hydrogen peroxide and persulfate in the Phase 1 tests.

3.1.1 HYDROGEN PEROXIDE

3.1.1.1 Acid Buffering Capacity

Results from the acid buffering capacity are presented in Figure 1. Test results indicated that the test condition with the highest concentration of acid was not sufficient in lowering the pH to the desired range of pH 3 to 4 for hydrogen peroxide. The highest loading of sulfuric acid, 20 g/L, or 5.5 g sulfuric acid per kg of soil, resulted in a pH 6.5.

3.1.1.2 Hydrogen Peroxide Stability

The 7% hydrogen peroxide stability tests are shown in Figure 2 and the resulting half-lives based on pseudo-first order kinetics are shown on Table 1. The 7% hydrogen peroxide without a stabilization agent decomposed quickly; almost no hydrogen peroxide remained after the first few minutes of contact with the soil and groundwater. The addition of citric acid as a stabilizer did not significantly decrease the rate of decomposition of hydrogen peroxide. As shown in Table 1, the addition of increasing amounts of citric acid had minimal effect on the half-life of hydrogen peroxide, each resulting in half-lives of less than 1 hour. Half-lives of at least 15 hours are ideal in a field application in order to give the hydrogen peroxide enough time to be distributed from the injection point. The observed minimal stability of hydrogen peroxide and high acid demand, depending upon site design parameters, could be considered a potential failure mechanism for the field application of hydrogen peroxide at this site.

3.1.1.3 *<u>Gas and Heat Evolution</u>*

The decomposition of hydrogen peroxide and degradation of organic material both have the potential to generate gases. The rate at which gases evolved from the various systems in the hydrogen peroxide stability testing was quantified and the results are presented in Figure 3. The data show that a majority of the test conditions resulted in the evolution of a significant quantity of gas within the first few minutes of the test. The addition of 50 mM citirc acid slightly decreased the rate of evolution and the quantity of gas.

Heat evolution was also monitored during the tests, as the evolution of heat is possible during the application of hydrogen peroxide. The results of the heat evolution measurements are presented in Figure 4. The data show that a significant amount of heat rapidly evolves from the hydrogen peroxide test conditions within the first several minutes of the test.

The amount of gas and heat generated from hydrogen peroxide in contact with the site soil and groundwater could be considered a potential failure mechanism for the field application of hydrogen peroxide at this site.

3.1.2 SODIUM PERSULFATE TESTS

3.1.2.1 *<u>Base Buffering Capacity</u>*

Results from the base buffering capacity test are presented in Figure 5. Test results indicated that after 14 days of contact between the sodium hydroxide solution and the soils, 1.2 g of sodium hydroxide per Kg of soil was required to elevate the pH to greater than pH 10.5. A field design needs to consider upscaling these results to the field. The reaction will likely be a function of the surface area contacted by the reagents. The surface area contacted in the bench scale is likely higher per Kg than will be required in the field.

3.1.2.2 *<u>Persulfate Stability</u>*

The persulfate stability test evaluated the persistence of unactivated, iron activated, and alkaline activated persulfate in the presence of site soil and groundwater. The test evaluated persulfate in reactors with initial target concentrations of 100 g/L and 200 g/L sodium persulfate dissolved in site groundwater in contact with site soil for each activation method (Figure 6). The data show that unactivated, iron activated, and alkaline activated persulfate persisted in site soil for the 14 day period tested. Given the residual concentrations at the end of 14 days, it is reasonable to expect treatment to occur for greater than 14 days. While some phases of contamination may require additional contact time, 14 days is considered to be sufficient to adequately distribute the oxidant and establish contact with readily available contamination. Also, iron activated and alkaline activated persulfate systems generally resulted in lower residual concentrations of sodium persulfate than the unactivated persulfate system.

3.1.2.3 Total and Soil Oxidant Demand

Results from the TOD and SOD tests after 14 days of contact with 100 g/L and 200 g/L persulfate for the unactivated, iron activated, and alkaline activated systems are presented in Table 2. The data show that the SOD ranges from 17 to 28 g/Kg for the unactivated persulfate system. TOD ranges from 15 to 25 g/Kg for the iron activated system and 33 to 58 g/Kg for the alkaline activated system. The TOD and SOD results are in the typical ranges observed at sites. It is common to have SOD and TOD increase with increasing persulfate concentrations.

TOD and SOD are intended to be an estimation of the mass of oxidant that will be consumed during the application of activated persulfate in site groundwater and soil. TOD is intended to include decomposition of oxidant based on the activator as well as SOD. TOD tends to be used most often as a design engineering parameter. SOD is intended to estimate the role of non-target reactions with natural organic material and mineralogy. As unactivated persulfate does not have oxidant demand due to an activator, TOD and SOD are theoretically the same, with any difference due to the method of calculation.

3.2 PHASE 2 TESTS: INJECTION SIMULATION

Based on the Phase 1 test results, hydrogen peroxide is considered inappropriate for a field application at this site due to the high acid buffering capacity of the soil, and the very short half-life of the peroxide in contact with the site soils and the associated heat, and gas evolution measured. Therefore, alkaline activated persulfate was selected for the Phase 2 injection simulation tests. Alkaline activated persulfate is known to successfully degrade the contaminants found at this site, and has been used successfully at similarly contaminated sites.

3.2.1 ISCO TREATMENT EFFECTIVENESS

The injection simulation test results are discussed below. Results are shown on Tables 3 through Table 6, with analytical laboratory reports attached in Appendix A.

The analytical data for VOCs is presented on Tables 3 and 4 for groundwater and soil, respectively. The analytical data for SVOCs and TPH-DRO is presented on Tables 5 and 6 for groundwater and soil, respectively. The percent reductions in concentrations compared to the control reactors are also shown. The sample detection limit was used for compounds reported as non-detect. It should be noted that the percent reduction calculations can be skewed if the sample had to be diluted for the analysis, yielding higher detection limits that get factored into the calculations. The data are summarized in the table below:

Test Condition	**VOCs**		**SVOCs**		**TPH-DRO**	
	% Reductions		**% Reductions**		**% Reductions**	
	Groundwater	**Soil**	**Groundwater**	**Soil**	**Groundwater**	**Soil**
10-Day Test Period						
100 g/L AAP	76	44	88	N/A	76	N/A
200 g/L AAP	88	47	68	N/A	48	N/A
200 g/L AAP - Quick TAT[1]	45	7	N/A	57	45	49
20-Day Test Period						
100 g/L AAP Re-Dose	89	73	45	41	68	55
200 g/L AAP Re-Dose	97	98	N/A	80	62	89
200 g/L AAP - Surfactant[2]	98	94	N/A	65	82	71

VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds
TPH-DRO = total petroleum hydrocarbons - diesel range organics
g/L = grams per liter
AAP = alkaline activated persulfate
N/A = not applicable, the data indicated no reduction in concentrations compared to the control; therefore, a degradation ratio could not be calculated.

[1] At the request of FLS, a quick turn-around time (TAT) test condition with controls was submitted for laboratory analyses.

[2] A surfactant, VeruSOL, was added to the reactors at 20 g/L for this test condition.

[3] Percent reductions were calculated for the detected compounds by comparison with the control.

At the end of the reaction periods for all test conditions, 16% or more of the persulfate remained, indicating that treatment would continue beyond the time when the data was collected. The 200 g/L test condition with the surfactant utilized most of the oxidant compared to the other test conditions, with 16% persulfate remaining at the end of the test. With the exception of the 200 g/L test condition with surfactant, the pH of the alkaline activated persulfate for all test conditions remained above 10.5 (the optimal pH for alkaline activated persulfate) throughout the test. The pH of the test condition with surfactant had to be adjusted periodically by adding sodium hydroxide to keep the pH above 10.5. The test results and residual oxidant suggest that further treatment of the contaminants would occur with additional treatment / contact time.

The degradation ratio is a ratio of the mass of oxidant consumed during the reaction divided by the mass of contamination degraded as compared to the control reactors. As shown in Table 7, the degradation ratios for VOCs were higher than those for the SVOCs and TPH-DRO. This is to be expected since VOCs reductions in soil and groundwater were greater than for SVOCs and TPH-DRO. The degradation ratios calculated for VOCs range from 498 to 4,952, for SVOCs range from 38 to 103, and for TPH from 10 to 22 gram oxidant per gram contaminant. The degradation ratios are not cumulative but reflect the amount of oxidant used to meet the measured reductions for each of the contaminant analytical methods used. The ranges determined from the bench testing are used in conjunction with field experience in the selection of the dosing required to meet the regulatory cleanup goals in the full-scale field application design.

Acetone, 2-butanone, and bromomethane were also detected in groundwater for some of the test conditions. These compounds are often measured in groundwater initially following the application of ISCO and typically are not present in samples collected in field performance monitoring several months after field applications. As acetone was also present in one of the controls, it is also possible it was an impurity or analytical contaminant.

3.2.2 CHEMICAL COMPATIBILITY OF ALKALINE ACTIVATED PERSULFATE

One of the concerns to be addressed prior to an ISCO field application at the site is the chemical compatibility of proposed oxidant with nearby buildings, infrastructure, and foundation elements. XDD has gathered data regarding the chemical compatibility of alkaline activated persulfate with steel and concrete from the persulfate vendor. The chemical compatibility data produced by FMC (manufacturer of sodium persulfate) is included in Appendix B. The major findings are as follows:

- “High pH activated Klozur” (i.e., alkaline activated persulfate)
    - Carbon Steel: FMC has rated alkaline activated persulfate as compatible with carbon steel [<2 milli-inches per year (mpy) of corrosion].
    - Concrete: FMC noted that concrete gained weight and had a bleached appearance after contact with alkaline activated persulfate. It was rated as neither compatible nor non-compatible.
- Unactivated persulfate. A site may have residual unactivated persulfate if the pH decreases to below pH 10.5 while there is still residual persulfate at the site.
    - Carbon steel: FMC rated carbon steel as non-compatible observing corrosion at rates from < 20 mpy to > 200 mpy.
    - Concrete: FMC again noted weight gain and a bleached appearance.

There are several options that can help minimize the corrosive effect on the steel support piles, if deemed necessary. These include:

- Injecting potable water, potentially containing a persulfate scavenger, in close proximity to the building structural supports to maintain a hydraulic gradient between the supports and injection wells.
- Using a recirculation system to inject the reagents where water would be extracted near the steel support piles supports to minimize the potential for the active reagents to contact the supports.
- Extracting the reagents in their entirety shortly after the injection event to minimize contact time with the steel support piles.

4.0 CONCLUSIONS

The bench scale data support the following conclusions:

- Phase 1 ISCO Tests:
  - Hydrogen Peroxide: The results from the Phase 1 tests for hydrogen peroxide indicate several parameters could present issues in a field scale application. Specifically, the stability of the hydrogen peroxide may limit the time for the reagents to be distributed within the subsurface. The evolution of heat could impact equipment and increase the rate of autodecomposition of the hydrogen peroxide. Gases that evolve at a rate greater than they can dissipate could form pockets in the subsurface preventing distribution of the reagents. Due to these potential issues, it was decided to eliminate hydrogen peroxide from consideration for field application at this site.
  - Persulfate: The base buffer capacity, stability of the persulfate, and SOD/TOD were within typical ranges for a potential field application. Based on the Phase 1 test results and prior experience at similar sites, alkaline activated persulfate was selected for the Phase 2 testing.
- Phase 2 ISCO Injection Simulation Tests:
  - Compared to the SVOCs and TPH results, the VOCs results showed the greatest reductions in soil and groundwater concentrations, with greater reductions observed for the 20-day test conditions.
  - Reductions in SVOCs concentrations were variable, ranging from no reduction compared to the controls to up to 88% reduction in groundwater concentrations and 80% reduction in soil concentrations. It is expected that additional reductions in compound concentrations would occur with additional contact

time since significant persulfate remained at the end of the 10-day and 20-day test periods.

  - Reductions in TPH-DRO improved with longer contact time with the oxidant, with up to 82% and 89% reductions measured in groundwater and soil, respectively.
  - The 200 g/L test conditions with and without surfactant showed similar reductions in groundwater and soil VOCs concentrations. Both test conditions also showed similar results for TPH-DRO reductions, with 62% or greater reduction in soil and groundwater measured. The surfactant test condition showed higher groundwater concentrations of SVOCs compared to the control and reductions in soil SVOCs were 65%. Since the test condition without surfactant performed as well or better than the test condition with surfactant, there appears to be little value to adding a surfactant to the field application of ISCO at this site.
  - Degradation ratios were highest for the VOCs, which is expected since the VOCs results showed the greatest reductions compared to the SVOCs and TPH-DRO. The degradation ratio is a tool used to aide in the design of the field application.

5.0 RECOMMENDATIONS

Based on the Phase 1 and Phase 2 bench scale test results, alkaline activated persulfate is the recommended oxidant technology for field scale application for this site for the following reasons:

- Stability over the test period was acceptable.
- SOD/TOD were within typical ranges observed at other sites.
- The technology was effective in treating the contaminants of concern at the site and additional treatment would be expected in the field with a longer contact period than used in the bench testing.

5.1 FIELD APPLICATION DOSING

It is estimated that a contaminant mass of 1,200 lbs is present within the target treatment area. Based on the bench test results (calculated SOD and degradation ratio), a maximum oxidant injection concentration of 300 g/L, there is a moderate to high certainty that a second application will be required to reduce TVOC mass in groundwater by 90 percent within the treatment area. The first application will include the injection of up to 22,040 lbs of sodium persulfate at an injection concentration of approximately 300 grams per liter (g/L) with approximately 8,000 lbs of 100% sodium hydroxide (NaOH). The oxidant mass required for a second application, if necessary, will be based on performance monitoring following the preliminary ISCO application. The treatment dosing was calculated based on the following assumptions:

- An estimated mass of 1,200 lbs TPH-DRO in the treatment area.
- SOD test results indicate a non-target demand of 27 g/kg for persulfate concentrations of both 100 g/L and 200 g/L. Therefore, it is assumed that a SOD value of 27 g/kg is applicable for AAP applied at 300 g/L.
- It is expected that both the non-target demand as well as the base buffering capacity of the soils will be overcome during the preliminary application. Therefore, it is likely that less oxidant and activator (NaOH) will be required for a second application, if required.
- An estimated 75 percent of one pore volume will be injected for each application.

Figures

Tables

Appendix A

Laboratory Analytical Data Reports

Appendix B

FMC Klozur Corrosion and Material Compatibility Technical Bulletin

APPENDIX E

Stormwater Pollution Prevention Plan

Queens Plaza Residential Development – Site B
Brownfield Cleanup Program (BCP) No. C241151
Long Island City, NY

STORM WATER POLLUTION PREVENTION PLAN

LIC Development Owner, LP
c/o Tishman Speyer
45 Rockefeller Plaza
New York, New York 10111

Project Number: 10112-004

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 2
47-40 21st Street
Long Island City, NY 11101-5407

Arnold F. Fleming, P.E.

November 2014

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APPENDIX

FIGURES

1.0 INTRODUCTION

1.1 PURPOSE OF STORM WATER POLLUTION PREVENTION PLAN

This Storm water Pollution Prevention Plan (SWPPP) was prepared by Arnold F. Fleming, P.E. to address conditions as specified in the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) General Permit for Storm water Discharges from Construction Activity (Permit GP-0-10-001). The SWPPP was developed according to the current New York State Storm Water Management Design Manual and the New York Standards and Specifications for Erosion and Sediment Control. The SWPPP describes the measures for controlling runoff and pollutants during the implementation of the proposed soil remediation of the Queens Plaza Residential Development – Site B (the "Brownfield Site"). Note that the Site area is less than 1 acre and technically is outside the jurisdiction SWPPP requirements. This plan is prepared for the sake of completeness and to support best management practices.

The Brownfield Site is in the NYSDEC Brownfield Cleanup Program (C241151). LIC Development Owner, L.P. (the "Volunteer") is a contract vendee and the BCP Volunteer. The Brownfield Site remediation will be conducted in accordance with the approved Interim Remedial Measure Work Plan (IRMWP). The objectives of the SWPPP include the following:

- Reduction and minimization of erosion during and after remediation and sediment loading of storm water entering or exiting the Brownfield Site during remediation activities
- Control and reduction of storm water entering the Brownfield Site during excavation and remediation
- Control of the volume and peak rate of runoff during and after remediation
- Maintenance of storm water controls before, during and after remediation.

In order to comply with the SPDES General Permit for storm water Discharges from Construction Activity Permit, the SWPPP identifies potential pollution sources that could affect the quality of storm water discharges during remediation. The SWPPP also identifies controls and practices that will be used during and after remediation to minimize runoff, reduce pollutants in discharges, and establish compliance with terms and conditions of the SPDES permit.

The storm water pollution prevention devices and practices described in this document and in the remediation documents will provide effective attenuation and removal of sediments and pollutants in storm water runoff during remediation at the Brownfield Site.

The improvements are designed to control the rate, the volume, and the sediment/pollutant loading of storm water discharges during and after the proposed remediation. Proper implementation of this SWPPP will result in compliance with the provisions of the General Permit GP-0-10-001.

1.2 IMPLEMENTATION OF STORM WATER POLLUTION PREVENTION PLAN

The Contractor will be responsible for complying with all conditions and requirements of this SWPPP, in addition to the conditions of the General Permit GP-0-10-001. The Contractor shall keep all remediation activities under surveillance, management and control to avoid pollution of surface waters and groundwater. The Contractor will be required to submit a Method of Erosion Control and a final Site-specific Erosion and Sediment Control Plan. The Contractor will be required to initiate and maintain erosion controls before and during remediation to prevent siltation of any affected collection basins, manholes, channels, combined sewers, storm sewers, down gradient properties, or receiving waters, as well as any public right-of-ways. In the event that the temporary controls implemented by the Contractor prove to be ineffective or inadequate in controlling sediment and erosion at the Brownfield Site or otherwise unacceptable, the SWPPP will be modified accordingly and the Contractor will then be required to make the appropriate modifications or additions at the remediation site. Furthermore, if a new Contractor or Subcontractor assumes responsibility for implementing any portion of the SWPPP or if there is a significant change in design, remediation, operation or maintenance that was not considered or addressed in the SWPPP, the SWPPP shall be revised to include the relevant information and controls. If significant changes are made, the revised SWPPP will be certified and resubmitted to the NYSDEC for review and approval.

1.3 PROJECT DURATION

Remediation/demolition is anticipated to begin in August 2014 and terminate in December 2015.

2.0 PROJECT DESCRIPTION

2.1 PRE-REMEDIATION SITE CONDITIONS

The Brownfield Site is in the Brownfield Cleanup Program (BCP) and is listed as BCP Site No. C241151. LIC Development Owner, L.P. (the "BCP Volunteer") is a contract vendee and the BCP Applicant. The Brownfield Site B consists of two and three-story buildings, and one 5-story building: Buildings 3A, 3B, Building 4, and a small open area known as Area F. The Brownfield Site is also a New York City "E" Designated site. The Site is currently vacant.

The Brownfield Site is in Long Island City, Queens County, New York and encompasses a trapezoid-shaped parcel bounded on the north by the Queens Plaza Residential Brownfield Site A. (C241105) and Jackson Avenue. On the west, Brownfield Site B abuts Orchard Street, a mapped and dedicated city street. The southern boundary of Site B is the Long Island Rail Road (LIRR) Sunnyside Yard property. The eastern side of Brownfield Site B abuts Queens Boulevard. Figure 1 presents a Brownfield Site Location Map and Figure 2 presents a Brownfield Site Plan. This SWPPP applies to the Brownfield Site, which covers approximately 1.89 acres.

Historically, chemical manufacturing/storage was the principal activity on the Brownfield Site. The former owner, West Chemical Company, manufactured soaps, disinfectants, floor waxes and other household and industrial cleaners and products. Creosote was used in large quantities as a disinfectant and creosote spills represent the most significant contamination of the Brownfield Site's soil and groundwater. Creosote has impacted soils and formed a contaminated zone atop the bedrock and till layers at depth. Chlorinated solvents appear in soils and groundwater at lower levels.

The surrounding properties are primarily used for light manufacturing and/or commercial purposes, with sporadic residential use. To the south is the LIRR Sunnyside Yard, which is a major train repair and service center. The Brownfield Site was historically zoned as "M1-6/R10 Light Manufacturing," until the 2001 Long Island City rezoning changed the classification to M1-6/R10 under the special Long Island City Mixed Use District, allowing high density commercial, retail and residential development on the Brownfield Site.

2.1.1 Drainage

The Brownfield Site is currently served by the New York City combined sewer located in Orchard Street. Storm water inlets are located in various locations on the Brownfield Site. The Brownfield Site is paved with concrete/asphalt, and there is no storm water infiltration. No off-Site discharges have been noted during significant rainfall events.

2.1.2 Geology and Hydrogeology

The Brownfield Site is located on gently sloping land with a surface elevation of approximately 13.6 feet relative to the North American Vertical Datum 88 (NAVD88). The generalized subsurface profile consists of fill overlying silty sand and glacial till, with bedrock below the till. A bedrock elevation contour map is shown as Figure 3.

Surface soils consist of a fill layer approximately 5 to 9 feet in thickness. This fill is a mixture of fine to medium sand, with some silt and gravel and traces of brick, cinders, concrete, cobbles, and wood. The fill is underlain by silty sand and glacial deposits followed by a layer of fine sand with intermittent seams of silt and clay. Thicker layers of varied silt and clay are present within this sand unit in some locations on the Brownfield Site. The sand layer varies in thickness from approximately 5 to 7 feet. Additionally, a till layer is present over most of the Brownfield Site beginning from approximately -0.4 to -9 feet NAVD88and extending to the top of bedrock at elevations of approximately -2 to -12 feet NAVD88. Based on soil boring data from previous investigations, bedrock at the Brownfield Site is gneiss.

Groundwater occurs within the unconsolidated geologic materials covering the Brownfield Site. The upper surface of the groundwater reservoir is marked by the groundwater table, which fluctuates seasonally in response to precipitation. The groundwater table elevation ranges from approximately 9 feet to 11 feet NAVD88 over most of the Brownfield Site. Groundwater flow direction is predominantly to the south-southwest. Figure 5 shows the direction of groundwater flow on the Brownfield Site.

No surface water bodies exist on the Brownfield Site. The closest surface water body is the Dutch Kill coming from the Newtown Creek, located approximately 1,600 feet south of the Brownfield Site, and the East River approximately 4,200 feet to the west.

2.1.3 Results of Previous Investigations

Previous investigations found that soil contamination originated predominantly from creosote spills and to a lesser extent from petroleum-based spills. The sources of these spills are greatest near where the material was stored and processed on Brownfield Site A, immediately north of Brownfield Site B.

Creosote spills impacted soils in the form of a smear zone and deeper soils in the form of residual DNAPL. Creosote has migrated through soil and possibly over the bedrock surface to where it has entered the basement of Building 4. Creosote covers the floor and some portion of the basement walls in Building 4. Comparatively fewer soil borings have been completed on Brownfield Site B because buildings cover most of the Site. For this reason, the understanding of contamination on Site B is limited.

2.2 INTERIM REMEDIAL MEASURE WORK PLAN

The elements of the proposed remediation (i.e. excavation, dewatering, sheeting and shoring etc.) for the Brownfield Site will be implemented during remediation. The remediation will be phased so as to minimize the exposure of soils underneath the current building slab and prevent sediment and pollutant runoff from occurring.

2.2.1 Remediation Phasing

The Interim Remedial Measure will consist of the following elements:

- Installation of site fencing
- Installation of stabilized remediation entrance

- Demolition of existing building
- Installation of a containment structure
- Installation of temporary sheeting and shoring
- Installation of berm along the Site perimeter
- Excavation
- Dewatering
- Remediation of building foundations
- Site Paving

2.2.2 Excavation

The method is to excavate and load soil (and debris) directly into trucks for disposal at off-Site facilities without stockpiling; however, some temporary stockpiling within the excavation may be necessary based on the availability of transport vehicles. There is insufficient space to routinely stockpile and segregate large volumes of soil and direct loading is the most effective means to meet the remediation schedule and control potential odors. Soil will be removed using appropriate or otherwise suitable excavation equipment. The excavation of OU-1, where creosote or petroleum contamination is anticipated, will be performed within an engineered containment structure designed for constant negative air pressure to contain odors. The area covered by the containment structure may be expanded based on the Remedial Investigation data.

Soil will be excavated over the entire BCP Site area and loaded directly into trucks for off-site disposal whenever possible. Soils not anticipated to be contaminated by petroleum or creosote may be excavated outside of a containment structure, if feasible, but may still require alternative odor control measures. This decision will be made in conjunction with the Department. Soils not anticipated to be contaminated by petroleum or creosote may be excavated outside of a containment structure, if feasible. Any soil stockpiled outside a containment structure will be placed upon plastic sheeting and covered with plastic sheeting at the end of each day. Soils stockpiled within the containment structure will be placed on plastic sheeting but not covered. At the conclusion of each work day, exposed contaminated soil within the containment structure will be covered with plastic and/or long-duration foam and then the air handling system will be turned off.

2.2.3 Temporary Sheeting, Shoring and Underpinning

Within the Brownfield Site, a combination of sheeting, shoring, and underpinning will stabilize the excavation. Shoulder beams and lagging will be constructed along the Brownfield Site perimeter accessible to the public (along Orchard Street and along the southern perimeter where there are no adjacent building foundations). Underpinning will be used to support the foundations of the buildings that abut the eastern, northern and southern boundaries of the Brownfield Site. Where excavation is shallow, slope stabilization, slope cuts (1:1 or 2:1, as necessary) or other acceptable means may be used where sheeting and shoring are unnecessary.

2.2.4 Permanent Sheeting

It is possible that NAPL could migrate back into the remediated OU-1 area from sources outside the Brownfield Site. A means of preventing re-contamination of the remediated areas is therefore necessary. Three methods of preventing re-contamination will be used depending on the structures and nature of the contamination near them. Steel sheeting will be used where there is insufficient space to drive the sheet piles and where the structures can sustain the vibration and pounding. Where these conditions cannot be met, the approach will be to use underpinning of the structures. If foundation walls extend to bedrock, then these will be left in place to control migration, if conditions warrant.

2.2.5 Containment Structure

Creosote is responsible for most of the impacts and generates strong odors. Consequently, soils in the Brownfield Site must be excavated beneath an enclosure (OU-1) so that odors can be controlled. The enclosure(s) may be a sprung structure, scaffolding, or an enclosure formed by tarps or plastic coverings attached to adjacent buildings, or a hybrid. The enclosure will be sufficiently large to accommodate excavation equipment and accommodate truck loading and will have air exchange with filtering. Other areas may require excavation within an enclosure if warranted by excessive odors or VOC levels. This decision will be made based on field conditions.

2.2.6 Dewatering

Dewatering will be used as necessary in OU-1 to complete the work and excavate to the desired depths. Water will be pumped from the excavation to temporary well points placed on the perimeter of the Brownfield Site in the sheeting excavation. Groundwater will then be pumped to a treatment suite consisting of settling tanks to remove suspended solids, a separator to remove any free product, and granular activated charcoal (GAC) units to remove dissolved organic contaminants. From there the water will be discharged to the New York City combined sewer through a connection to the existing sewer line on Orchard Street. Discharge will comply with New York City Department of Environmental Protection (NYCDEP) permit requirements. No dewatering liquids will be discharged back into the excavation. No dewatering is anticipated in OU-2.

3.0 PROPOSED STORM DRAINAGE CONDITIONS

The proposed storm drainage system will be adapted to Site conditions as the Brownfield Site is developed.

Existing Conditions

The Brownfield Site is currently served by the New York City combined sewer located in Orchard Street. Storm water inlets are located on the Brownfield Site as shown on Figure 5.

Remediation

The anticipated storm water control and remediation sequencing at the Brownfield Site is described below. If changes are made to the remediation sequencing, the SWPPP will be adapted as necessary.

1. Prior to beginning excavation, install a security fence around the perimeter of the Brownfield Site open to public access. A temporary asphalt berm will be installed around the outer perimeter of the Brownfield Site along Orchard Street, preventing storm water from entering the Brownfield Site from off-Site sources.
2. Paving will be removed across the Brownfield Site, to bring the Site elevation below sidewalk elevation, preventing storm water from leaving the Brownfield Site. If necessary, during this process, storm water will be collected on-Site and pumped into a baker tank, and then pumped into the New York City combined.
3. The entire perimeter of the Brownfield Site along Orchard Street will be sheeted, outside the property line on the sidewalk. The area between the property line and the proposed sheeting will be excavated to facilitate sheeting installation. Temporary well points will be installed in this excavation at various points around the Brownfield Site to collect storm water and eventually groundwater. These well points will act as the dewatering system for the excavation, once underway.
4. Along the buildings on the eastern northern and northern sides of the Brownfield Site, underpinning will be installed to support the adjacent buildings' foundations. On sides where the boundary of the Brownfield Site does not abut a building, sheeting will be installed for stabilization.
5. Stabilized pads will be installed at each vehicle access point. These locations will be determined by the Contractor prior to beginning work on-Site.
6. Excavation will be at least to the depths below ground surface as identified in the Remedial Investigation. Excavation may be deeper in some places. Creosote-impacted soils will be characterized for waste characteristics, removed from the Brownfield Site, and disposed off-site at an approved facility. Once operational, the remediation dewatering system will collect the storm water and groundwater and pump it to the on-Site treatment system (see Section 4.0). After treatment, the storm water will discharge to the combined on Orchard Street.

7. Brownfield Site remediation activities will be completed, including excavation of contaminated soil, transportation of contaminated soil from the Brownfield Site, and backfilling of the disturbed area as necessary to support the proposed building foundation. The dewatering system will operate until the building superstructure is stabilized.

8. The SWPPP plan calls for minimizing the stockpiling of soil. But in the event temporary stockpiling becomes unavoidable, then either of two options will be used. Option 1, the preferred option, will be to stockpile soil within the excavation, where the lower elevation will prevent runoff. Exposed stockpiles will be covered by plastic sheeting, when inactive, until removal. The second option, available only at the very beginning of the project when on-Site unexcavated space is available, will be to temporarily stockpile soil on asphalt/concrete, cover it with plastic sheeting, and encircle it with hay bales, when inactive, until removal. The SWPPP controls will prevent additional protection against runoff from the Site.

4.0 EROSION AND SEDIMENT CONTROLS

Adequate erosion and sediment control methods will be provided prior to any grading, excavating, trenching or otherwise disturbing any areas. The following describes the temporary erosion and sediment controls that will be implemented at the Brownfield Site, as shown on Figure 6.

Stabilized Remediation Entrances

A stabilized pad will be installed consisting of gravel underlain by filter cloth. This temporary measure will be used to reduce the tracking of sediments outside the work area onto adjacent pavements and public streets. A pad of gravel will be placed at the point of entry for remediation traffic onto the Brownfield Site, which will be determined by the Contractor prior to beginning work on-Site. Tires will be washed before leaving the Project Site. The truck wash wastewater drain will connect to the New York City combined on Orchard Street through the dewatering system.

Storm Drain Inlet Protection

Silt barrier/geotextile material and hay bales will be placed around existing and newly constructed inlets to reduce or eliminate sediment entering the storm drainage system. Inlet protection will be critical in reducing sediment content of water entering the storm drain system (See Figures 7 and 8).

Temporary Berm

A temporary berm will be constructed to prevent storm water from entering or exiting the Brownfield Site. The hand-formed asphalt berm will be approximately 3 inches high. The berm will be constructed along Orchard Street as shown on Figures 7 and 8.

Spill Prevention Control and Countermeasure (SPCC) Plan

The Contractor will submit a Site-specific SPCC plan detailing its methods for preventing spills to the ground during all handling and operations. The SPCC plan shall include details of all containment and contingencies for quickly and effectively cleaning up any spilled material. Specifications and locations of materials (absorbents, etc.) will be included.

Dust Control

Several methods of controlling dust will be utilized including sprinkling water or other moisture retaining agents on dirt roadways and covering all haul trucks carrying loose materials (as necessary). The slopes on the edges of the excavations will be covered with a dust and odor-suppressing foam, such as Geomar. The Contractor will also employ dust control measures, such as speed restrictions on Brownfield Site roads, and covering of haul trucks.

Groundwater Treatment

Groundwater will be treated prior to discharge to the combined. Groundwater will be pumped into a settling tank, through bag filters, and finally activated charcoal polishing before discharge to the combined.

Listed below are several general practices that will be employed during remediation:

- Any materials deposited onto public thoroughfares will be promptly removed and properly disposed.
- Captured liquids requiring disposal will be containerized and transported off-Site for treatment and/or proper disposal.
- The pavement will be swept as necessary to maintain a clean work area and prevent silt from entering storm water runoff.

5.0 OPERATION, MAINTENANCE AND INSPECTION

The Contractor will have overall responsibility for implementing, monitoring and maintaining the project schedule and documenting/monitoring that appropriate controls are in place. Before, during, and after remediation of the Brownfield Site, a number of erosion and sedimentation control measures will be implemented as described in Section 4. These controls will be maintained such that the quality and quantity of storm water runoff leaving the Brownfield Site will not be adversely affected by remediation operations. The controls will also be maintained to deter storm water from entering the Brownfield Site and the excavation**.** The Prime Contractor/Subcontractor Certification for SWPPP implementation is provided as Appendix A.

5.1 REMEDIATION-PHASE OPERATION, MAINTENANCE AND INSPECTION

The Contractor will designate a Site Coordinator who will perform regular inspections (at least every seven calendar days and within 24 hours of the end of any storm event of 0.5 inches of rain or greater) to document/monitor that adequate pollution control measures are in place. The Brownfield Site Coordinator will also conduct regular inspections of the erosion control items currently in place to evaluate their adequacy and effectiveness, and will identify any required corrective measures and additional items required to maintain effective erosion control. It will also be the Site Coordinator's responsibility to determine what areas have been satisfactorily stabilized and determine when to remove temporary erosion control measures established for remediation. Disturbed and stabilized areas, changes in flow patterns, fencing, or preventive measures shall be documented on a Site map. A log book will be maintained to record all inspection and maintenance information and made available to regulatory authorities upon request.

The Contractor shall have a Qualified Inspector conduct site inspections in conformance with the GP-0-10-001 requirements. The Qualified Inspector shall prepare an inspection report subsequent to each and every inspection and is required to present photo documentation of practices that are identified as needing corrective actions. The photos need to be date stamped. The SWPPP will be updated monthly to indicate changes that occurred, and anticipated changes for the month ahead.

5.2 POST-REMEDIATION OPERATION, MAINTENANCE AND INSPECTION

A final Site inspection will take place before the filing of the Notice of Termination to certify that the Brownfield Site has undergone final stabilization using vegetative or structural measures and that all temporary controls have been removed or converted to permanent controls (as applicable). All disturbed areas will have permanent measures applied.

6.0 REFERENCES

- Empire State Chapter, Soil and Water Conservation Service, 2004. *Draft New York Guidelines for Urban Erosion and Sediment Control.* 2004.

- New York State Department of Environmental Conservation, 2010. *SPDES General Permit for Storm water Discharges from Construction Activity – Permit GP-0-10-001.* January 2010.

- Center for Watershed Protection, *New York State Storm Water Management Design Manual,* August 2010.

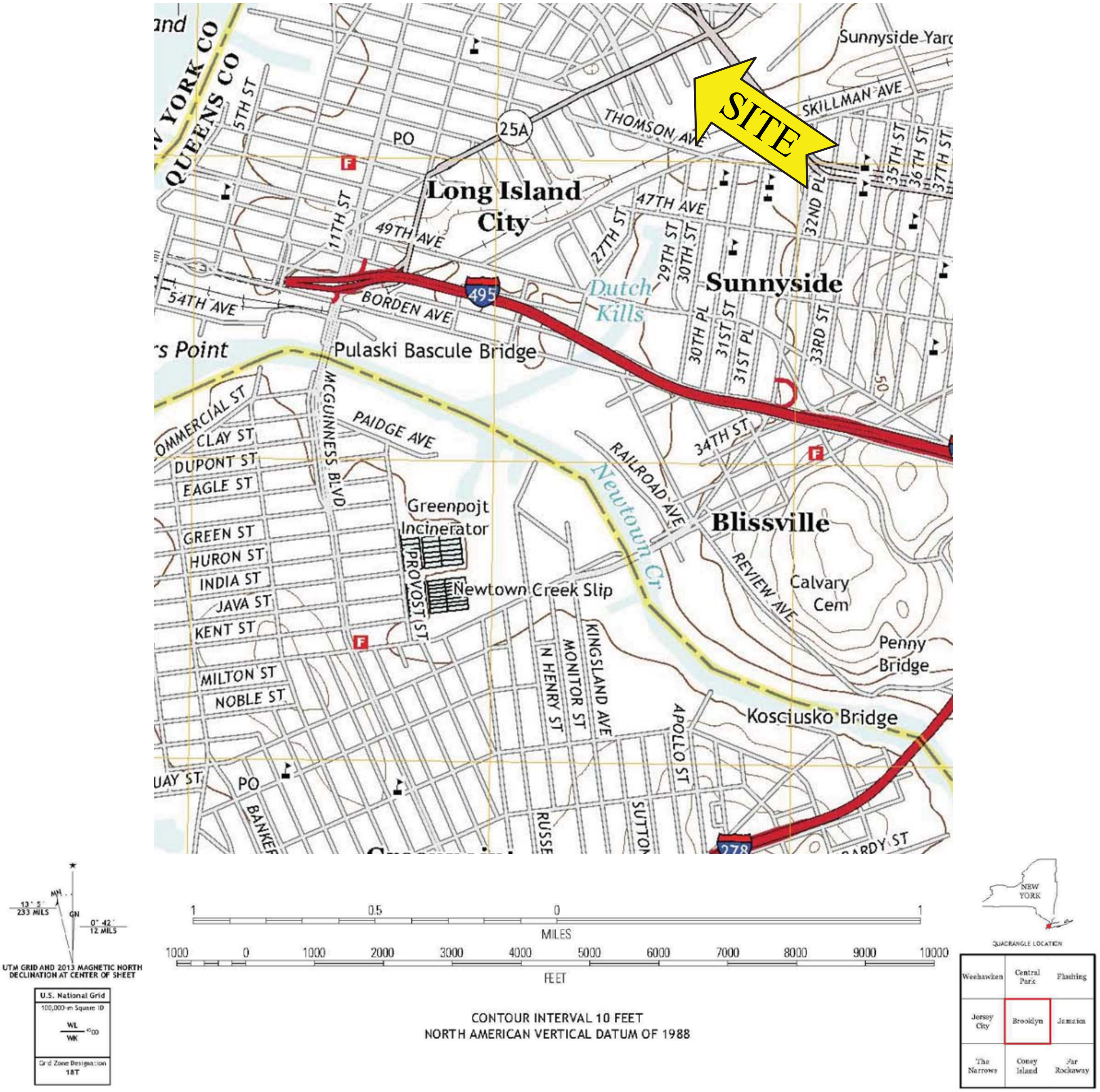
- New York State Department of Environmental Conservation*, New York Standards and Specifications for Erosion and Sediment Control*, August 2005

- New York State Department of Transportation (NYSDOT), *2002. Standard Specifications, Section 209-3, Construction Details.* 2002.

- United States Environmental Protection Agency, *Best Storm water Management Practices*

- New York City Department of Environmental Protection, *Rules and Regulations Governing the Construction of Private Sewers and Drains*

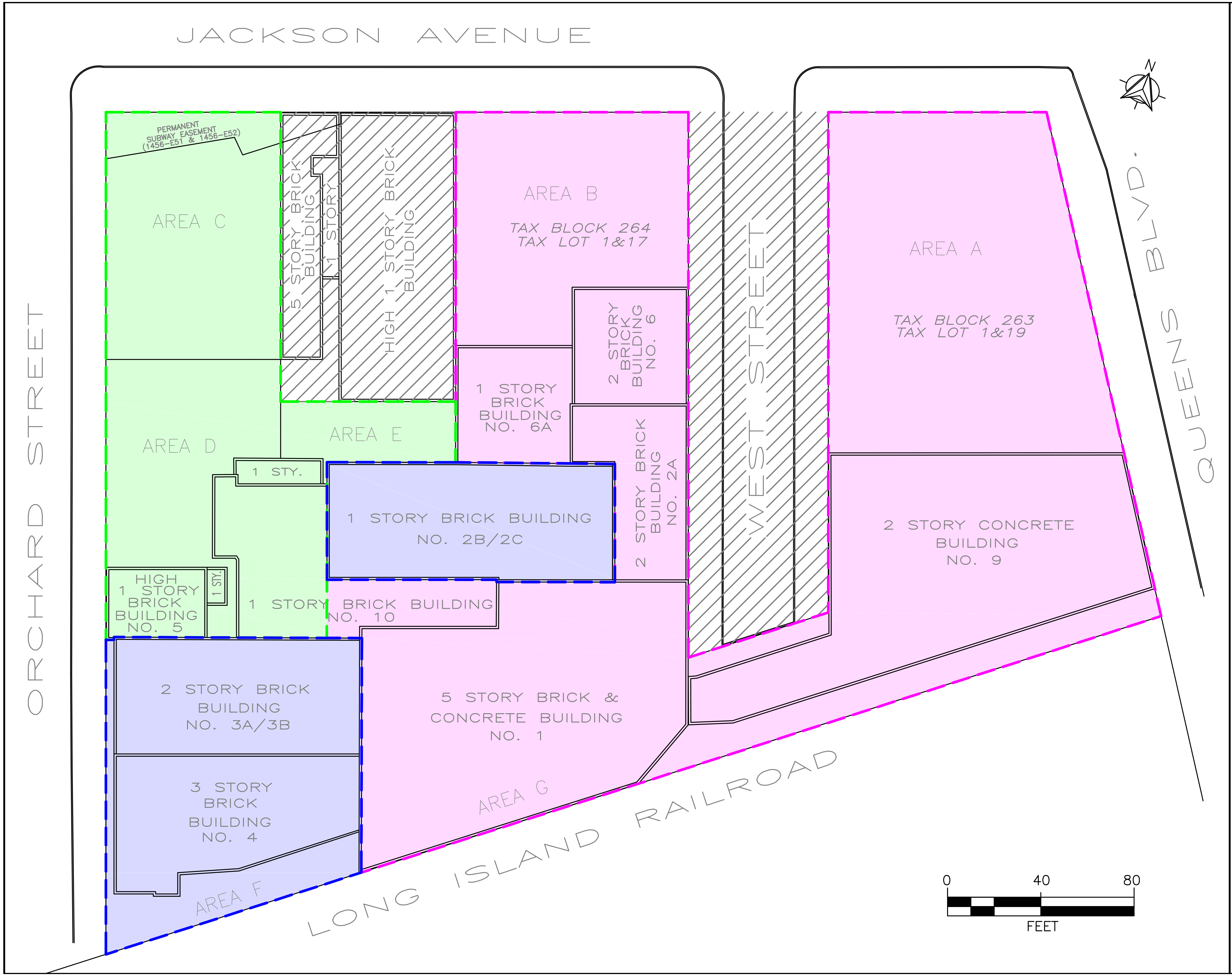
Figures



Fleming Lee Shue

FIGURE 1: SITE LOCATION

SITE: Queens Plaza Residential Development - Site B
Long Island City, NY
CLIENT: TST LIC Development LLC



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Fleming Lee Shue

Environmental Management & Consulting

158 West 29th Street, 9th Fl.
New York, NY 10001

Queens Plaza Residential Development - Site B (C241151)

FIGURE 2

SITE PLAN

Date
June 2014

Project Number
10112-005-1

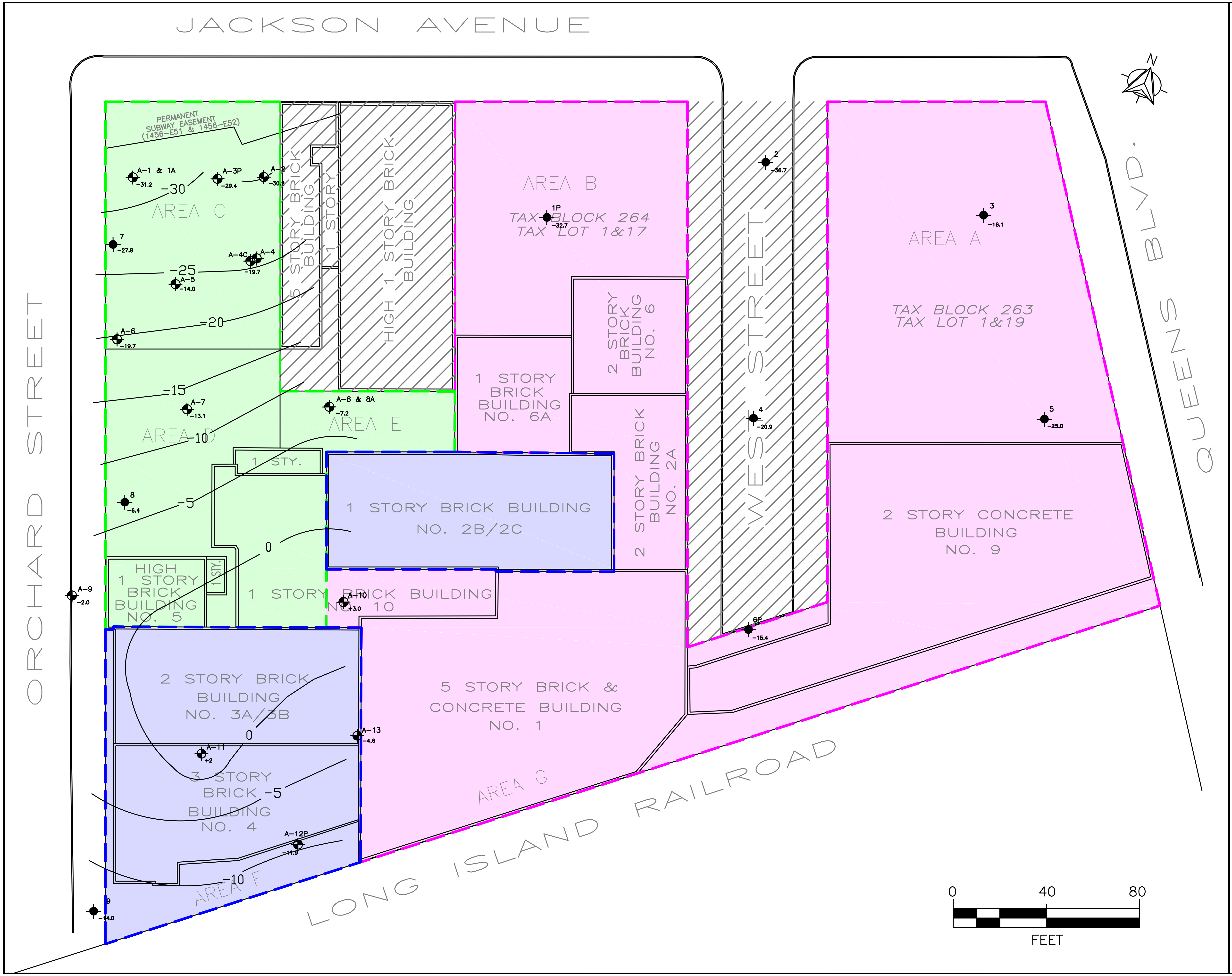
LEGEND

🟩 BCP SITE A

🟦 BCP SITE B – OU-1

🟪 BCP SITE B – OU-2

▨ OUTSIDE OF SITE



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New York, NY 10001

Queens Plaza Residential Development - Site B (C241151)

FIGURE 3

BEDROCK ELEVATION CONTOUR MAP

Date
June 2014

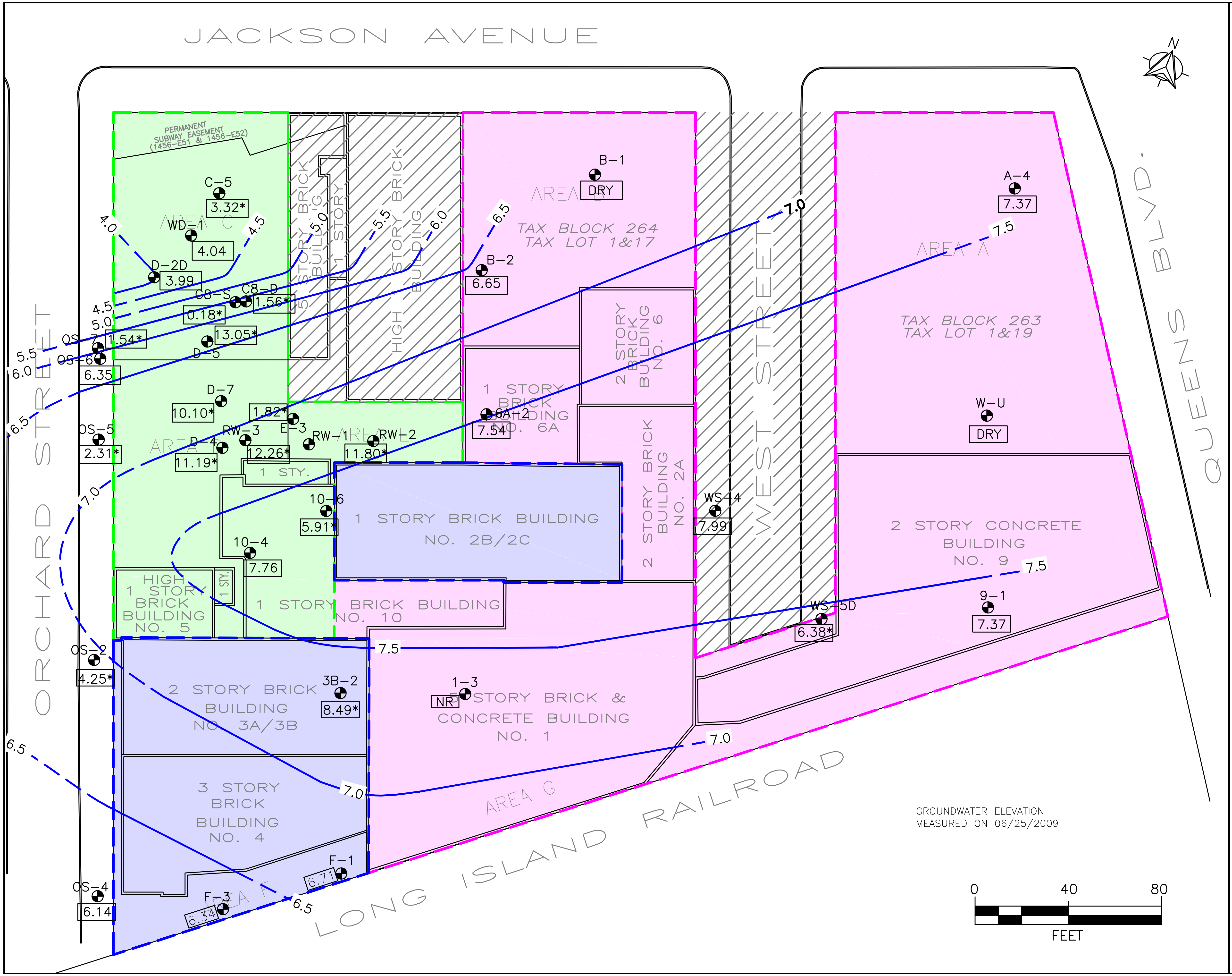
Project Number
10112-005-1

LEGEND

🟩	BCP SITE A
🟦	BCP SITE B – OU–1
🟪	BCP SITE B – OU–2
A–10 +3	BORING MADE IN 2007. ELEVATION OF TOP OF ROCK "P" INDICATED PIEZOMETER INSTALLATION. "A" INDICATED OFFSET FROM ORIGINAL LOCATION
9 −14.0	BORING MADE IN 1988. "P" INDICATED PIEZOMETER INSTALLATION. ELEVATION OF TOP OF ROCK
—5—	CONTOUR OF ELEVATION OF TOP OF ROCK

ELEVATION IN QUEENS BOROUGH DATUM (QBD) 1929

SOURCE: GEOTECHNICAL SUMMARY REPORT, MUESER RUTLEDGE CONSULTING ENGINEERS, APRIL 20, 2007



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New York, NY 10001

Queens Plaza Residential Development - Site B (C241151)

FIGURE 4

GROUNDWATER ELEVATION CONTOUR MAP

Date
June 2014

Project Number
10112-005-1

LEGEND

🟩	BCP SITE A
🟦	BCP SITE B – OU-1
🟪	BCP SITE B – OU-2
▨	OUTSIDE OF SITE
◐	MONITORING WELL
– –	GROUNDWATER ELEVATION CONTOUR (QBD) – DASHED WHERE INFERRED
7.37	GROUNDWATER ELEVATION (QBD)
*	ELEVATION NOT USED DUE TO ANOMALOUS READINGS OF GROUNDWATER LEVEL
NR	NOT RECORDED

ELEVATION QUEENS BOROUGH DATUM (QBD) 1929

QBD IS 1.625 FT HIGHER THAN NORTH AMERICAN VERTICAL DATUM (NAVD88). TO CONVERT FROM QBD TO NAVD88 = QBD + 1.625 FT

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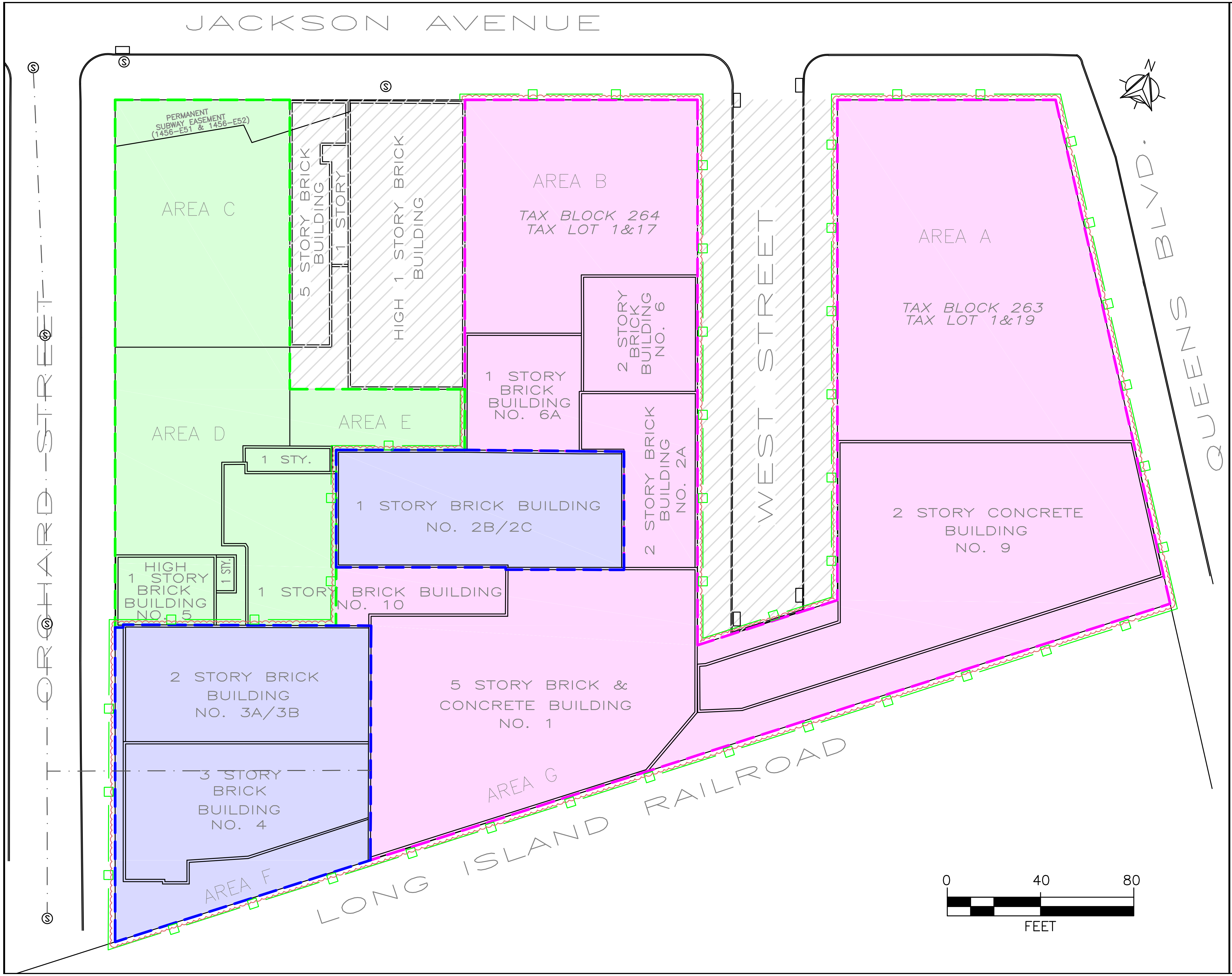

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158 West 29th Street, 9th Fl.
New York, NY 10001

Queens Plaza Residential Development - Site B (C241151)

FIGURE 5

SOIL EROSION AND SEDIMENT CONTROL MEASURES

Date
June 2014

Project Number
10112-005-1

LEGEND

🟩 BCP SITE A

🟦 BCP SITE B – OU–1

🟪 BCP SITE B – OU–2

▨ OUTSIDE OF SITE

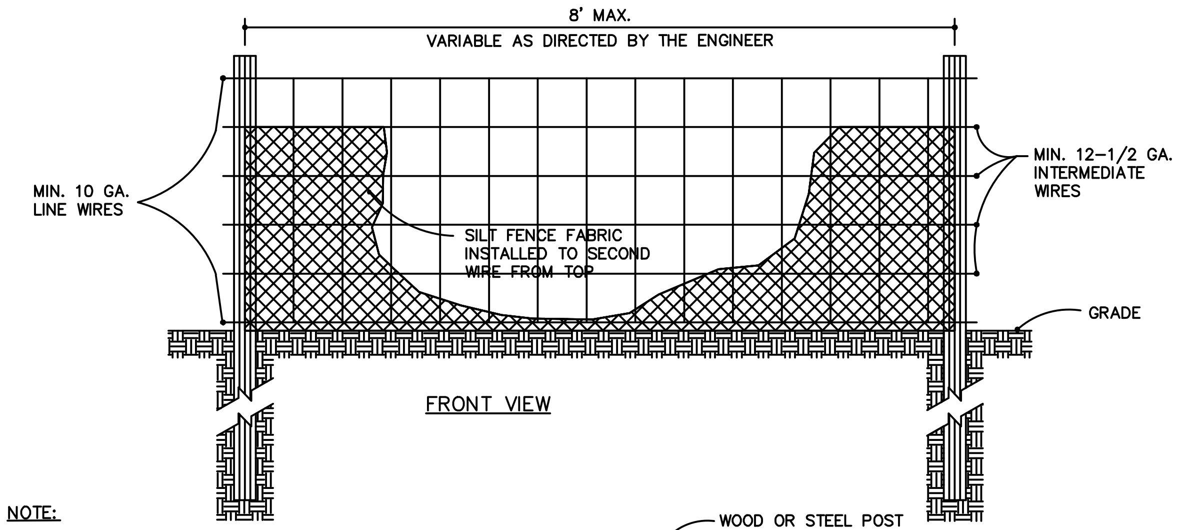
TEMPORARY ASPHALT BERM

CONSTRUCTION FENCE

COMBINED SEWER LINE

Ⓢ COMBINED SEWER MANHOLE

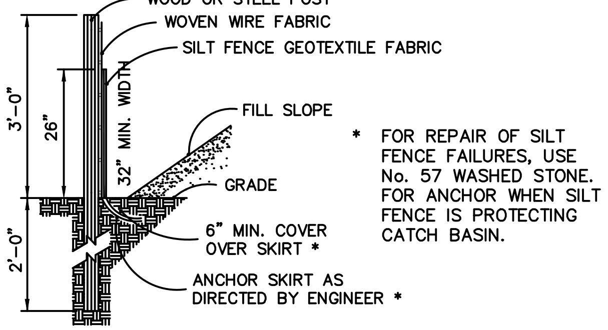
FILE: P:\Project Files\10112 – Tishman Consulting\001-10 – Site B\Figures\Site B RAWP June 2014\SWPPP Figures\Figure 5.dwg DATE: 6/11/2014



FRONT VIEW

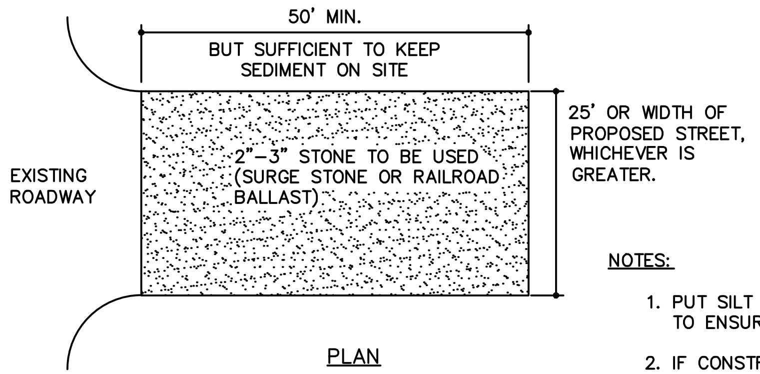
NOTE:

- –USE SILT FENCE ONLY WHEN DRAINAGE AREA DOES NOT EXCEED 1/4 ACRE AND NEVER IN AREAS OF CONCENTRATED FLOW
- –END OF SILT FENCE NEEDS TO BE TURNED UPHILL.



SIDE VIEW

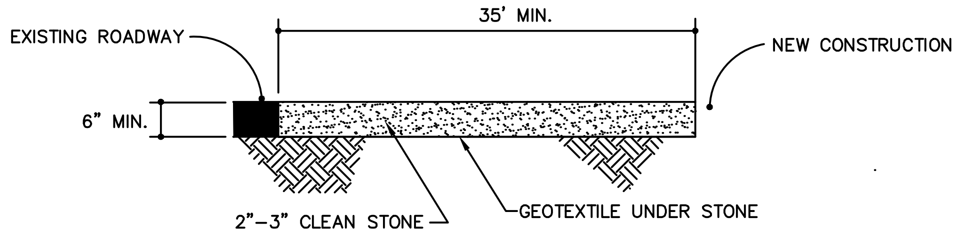
STANDARD TEMPORARY SILT FENCE 1



PLAN

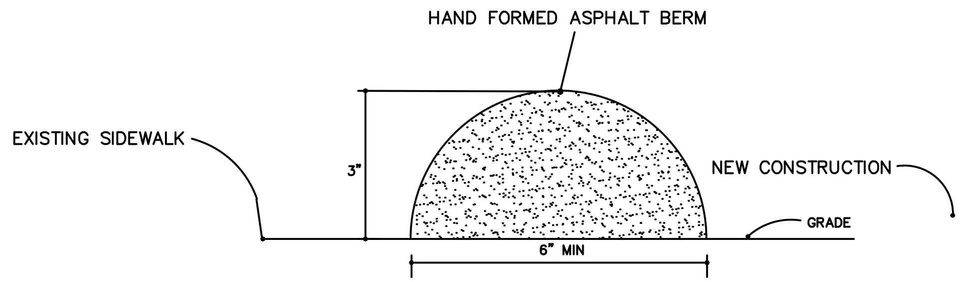
NOTES:

1. PUT SILT FENCE OR TREE PROTECTION FENCE UP TO ENSURE CONSTRUCTION ENTRANCE IS USED.
2. IF CONSTRUCTION ON THE SITE IS SUCH THAT THE MUD IS NOT REMOVED BY THE VEHICLE TRAVELING OVER THE STONE, THEN THE TIRES OF THE VEHICLES MUST BE WASHED BEFORE ENTERING THE PUBLIC ROAD.



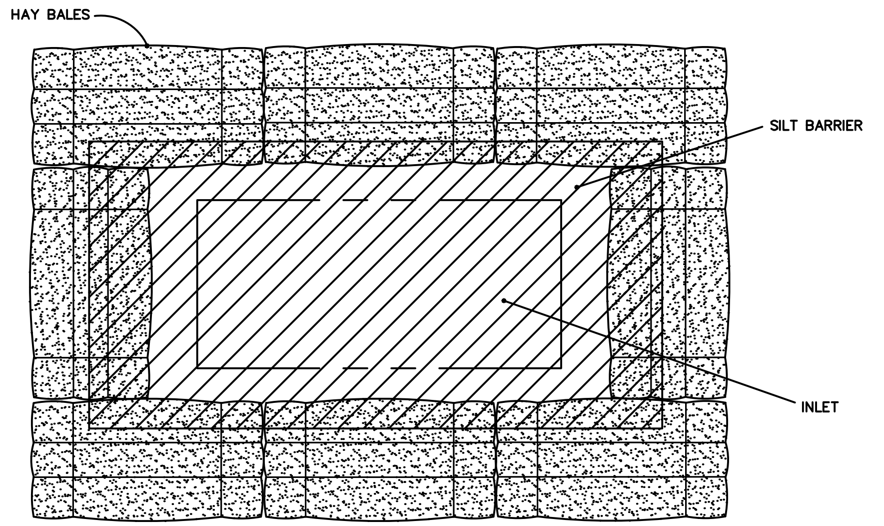
CROSS SECTION

CONSTRUCTION ENTRANCE 2

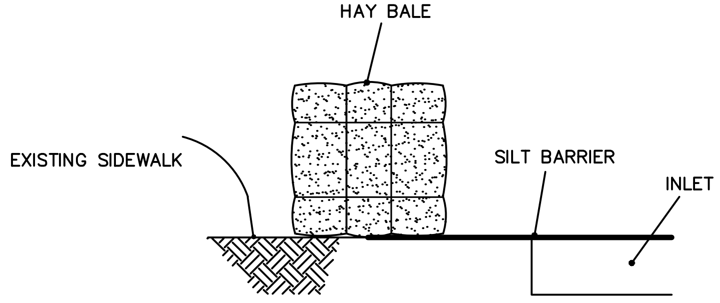


CROSS SECTION

TEMPORARY BERM 3



PLAN VIEW



SIDE VIEW

INLET PROTECTION 4

Fleming Lee Shue

Environmental Management & Consulting

158 West 29th Street, 9th Fl.
New York, NY 10001

Queens Plaza Residential Development - Site B (C241151)

FIGURE 6

SOIL EROSION AND SEDIMENT CONTROL DETAILS

Date
June 2014

Project Number
10112-005-1

LEGEND

FILE: P:\Project Files\10112 – Tishman Consulting\001-10 – Site B\Figures\Site B RAWP June 2014\SWPPP Figures\Figure 6.dwg DATE: 6/11/2014

Appendix A

CERTIFICATION OF STORM WATER POLLUTION PREVENTION PLAN

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

Name

Title

Date

PRIME CONTRACTOR/SUBCONTRACTOR CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) General Permit for Storm water Discharges from Construction Activity (Permit GP-0-10-001) that authorizes the storm water discharges associated with the remediation activities at the Queens Plaza Residential Development Site (Brownfield Site), located along Jackson Avenue at Orchard Street, Long Island City, New York.

Name

Title

Company

Date

APPENDIX F

Quality Assurance/Quality Control (QA/QC) Plan

Queens Plaza Off-Site – Tax Lot 14
Long Island City, New York
Site No. C241151A

QUALITY ASSURANCE/QUALITY CONTROL PLAN

LIC Operator Co. L.P.
c/o Tishman Speyer
45 Rockefeller Plaza
New York, New York 10111

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, New York 12233-7016

September 2015

Arnold F. Fleming, P.E.

QUALITY ASSURANCE/QUALITY CONTROL PLAN
Queens Plaza Residential Development

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LIST OF TABLES

1.0 QUALITY ASSURANCE PROJECT PLAN (QAPP)

The Quality Assurance Project Plan (QAPP) outlines the protocols and procedures that will be followed during the Remedial Action on the Queens Plaza Residential Development Site and Off-Site. The QAPP has been prepared in order to ensure Quality Assurance (QA) and Quality Control (QC) for the environmental sampling that will take place under the Interim Remedial Measure Work Plan (IRMWP) to ensure the acquisition of defensible data that fulfill the stated objectives.

Project Team

The project team will consist of FLS personnel and subcontractors. All field personnel and subcontractors will have completed a 40-hour HAZWOPER training course and the annual HAZWOPER 8-hour refresher in accordance with the Occupational Safety and Health Administration (OSHA) regulations and will have the training required for their respective duties as outlined for this investigation.

Project Director

The general oversight of all aspects of the project will be conducted by the project director. Tasks will include the scheduling, budgeting, data management and decision-making for the field program. Mr. Arnold F. Fleming, PE, will act as the Project Director for the RWP.

Project Manager

All components of the Remedial Investigation will be directed and coordinated by the Project Manager. He/she will ensure a smooth flow of information between all parties involved in the investigation by communicating regularly with professionals from the New York State Department of Environmental Conservation (NYSDEC), the Brownfield Site management personnel, and all members of the FLS project team. Mr. Steven Panter, CGWP, Senior Consultant will act as the Project Manager.

Field Team Leader

Daily on-site sampling and health and safety activities will be supervised by a Field Team Leader. The team leader's responsibilities will include ensuring adherence to the work plan and HASP and regularly reporting daily progress and deviations from the work plan to the Project Manager. Upon approval of the IRMWP, FLS will assign the role of Field Team Leader to appropriate FLS personnel.

Project Quality Assurance / Quality Control Officer

Adherence to the QAPP will be ensured by a FLS QA/QC Officer. Tasks will include reviewing the QA procedures with all personnel before any fieldwork is conducted on-site as well as completing periodic Brownfield Site visits in order to assess the implementation of these procedures. Mr. Mark Hutson, Geologist, will act as the QA/QC officer for the investigation.

Laboratory Quality Assurance / Quality Control Officer

Quality control procedures will be ensured by a laboratory QA/QC officer in the designated laboratory. This officer will be responsible for the adherence to laboratory protocols, quality control procedures, and checks in the laboratory. The officer will track the movement of the samples from check in to issue of the analytical results, conducting a final check on the analytical calculations, and signing off on the laboratory reports. The laboratory QA/QC Officer will be assigned by the laboratory for the investigation.

The sample analytical reports will undergo a third party review of the analyses conducted. The third party (yet to be chosen) will produce a Data Usability Summary Report (DUSR) which will be submitted to the NYSDEC. Five percent of the post-excavation soil samples will undergo third party data review.

2.0 LABORATORY PROCEDURES

The sample container type, preservation, applicable holding time, and laboratory methods of analysis of the field samples have been included as Table 1. Sample analyses will be completed in a New York State Department of Health Environmental Laboratory Approval Program (NYSDOH-ELAP) certified laboratory and reported using Category B deliverables.

Table 1
Summary of Analytical Methods/Quality Assurance
Queens Plaza Residential Development

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	Analytical Method	Sample Preservation	Holding Time[2]	Sample Container[3]
Soil	VOCs, TCL or NYS STARS	Post-Ex. Grab	50	SW-846 Method 8260B	Cool to 4^0 C; no headspace	14 days to analysis	(2) 2-oz. glass jars
Soil	TCL Pesticides & PCBs	Post-Ex. Grab	50	SW-846 Method 8082 & 8081	Cool to 4^0 C	14 days to extraction; 40 days from extraction to analysis	(1) 300 mL amber glass jar
Soil	SVOCs, TCL	Post-Ex. Grab	50	SW-846 Method 8270C	Cool to 4^0 C	14 days to extraction; 40 days from extraction to analysis	(1) 300 mL amber glass jar
Soil	Metals, TCL	Post-Ex. Grab	50	SW-846 Method 6010B/7000 Series	Cool to 4^0 C	28 days to analysis for Hg; 6 months to analysis for other metals	(1) 300 mL amber glass jar
Solid Waste	TCLP VOCs	Grab	TBD	SW-846 Methods 1311/8260B	Cool to 4^0 C; no headspace	14 days to TCLP extraction; 14 days from TCLP extraction to analysis	(1) 60 ml VOC vial
Solid Waste	TCLP SVOCs	Grab	TBD	SW-846 Methods 1311/ 8270C	Cool to 4^0 C	14 days to TCLP extraction; 7 days from TCLP extraction to SVOC extraction; 40 days from SVOC extraction to analysis	(1) 950 mL amber glass jar
Solid Waste	TCLP Pesticides	Grab	TBD	SW-846 Methods 1311/8081A	Cool to 4ºC	14 days to TCLP extraction; 7 days from TCLP extraction to pesticide extraction; 40 days from pesticide extraction to analysis	(1) 950 mL amber glass jar
Solid Waste	TCLP Herbicides	Grab	TBD	SW-846 Methods 1311/8151A	Cool to 4ºC	14 days to TCLP extraction; 7 days from TCLP extraction to herbicide extraction; 40 days from herbicide extraction to analysis	(1) 950 mL amber glass jar

Table 1
Summary of Analytical Methods/Quality Assurance
Queens Plaza Residential Development

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	Analytical Method	Sample Preservation	Holding Time[2]	Sample Container[3]
Solid Waste	TCLP Metals	Grab	TBD	SW 846 Methods 1311/ 6010B/7000 Series	Cool to 4^0 C	Hg: 28 days to TCLP extraction; 28 days from TCLP extraction to analysis Other Metals: 6 months to TCLP extraction; 6 months from TCLP extraction to analysis	(1) 500 mL amber glass jar
Solid Waste	Ignitability	Grab	TBD	SW-846 Method 1010	Cool to 4^0 C	None specified	(1) 500 mL amber glass jar
Solid Waste	Corrosivity	Grab	TBD	SW-846 Method 9045C	Cool to 4^0 C	As soon as possible (within 3 days of collection)	(1) 500 mL amber glass jar
Solid Waste	Reactive cyanide	Grab	TBD	SW-846 Chapter 7, Section 7.3.3	Cool to 4^0 C; no headspace	As soon as possible (within 3 days of collection)	(1) 500 mL amber glass jar
Solid Waste	Reactive sulfide	Grab	TBD	SW-846 Chapter 7, Section 7.3.4	Cool to 4^0 C; no headspace	As soon as possible (within 3 days of collection)	(1) 500 mL amber glass jar

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

[2] From date of sample collection

[3] MS/MSDs require duplicate volume for all parameters for solid matrices; MS/MSDs require triplicate volume for organic parameters for aqueous matrices and duplicate volume for inorganic parameters for aqueous matrices

TBD - To Be Determined

TCL – Target Compound List

3.0 QUALITY CONTROL SAMPLING

Additional analysis will be conducted for QC assurance in addition to the laboratory analysis of the field soil and groundwater samples. QC samples will include: one equipment rinsate blank and one set of duplicate samples per twenty field samples, and one trip blank per sample shipment. The quantities of field samples and quality control samples have been summarized in Table 2.

The equipment blank and duplicate samples will be analyzed for the same parameters as the soil and groundwater samples, whereas trip blanks will be analyzed solely for VOCs.

Table 2
Summary of Quality Control Samples
Queens Plaza Residential Development

Sample Matrix	Analytical Parameter	Sample Type	No. of QA/QC Samples
Water.	VOCs	Trip Blank	1 per shipment
Soil, Post-Ex.	VOC, SVOC, Metals	Duplicate	1 per 20 samples
Water	VOC, SVOC, Metals	Equipment Blank	1 per 20 samples

4.0 STANDARD OPERATING PROCEDURES

The standard operating procedures (SOPs) for monitoring well installation and development and sampling equipment decontamination are described in the following sections.

Soil Borings

Where soil borings will be installed by means of hollow stem augers, soil samples will be collected on a continuous basis by means of a two-foot long, 2-inch diameter, stainless steel split spoon samplers. The augers will be advanced to the top of the desired sampling interval depth and the split spoon and connected rods will be lowered through the auger and driven into the soil another two-feet using a 140-pound weight dropped through a 30-inch interval. The split spoon and rods will be withdrawn to obtain the soil sample. Where a sonic rig is used, samples will be collected using 3-inch-diameter, 5-foot-long core barrels that are steam-cleaned and/or pressure washed between sample intervals. The appropriate sample volume will be collected based on project-specific procedures.

Where subsurface materials consist mostly of sand mixed with fill material smaller than cobble-size, FLS may obtain soil samples using a smaller direct push Geoprobe® sampling rig. In this case, a macrocore sampler with plastic liners and end plug, as necessary, will collect undisturbed soil cores down to the required depth. The four-foot long macrocore with end plug, as necessary, is pushed into the soil using the hydraulic pressure generated by the Geoprobe® rig. If resistance is encountered the Geoprobe® unit has a vibrating unit that either breaks up the resisting object or vibrates it aside. When the sampling depth is reached, the end plug is removed and the macrocore is then advanced through the sampling interval to collect the soil sample. Plastic acetate liners are placed within the core barrel of the macro core to store the soil/sediment sample, and to prevent any cross-contamination between soil borings. To further reduce the chance of cross-contamination during sampling, the macrocores and equipment will be decontaminated between uses with a non-phosphate detergent wash followed by a clean water rinse, followed by a final rinse with deionized water. Once the macrocore is retrieved from its desired depth, the cutting end of the core barrel is removed, and the plastic core liner is removed. The acetate liner is then cut length-wise with a special knife. PID readings are taken from the soil while still in the core and undisturbed.

The following procedures will be used to complete all soil sampling (these may be superseded by project-specific procedure):

- Identify that the staked-out sampling location is consistent with the location designated on the soil boring location plan, and in a safe location relative to overhead and underground utilities.
- Cleaning/decontamination of the split spoon samplers/macrocores

- The driller will push the sampler, and end plug as necessary, through the overlying strata to the top of the desired sampling interval.
- Recover the sampler and open to retrieve soil core. Split/cut the sample lengthwise for inspection.
- The end plug will be removed at the top of the desired sampling interval and the sampler will then be pushed through the sampling interval.
- Observe the soil core for visual evidence of contamination (i.e., staining, sheens, odor and/or oil-like/ creosote-like material).
- Using a sampling utensil (i.e., sampling spoon), burrow small holes in the core at one-foot intervals, placing the photoionization detector (PID) probe in the holes along the way to retrieve measurements of organic vapor concentrations. Refer to Section 4.6 for project-specific procedures.
- Using the modified Burmister soil classification system to describe visual observations of the soil sample.
- Retrieve an aliquot from each one-foot interval soil samples and seal in a plastic bag in an ice-filled cooler until sample selection for laboratory analysis.
- Choose which samples will be analyzed at the laboratory and label and fill the laboratory-supplied sample jars with the selected soil aliquots from their respective depth intervals. Seal the sample jars and store in a cooler at 4º Celsius.
- Decontaminate soil sampling equipment between sample locations
- Record field observations in the field log book and/or boring log data sheet, including: boring number, sample depth and sample observations (PID readings, evidence of contamination, and soil classification).

Monitoring Well Installation

Borings will be advanced to the desired depths by means of hollow stem augers and a truck-mounted or skid-mounted drill rig for the installation of monitoring wells. The monitoring wells will be constructed of two-inch diameter PVC in accordance with the following procedures:

- Using an oil/water interface probe, measure and record the depth to water in the open hole.

- Lower a PVC riser with a 10-foot to 15-foot length of PVC slotted screen to the bottom of the borehole. Approximately seven feet of the screen will be placed below the water table.

- If dense non-aqueous phase liquids (DNAPL) (such as tetrachloroethene) are suspected, a two-foot sump of steel casing will be attached to the bottom of the screen.

- The PVC screen slot size will be selected based on the sediment grain size observed in the soil. A slot opening of 0.020 inches will be chosen when medium to coarse sand is the dominant grain size. If silty sands or fine sand is dominant, then a 0.010-inch slot size will be chosen.

- In the annular space around the well screen, install the sand filter pack (about one to two feet above the top of the screen).

- For the one to two feet above the filter pack, a bentonite seal will be installed in the annular space.

- The remaining annular space will be filled with a bentonite-cement grout.

- Install a locking cap, flush-with-grade, curb box that has been set in cement. Set up a cement apron around the curb box to direct run-off away from the well.

- Decontaminate the hollow stem augers prior to and following each well installation

- Record data regarding the well installation in the field logbook and/or field data sheets (i.e., location, depth, construction details, water level measurements).

Temporary Well Point Installation

In specific instances where a permanent or semi-permanent monitoring well is not planned or called for, but the field geologist or project manager makes a field decision to collect a groundwater sample; or the location of the boring does not allow the use of a larger hollow-stem auger drill rig, a temporary well point will need to be installed using a Geoprobe® drill rig to collect a groundwater sample. The temporary well point consists of a five to ten-foot length of approximately 1 ¼-inch-diameter PVC well screen placed into a borehole already produced by the Geoprobe® macrocore. A gravel pack consisting of pre-sized sand will be placed in the annular space between the screen and the borehole wall. A groundwater sample will then be collected following the procedures outlined below, except that in a temporary well the 14-day equilibration period will not apply. When the groundwater sample has been collected the PVC well screen and riser pipe will be retrieved and placed in plastic garbage bags for later disposal. The borehole is then backfilled with Bentonite hole plug, and the surface repaired with concrete or asphalt patch.

Monitoring Well Development

The following procedure illustrates the development of all new and existing wells:

- Measure, using a water-level meter or an oil/water interface probe, the depth to the water and, using a weighted tape, the total depth of the well. From these measurements, calculate the length of the water column (total depth minus depth to water). The volume of water in the well is calculated using the following conversion factors:

Well Diameter (Inches)	Volume per Foot of Water Column (gallons)
1	0.041
1 ¼	0.064
2	0.163
4	0.653
6	1.469

- Discharge the water to 5-gallon buckets using a submersible pump. Transfer water from the buckets to 55-gallon drums designated for well development water.

- When the turbidity is less than 50 nephelometric turbidity units (NTUs) (three successive readings), the well is close to being developed. If after one hour of steady pumping, the turbidity remains high, additional methods of surging and jetting may need to be considered.

- In the field logbook or on field data sheets, record the volume of water removal and any other observations made.

- The equipment must be decontaminated before and after development for each well location

Groundwater Sampling

Groundwater will be sampled according to the USEPA protocol for low-flow purging and sampling (http://epa.gov/region1/lab/qa/pdfs/EQASOP-GW001.pdf). Groundwater samples will be collected from the monitoring wells/well points applying the following procedures no sooner than 14 days following development:

- As the well plug is removed, measure the vapor concentrations in the well using a PID.
- Ensure that any pressure in the well dissipates and that water levels have stabilized before measuring fluid levels.
- Measure depth to water and check for LNAPL or DNAPL utilizing an oil/water interface probe, if applicable. If the NAPL is measurable, groundwater samples will not be collected from such a well.

- During the well development, calculate the mid-point of the water column length within the screen, using the water level and the total well depth measured. [For example, if the total depth is 40 feet, the screened interval is 30 to 40 feet, and the depth to water is 15 feet, the mid-point of the water column within the screened interval would be 35 feet.].
- Connect dedicated polyethylene or Teflon tubing to either a submersible or peristaltic pump and lower such that the intake of the pump is set at the mid-point of the water column within the screened interval of the well. The intake should be a minimum of 1 foot above the bottom of the well screen. Record the depth of the intake in the field notes. Connect the discharge end of the tubing to the flow-through cell of a multi-parameter (or equivalent) meter, such as a Hydrolab Quanta or a Horiba U-10 or U-22. Connect tubing to the output of the cell and place the discharge end of the tubing in a 5-gallon bucket.
- At its lowest flow rate setting, activate the pump (but no more than 0.5 L/min.).
- Measure the depth to water within the well. Increase the pump flow rate such that the water level a measurement does not deviate more than 0.3 feet compared to the initial static reading.
- Transfer discharged water from the 5-gallon buckets to 55-gallons drums designated for well-purge water.
- During purging, collect periodic samples (every five minutes) and analyze for water quality indicators (e.g., turbidity, pH, temperature, dissolved oxygen, oxidation-reduction potential, and specific conductivity).
- Continue purging the well until water quality indicators have stabilized (three successive readings) for the following parameters and criteria:

Parameter	Stabilization Criteria
pH	+/- 0.1 pH units
Temperature	+/- 3% degrees Celsius
Specific Conductance	+/- 3% S /cm
ORP/Eh	+/- 10 mV
Turbidity	+/- 10% NTUs (< 50 NTUs,): if 3 turbidity values are less than 5 NTU, consider the values as stabilized.
Dissolved Oxygen	10% for values greater than 0.5 mg/L, if 3 DO values are less than 0.5 mg/L, consider stabilized

Strive to reduce turbidity to the lowest practical limit. Record all efforts to stabilize the water quality for the well in the field book and then collect samples as described below. Discontinue purging after three well volumes have been removed and water quality parameters do not stabilize.

- After purging, disconnect the tubing to the inlet of the flow-through cell. Collect groundwater samples directly from the discharge end of the tubing (first VOCs then SVOCs) and place into the required sample containers. Containers are to be labeled as described in Section 5.3.7 and put in an ice-filled cooler.

- All sample bottles shall be filled to the top to minimize aeration and immediately placed on ice and in the dark to minimize temperature or photo-induced changes to the groundwater samples.
- Collect one final field sample and analyze for water quality parameters (e.g., turbidity, pH, temperature, dissolved oxygen, reduction-oxidation potential, and specific conductivity) and record the final readings in the field notes.
- Once sampling is complete, remove the pump and tubing from the well. Disconnect the tubing and place it back in the well for reuse during the next sampling event. Dispose of any sample filters in a 55-gallon drum designated for disposable sampling materials and PPE.
- Decontaminate the pump, oil/water interface probe and flow-through cell as described in Section 5.3.6.
- In the project logbook and field data sheet, record all measurements (depth to water, depth to NAPL, water quality parameters, turbidity), calculations (well volume) and observations.

Decontamination Procedures

Decontamination will be performed on plastic sheeting or in another containment area that is deemed to prevent runoff to the ground. Prior to use on-site and between sampling locations, the macrocore sampler, probe rods, pump, oil/water interface probe, and other non-disposable sampling equipment will be decontaminated using the following protocol:

1. Scrub using tap water / non-phosphate detergent mixture and bristle brush.
2. Rinse with tap water.
3. Repeat step 1 and 2
4. Final rinse with distilled water.
5. Air-dry the equipment.

The solid stem augers and hollow stem augers will be decontaminated with a steam cleaner or pressure washer using a tap water/non-phosphate detergent solution to remove any loose soil and petroleum.

Sample Identification

All samples will be identified using a format that provides the essential information on the use, tracking, location, and media sampled (groundwater, soil, sediment, soil gas, surface water, waste, etc.), date, time, location, and depth interval.

Examples are as follows:

Soil: B-10, 5.5-6.0’, indicates that the soil sample was collected from the 5.5 - 6.0-foot interval in boring B-10.

Groundwater: MW-1 indicates that the sample is a groundwater sample collected in monitoring well 1.

Duplicate samples will be labeled as blind duplicates by giving them sample numbers indistinguishable from a normal sample.

Blanks should be spelled out and identify the associated matrix, e.g., Field (Rinsate) Blank (FB)-Soil; Field Blank-Groundwater. Trip Blanks should be labeled with the prefix TB.

Sample Labeling and Shipping

All sample containers must contain the following information—written in waterproof indelible ink (Sharpie)—on the label:

- Project identification
- Sample identification
- Date and time of collection
- Analysis(es) to be performed
- Samplers initials
- Media Sampled

Collected and labeled samples will be placed in ice-filled coolers away from direct sunlight to await shipment/delivery to the laboratory.

To prepare the samples for shipment place each sample in a resealable plastic bag, then wrap each container in bubble wrap, only if being shipped, to prevent breakage. Finally, add fresh ice in two sealable plastic bags, or “blue ice” blocks, and the chain-of-custody form. Samples may be shipped overnight (e.g., via 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 coolers remain sealed during delivery. C*oolers must be heavily iced to bring the entire sample contents to* 4^0 *C.*

Sample Custody

Field personnel will be responsible for maintaining the sample coolers in a secured area until arrival at the laboratory or laboratory pick up. Sample possession record from the time of obtainment in the field to the time of delivery to the laboratory or shipping off-site will be documented on chain-of-custody (COC) forms. The COC forms will contain the following information: project name; names of sampling personnel; sample number; media sampled; date and time of collection and matrix; signatures of individuals involved in sample transfer; and the dates and times of transfers. Laboratory personnel will examine the custody seal’s condition at sample check-in.

Field Instrumentation

Equipment will be calibrated at the start of each day of field work in accordance with the manufacturer's specifications. In the instance that an instrument fails calibration, the Project Manager or QA/QC Officer must be contacted immediately so as to arrange repairs or obtain a replacement instrument. A calibration log will be maintained in the field log book in order to record specific details regarding instrument calibration, including: dates, problems, and corrective actions. The PID will be calibrated each day using a standard of 100 parts per million (ppm) isobutylene, zeroed as per manufacturer specifications.

Field personnel will be trained in the proper operation of all field instruments at the start of the field program; however, instruction manuals for all equipment will be stored on-site as a reference of the proper procedures for operation, maintenance and calibration.

APPENDIX G

Health and Safety Plan

Queens Plaza Off Site – Tax Lot 14
Long Island City, New York
Site No. C241151A

HEALTH & SAFETY PLAN

TST LIC Development LLC
c/o Tishman Speyer
45 Rockefeller Plaza
New York, New York 10111

Submitted to:

New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, New York 12233-7016

ARNOLD F. FLEMING P.E.

&

Fleming
Lee Shue

Environmental Management & Consulting
158 West 29th Street, 9th Floor
New York, New York 10001
http://www.flemingleeshue.com

October 2015

I, Mark Hutson, certify that the Tax Lot 14 Health & Safety Plan was prepared under my direction.

Date

Mark Hutson, FLS
Senior Project Manager

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ATTACHMENTS

1.0 INTRODUCTION

1.1 Purpose

The firms Fleming-Lee Shue, Inc. (FLS) and Arnold F. Fleming P.E. (AFF), prepared this site-specific Health and Safety Plan (HASP) to address the health and safety practices and guidelines that will be employed during the environmental investigation and remediation of the Queens Plaza Off Site Tax Lot 14 (hereafter referred to as the Site) located at 28-18 Jackson Avenue in Long Island City, New York. The Site operates under New York State Department of Environmental Conservation (NYSDEC) site number C241151A.

This HASP has been developed in accordance with the requirements of the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard, 29 CFR 1910.120. The HASP establishes the known chemical and physical hazards associated with the work activities and provides a description of the air monitoring requirements, personal protective equipment requirements and safe operating guidelines for use by FLS/AFF and our subcontractors. This HASP applies to the FLS and AFF scope of work: off-site investigation/remediation work. All subcontractors working with FLS/AFF will be provided with a copy of this HASP for review. Based on their means and methods of executing the work activities, the subcontractors will either accept the safety procedures outlined in this HASP and FLS/AFF Health and Safety Officer's supervision or the subcontractor can provide a HASP addendum, for FLS/AFF review and acceptance, stating any additional procedures that they wish to be incorporated. Other parties (Contractors, subcontractors, and their employees) performing their own scope of work not covered by this HASP can review this HASP but must prepare their own HASP that meets Occupational Safety and Health Administration (OSHA) requirements. Contractors providing their own HASP must indicate that their HASP was prepared under the direction of a CIH. This HASP will be kept onsite during field activities and shall be accessible at all times. This HASP will be reviewed as necessary and amended or revised as conditions change and additional activities arise. All FLS/AFF site personnel and subcontractors will receive site specific HASP training and will be required to sign the Acknowledgement Form (Attachment I). All visitors, who visit the site for the purposes of observing our work activities will also receive a health and safety briefing, sign the Acknowledgement Form, and be escorted at all times.

1.2. References

The general provisions of this HASP were developed in accordance with the provisions of OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard, 29 CFR 1910.120 or 29 CFR 1926.65.

The Occupational Safety and Health Act (1970) requires the following:

- Employers shall furnish each employee with a place of employment free from recognized hazards that are causing or likely to cause death or serious physical harm.
- Employers must comply with occupational health and safety standards and rules, regulations and orders pursuant to the Occupational Safety and Health Act, that are applicable to company business and operations.
- All employees must comply with occupational health and safety standards and regulations under the Act, which are applicable to their actions and situations.
- Employees are encouraged to contact their immediate superior for information that will help them understand their responsibilities under the Act.

In addition, all work will comply with the Owner Required Safety Performance Standards in the appendix.

2.0 PROJECT INFORMATION

2.1 Site Description

The Site is located at 28-18 Jackson Avenue in Long Island City, Queens County, New York (Figure 1) and is identified on a Tax Map as Block 264, Lot 14. The adjacent BCP Sites, which are currently undergoing remediation and development, are identified as Block 264, Lots 1, 1R, 17, and Block 263, Lots 1, 9, and 11. Figure 1 shows the layout of Tax Lot 14 and the adjacent BCP Sites.

The size and configuration of Tax Lot 14 present several access limitations and equipment constraints. Tax Lot 14 is 25 feet wide and approximately 125 long. The northern end overlies a subway tunnel and pile field, where drilling access is restricted by the MTA. The east side is bound by a MTA subway electrical switching station. The western and southern sides are bound by BCP Site A and are currently inaccessible due to the Support of Excavation (SOE) structures on these sides and the approximate 15-foot drop off imposed by the SOE. Along most of the southern side is SOE in the form of a three-foot-wide concrete secant wall. As of this date, construction equipment and a pile field block access to Tax Lot 14 and the only means of bringing equipment onto Lot 14 is via picking it with heavy equipment. A portion of the proposed residential building under construction, Tower A, extends from BCP Site A onto the northern portion of Lot 14. Tower A’s footprint extends approximately 56 feet south from Jackson Avenue on Lot 14. South of the Tower A footprint, Lot 14 is currently being used as a staging area for construction supplies for adjacent BCP Site A. The Site plan is presented in Figure 2.

The Site is in an area designated as M1-5/R9 within the Long Island City Special Purpose District assigned by the Department of City Planning. The Long Island City Special Purpose District is a special zoning provision to promote the development and transformation of historical industrial/ manufacturing areas into mixed use commercial and residential spaces.

2.2 Site Background and Previous Investigation Findings

2.2.1 Site Background

Tax Lot 14 was historically occupied by a blacksmith, wagon and carpenters shop in the 19th century. It was occupied by a 5-story mixed use residential and commercial building from

1915 until 2014 when it was demolished as part of the QPRD. This former building was historically occupied by primarily commercial occupants including a battery and ignition service, a paint store, a restaurant, a liquor store and exterminator. The building was also historically utilized for residential purposes.

The West Chemical Company occupied the adjacent BCP Sites A and B from the early 1900s until 1977, during which time it manufactured and stored a variety of commercial and household disinfectants, soaps, floor waxes, insecticides, and paper product dispensing machines. Among the materials stored in above-ground tanks was creosote, a flammable material then used as the active ingredient in the manufacture of disinfectants, one of WCC's main product lines.

In the 1950s a fire began at the former West Chemical facility within what is now the BCP Site A tract. In an effort to contain the blaze, the New York City Fire Department (FDNY) reportedly cut down the creosote tank. The tank ruptured and the contents ran over the ground and infiltrated the underlying soils. This release is believed to be the principal cause of soil and groundwater impacts at the BCP Sites and on the southern portion of Tax Lot 14. The contaminant source is predominantly on the southernmost edge of Lot 14 and at least 9 feet below grade or near the soil bedrock contact which ranges from 11 to 27 feet below grade.

2.2.2 Previous Investigation Findings

Previous Site investigations identified the following three historic instances of creosote contamination on the adjacent BCP Sites:

- Leaks in the bottoms of several aboveground storage tanks (ASTs) on adjacent BCP Sites. These are believed to all be removed.
- In 1950, the New York City Fire Department (FDNY) deliberately released the contents of a 5,000-gallon AST on adjacent BCP Sites of creosote to the ground during a fire as an explosion prevention measure.
- Former West Chemical personnel identified that creosote was historically delivered to the plant by means of a rail siding and the creosote was pumped into a fill line and delivered to storage tanks on the adjacent BCP Sites.

The following summarizes the history of petroleum bulk storage on the adjacent BCP Sites:

- Two, 500-gallon, gasoline underground storage tanks (USTs) were identified and were removed in 2003. They were located near the parking area that lies along Orchard Street.

- Four heating oil USTs were installed between 1947 and 1948. These USTs were originally used to store No. 6 fuel oil and later converted to No. 4 fuel oil. In 1990, the USTs were closed-in-place and a natural gas-fired heating system was installed. These are located in the western part of Building 10.

- Twenty-two aboveground storage tanks (ASTs) were identified on the Site in the 1940s and 1950s. The ASTs ranged in capacity from 3,000 to 24,000 gallons, with a total tank volume of 260,575 gallons. These have been removed.

- Forty-five process/storage vaults and kettles filled with unknown liquid were encountered in Buildings 2B, 3A, and Buildings 3A and 3B, and 10. The composition of the liquid and quantity, if any, is unknown for all of the units, but water mixed with soap and/or lye is suspected in at least one unit.

Nine previous environmental investigations, beginning in 1988, consisted of varying levels of soil and groundwater investigation, Non-Aqueous Phase Liquid (NAPL) product-level studies, and collection of soil gas data across the Site. Previous investigations included the following studies:

1. *Queens Plaza Site B Investigation*, AKRF, 1988
2. *Outlet City Soil and Groundwater Sampling Results*, AKRF, 1990
3. *Outlet City Property*, Supplemental Site B Assessment/Remedial Investigation, AKRF, 1998
4. *Soil and Groundwater Sampling and Analysis*, ELM, 2001
5. *Site Investigation*, AKRF, 2002
6. *Remedial Investigation*, Fleming-Lee Shue, Inc., August 2007
7. *Additional Remedial Investigation Report (Draft)*, Fleming-Lee Shue, Inc., February 2007 (and updated draft revision February 2010)
8. *Site Characterization Investigation Data Summary*, SCS Engineers, July 12, 2013.
9. *Supplemental Remedial Investigation*, Fleming-Lee Shue, Inc., August 2015.

Soil Contamination

The nine previous investigations (primarily on the adjacent BCP Sites) found that soil contamination originated predominantly from creosote spills and to a lesser extent from petroleum-based spills on the BCP Sites. Much of this contamination is on the southern part of Tax Lot 14 and the western part of the BCP Site.

In August of 2015, five soil borings were advanced to bedrock to characterize soils and the extent of impacts and two monitoring wells were installed to determine groundwater quality. Figure 2 shows the locations of the soil borings and monitoring wells. A total of 21 soil samples (including one duplicate) were collected and analyzed for volatile organic compounds (“VOCs”), semi-volatile organic compounds (“SVOCs”), metals, pesticides, and polychlorinated biphenyls (“PCBs”). The principal impacts occurred in the samples collected from borings SB-4, SB-5, and SB-6, located in the southern portion of Tax Lot 14. The location and concentrations of contaminants detected in soil at levels exceeding regulatory standards is shown in Figure 3. The compounds indicated that the impacts were primarily from VOCs and SVOCs associated with petroleum, creosote, or a petroleum/creosote mixture. Most soils results, except naphthalene, two VOCs, and polycyclic aromatic hydrocarbons (“PAHs”), were below the Part 375 Restricted Residential Soil Cleanup Objectives (“SCOs”) but were above the Protection of Groundwater SCOs.

Soils stained with Non-aqueous Phase Liquid (“NAPL”) were limited to SB-5 and SB-6 located along the southernmost edge of Tax Lot 14. Stained soils in these borings were identified near the bedrock contact. A specific gravity sample of product from Lot 14 measured 0.96, making the material a Light Non-Aqueous Phase Liquid (“LNAPL”).

Groundwater Contamination

In August 2015, two groundwater samples were collected from monitoring wells MW-5 and MW-6 located on Tax Lot 14. The results identified a number of VOCs and SVOCs above Technical and Operational Guidance Series 1.1.1 (“TOGS”) criteria. The location and concentrations of contaminants detected in groundwater at levels exceeding regulatory standards is shown in Figure 4. Most of these compounds are associated with petroleum, creosote, or a petroleum/creosote mixture. A number of chlorinated VOCs above TOGS were also identified above TOGS criteria.

Sub-Slab Vapor and Indoor Air Contamination

In October 2014, three soil vapor samples and one ambient indoor air sample were collected and analyzed for VOCs. No VOCs were detected in the ambient indoor air sample at concentrations exceeding the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion. Concentration of tetrachloroethylene exceeded the NYSDOH guidance values in the duplicate sample and concentration trichloroethylene slightly exceeded the NYSDOH guidance values in one of the soil vapor samples.

3.0 SCOPE OF WORK

This HASP addresses the general activities associated with the planned environmental investigation and remediation of the Site. These activities include, but are not limited to, the following:

- Mobilization/demobilization
    - Mobilization and demobilization of equipment and supplies
    - Establishment of Site access procedures, site security and work zones
- Pre-Investigation Activities
    - Site Inspection, Geophysical Survey
    - Utility Clearance (clearing drilling and sampling locations by identifying utilities) and Permitting
- Investigation Activities
    - Inspection of recognized environmental conditions
    - Soil boring installation and soil sample collection
    - Monitoring well installation and groundwater sample collection
    - Test pit installation (when deemed necessary)
    - Soil vapor and indoor air sampling
    - Investigation derived waste handling and storage activities
- Remedial Activities
    - Grout Wall Installation
    - Soil Removal through Augering
    - Soil and materials management and disposal
    - Collection of samples for remediation (i.e. waste classification, contamination delineation etc.)
    - Sampling, investigation, and remediation
    - Installation of Chemical Oxidation Injection Wells
    - In Situ Chemical Oxidation (ISCO)

The planned environmental investigation and remediation activities are detailed in the succeeding sections.

3.1.2 Soil, Groundwater and Soil Vapor Sampling

Soil Investigation

Soil Boring Installation

Soil borings will be installed throughout the Site. A number of soil borings will be converted into monitoring wells. Because the general subsurface geology of the Site consists of fill, silty sand, with glacial till overlying bedrock, a Sonic drill rig (or equivalent) will be used to advance the soil borings. A Geoprobe direct-push drill rig may be used to advance borings where conditions warrant, such as where borings are shallow and/or inside buildings where access for larger drill rigs is limited.

After the soil borings have been completed, FLS will have a New York State Licensed Surveyor survey the locations.

Soil Screening

Soils will be field-screened using a photoionization detector (PID) and described along the vertical depth of each boring at each sampling location. The PID readings will be documented as well as visual and olfactory observations.

Soil Sampling and Analysis

Soil samples will be obtained by a dedicated plastic liner. The Sonic drill rig sampler will be advanced to collect soil samples down to the proposed development depth or until bedrock is encountered.

The soil samples will be containerized in accordance with EPA analytical protocols. Each sample will be labeled, sealed, and placed in a chilled cooler for shipment to the laboratory and will be analyzed for the following parameters:

- Target compound list (TCL) VOCs by EPA Method 8260
- TCL SVOCs by EPA Method 8270
- Pesticides/polychlorinated Biphenyls (PCBs) by EPA Method 8081/8082

- Target analyte list (TAL) metals by EPA Method 6010/7000

Groundwater Investigation

Monitoring Well Installation

A machine-slotted PVC well screen will be installed into the saturated zone. A No. 1 Morie Sand/equivalent gravel pack will be tremied into the annular space outside the well screen to a minimum of 2 feet above the top of the well screen. A minimum 2-foot bentonite seal will be installed above the gravel pack. Any remaining annular space will be sealed with a Portland cement mix. A surface completion consisting of a flush-mounted, watertight manhole will be cemented into the pavement above the well. The monitoring wells will be developed by pumping with a submersible pump until the discharge is silt-free. Other existing monitoring wells on the Site will also be developed. Diagrams of the construction of the newly installed wells along with the existing ones will be provided in the final report. The wells will be allowed to equilibrate for a minimum of 1 week prior to sampling.

Monitoring Well Gauging

A synoptic round of water-level measurements from the newly installed wells will be collected along with the existing monitoring wells. FLS will also retain a New York State Licensed surveyor to survey the well locations and the top of casing elevations.

Groundwater Sampling and Analysis

Groundwater samples will be collected from each of the monitoring wells using low-flow sampling methods. One trip blank will also be analyzed for quality control. The groundwater samples will be analyzed for the following parameters:

- TCL VOCs by EPA Method 8260
- TCL SVOCs by EPA Method 8270
- Pesticides/polychlorinated Biphenyls (PCBs) by EPA Method 8081/8082
- TAL metals by EPA Method 6010/7000

Soil Vapor Investigation

There is potential to collect soil vapor samples at locations throughout the Site. If required, the following procedures will be implemented. Soil vapor samples will be collected from temporary soil vapor sample points installed to two feet below the floor slab. At each sample location, a 0.5-inch diameter and 3.5-inch long decontaminated stainless steel sampling probe will be driven approximately 2 feet into the underlying soil under the basement floor slab. The sampling probe will be retracted approximately 4-inches to expose a sampling screen. The borehole above the sampling probe will be sealed with clay to prevent ambient above-ground air from mixing with the soil vapor. To ensure a satisfactory seal above the sampling probe, helium will be utilized to enrich the atmosphere above the sealed borehole. Soil vapor will be purged through a 0.25-inch polyethylene (PE) tubing and screened for the presence of helium, utilizing a calibrated MGD2002 helium leak detector. Once it was confirmed that helium is not being detected in the soil vapor and an appropriate seal was constructed, the soil vapor point will be purged at a flow rate of approximately 0.2 liters per minute (Lpm). Following the purging procedure, an individually-certified clean 6-liter SUMMA canister with a 2-hour regulatory control valve will be connected to the PE tubing to collect a representative soil vapor sample.

Investigation Derived Waste Management

All investigation derived waste (IDW) generated during the Site investigation activities will be direct loaded or stockpiled on-site or the adjacent BCP Site, An appropriate waste designation will be assigned based on the remedial investigation results and the IDW will be properly disposed of according to local, state, and federal regulations.

3.2 Description of Tax Lot 14 Remedy

The proposed remedy for Tax Lot 14 contemplates the following:

- installation of a perimeter containment cut-off wall (grout wall) around four sides of Tax Lot 14 to isolate contamination onsite;

- *in situ* chemical treatment to address and treat residual soil and groundwater contamination within the isolated grout wall perimeter; and

- Limited source removal via drilling in the southern portion of Tax Lot 14 to reduce the residual contaminant mass.

The Tax Lot 14 remedy does not include grout wall drilling, source removal drilling or *in situ* chemical oxidation on the northern portion of Tax Lot 14 under the Tower A footprint since this area of the Site contains very little contaminated media per the findings of the Remedial Investigation and these remedies are subject to restrictions imposed by the MTA due to proximity of the underlying and adjacent subway tunnel. The northern portion of Tax Lot 14 under the proposed building footprint extends 56 feet south of Jackson Avenue and currently contains a pile field, pile caps, and building foundation elements in place which would preclude any deep remedial work in this portion of the site.

The northern portion of Tax Lot 14 will contain a vapor barrier and SSDS common to both BCP Site A and under the proposed building footprint on Tax Lot 14 to prevent soil vapor intrusion into the proposed building. Provided below is a description of means and methods to implement the proposed remedy.

3.2.1 Extent of Soil Removal via Drilling

Soils will be removed via auger drilling to extract grossly contaminated source material and to install the grout cut-off wall for hydraulic containment. The cut-off wall will consist of overlapping, 14-inch-diameter borings drilled with casings to bedrock and grouted to grade. The borings will be drilled on 12-inch centers such that the borings overlap and form a continuous, impermeable barrier between Lot 14 and BCP Site A from bedrock to ground surface. The cut-off wall will extend from the southwest corner of Lot 14 northward for 69 feet along the property line and then will turn 90 degrees and run east approximately 20 feet to within 3 to 5 feet of the adjacent MTA building. Once adjacent to the MTA building, the grout wall will run south 69 feet to key into the secant wall present on the southern border of Tax Lot 14. Figures 5 and 6 show the layout and cross-section, respectively, of the proposed grout cut-off wall.

In addition to drilling the perimeter grout wall, augered bore holes will be drilled within the south central portion of Tax Lot 14 to remove grossly contaminated soil. This drilling will consist of an estimated 28 borings spaced 3 feet apart within the southern 10 feet of Tax Lot

14, and the existing secant wall. Once completed, each bore hole will be grouted to grade with the same material as the cut-off wall.

Soil with LNAPL, DNAPL, creosote, or petroleum staining may be expected. Some of the soil will be extremely odorous. To control dust, suppression methods will be achieved through the use of hydrants and hoses for road wetting. The hoses shall be of sufficient length to reach all portions of the site. Water will be available on-site at suitable supply and pressure for use in dust control. To control odors procedures may include the following: (a) limiting the area of open excavations; (b) shrouding open excavations with tarps and other covers; and (c) using foams to cover exposed odorous soils. If odors develop and cannot be otherwise controlled, additional means to eliminate odor nuisances will include: (d) direct load-out of soils to trucks for off-site disposal; (e) use of chemical odorants in spray or misting systems; and, (f) use of staff to monitor odors in surrounding neighborhoods.

3.2.2 ISCO Injection Program

As discussed, an ISCO injection program will be performed to address contaminated groundwater beneath the Site. FLS will provide oversight and HASP implementation during the installation and implementation of a chemical oxidation remediation system and during the collection of confirmatory groundwater samples after the remedy is completed.

As a result of the concentrations of VOCs and SVOCs, alkaline activated persulfate is proposed as the most likely oxidant subject to MTA approval. Since this is a very strong oxidant, and is a source of sulfate, persulfate, in addition to oxidizing the contaminant directly, adds a source of sulfate that promotes natural degradation of contaminant once the oxidant has been expended. A product brochure of Klozur® persulfate is provided in Appendix G.

The chemical oxidant will be injected into three existing injection wells (IW-4, IW-5 and IW-6). The oxidant will be distributed evenly among the injection wells using a 5% to 8% solution. Volume and density application rates for the chemical oxidant will be based on the manufacturer's recommendations and a bench scale treatability study that is ongoing.

The injection wells construction details are provided in Table 1. The injections will occur at a depth of approximately eight to 13 feet below ground surface in IW-5 and IW-6 and 23 to 28 feet below ground surface in IW-4. All injections will take place below the water table. The locations of the injection wells are shown on Figure 7.

Klozur® will be transported in accordance with DOT regulations and stored in bulk in a specified location on Site away from any residences, structures or flammable materials. Smaller quantities will be distributed to the work area for use in remediation activities. The chemicals will be transported to the work area in accordance with DOT regulations, and handled by workers utilizing eye and skin protection. All handling will take place in well-ventilated areas, if ventilation becomes limited, respiratory protection will be used. MSDS's for these chemicals are will be on file at all times. The contractor will provide task specific HASP materials.

4.0 PROJECT TEAM ORGANIZATION AND RESPONSIBILITIES

All personnel who participate in field activities will be required to attend a Health and Safety meeting prior to the commencement of field activities. The Health and Safety meeting will include all personnel and members of the Site Project Team. All Site workers must review and comprehend this HASP before entering the Site. The HSO or designee will ensure that personnel have reviewed the HASP and will provide an opportunity to ask health and safety questions during attendance at a pre-field safety meeting. Field personnel will sign the acknowledgment form (Attachment I) maintained on-Site by the HSO. The Site Project team organization and roles are described below.

Health and Safety Officer

- Administers all aspects of the occupational health and safety program to FLS and AFF personnel
- Develops programs and technical guidance to identify and remove physical, chemical, and biological hazards from facilities, operations, and sites
- Assists management and supervisors in the health and safety training of employees
- Conducts inspections to identify unhealthy or unsafe conditions or work practices. Takes immediate corrective action.
- Investigates all accidents and takes action to eliminate accident causes
- Monitors to determine the degree of hazard
- Determines the protection levels and equipment required to ensure the safety of personnel
- Evaluates on-site conditions (i.e., weather and chemical hazard information) and recommending to the project manager and/or the field coordinator, modifications to the work plan and personnel protection levels
- Monitors performance of all personnel to ensure compliance with the required safety procedures
- Ensures that all personnel have been trained in proper site-safety procedures including the use of Personal Protective Equipment (PPE), and have read and signed the Acknowledgment Form (Attachment I)
- Conducts daily health and safety briefings as necessary
- Halts work if necessary
- Ensures strict adherence to the Site HASP

- Reviews personnel medical monitoring participation to ensure compliance
- Records safety infractions and corrective actions in field log
- Notifies subcontractors of unsafe conditions
- Ensure overall project objectives are being met
- Ensures that safety equipment is available
- Requires all subcontractors and subcontractor personnel to comply with health and safety regulations

Project Manager

- Ensure overall project objectives are being met
- Supports HSO

All FLS and AFF Employees

The minimum personal qualifications for each individual participating in field activities are as follows:

- Has had all OSHA-specific medical examinations including, but not limited to, audiometric testing under the hearing conservation program and medical approval for the use of respirators
- Participation in the FLS Occupational Health Monitoring Program
- Successful completion of the 40-hour OSHA health and safety training for hazardous material sites (29 CFR 1910.120[e][3][i]) and valid/up-to-date 8-hour refresher training (29 CFR 1910.120[e][4])
- Be familiar with and comply with proper health and safety practices
- Use the required safety devices and proper personal protective safety equipment
- Notify HSO/supervisor immediately of unsafe conditions/acts, accidents, and injuries
- Be alert on Site and communicate unsafe conditions and safety infractions immediately.

Visitors

- Must be escorted upon entering the work location if they meet the health and safety requirements stated above. All non-qualified visitors will be limited to the support zone(s) for observation purposes.
- Be familiar with and comply with proper health and safety practices

- Use the required safety devices and proper PPE
- Be alert on site and communicate unsafe conditions and safety infractions immediately.

5.0 POTENTIAL CHEMICAL, PHYSICAL AND BIOLOGICAL HAZARDS AND CONTROLS

This section discusses the potential chemical, physical, and biological hazards and controls associated with the investigation tasks above. A summary of potential Site tasks, safety hazards, and safety requirements is presented in Table 1.

5.1 Site–Specific Potential Chemical Hazards/Controls

Based on data collected during previous investigations, the potential chemical hazards are creosote, petroleum hydrocarbons, and creosote-based SVOCs. The following are chemicals of concern:

- Creosote
- VOCs
    - Benzene
    - Toluene
    - Ethylbenzene
    - Xylene
- SVOCs
    - Polycyclic Aromatic Hydrocarbons
- Metals
    - Arsenic
    - Cadmium
    - lead
    - Mercury

Attachment III lists the recognized and suspected health hazards, exposure limits, physical and chemical properties, recommended protection levels and symptoms of exposure for the chemicals known or suspected. Any chemical hazards will be minimized by limiting exposure of personnel to soil and groundwater and by engineering control and PPE.

5.2 Physical Hazards/Controls

Physical hazards potentially present at the Site include, but are not limited to, the following:

Hazard	**Control**
Slip, trip and fall (uneven terrain and slippery surfaces)	Avoid uneven terrain, walk slowly, wear sturdy/supportive shoes
Environmental (heat/cold) stress	A discussion of heat stress and cold stress and related illnesses and controls is provided in Attachment IV.
Dust/Particulate Inhalation Hazard	Dust suppression and monitoring will be employed during this effort. A discussion of the dust suppression plan is presented in Section 7.11. The air monitoring requirements are presented in Section 8.0.
Vehicular Traffic	Avoid working in high traffic areas. If necessary, use cones, reflective vests, and consider use of a flagman/additional protection.
Fire	Ensure class ABC fire extinguisher is nearby to work area when using equipment that can provide an ignition source (heavy machinery, generators, power tools)
Noise hazards	Use ear plugs and/or ear muffs during demolition and excavation activities.
Use of heavy equipment	Stay clear of heavy equipment during operation. Maintain eye contact with operator when approaching equipment.
Flying/Falling Debris	Safety glasses and hard hats will be used during all demolition and excavation activities. Be vigilant.

Anticipated Site operations do not include the need for specific operations such as lockout/tag-out, scaffolds or confined spaces; therefore these items are not addressed in this HASP. If Site activities require these operations, the HASP will be amended and personnel properly trained, experienced and competent personnel shall be utilized.

5.3 Changing Conditions

Physical conditions change on Site and it is important to recognize this situation. One type of changing condition is the temporary enclosure. The structure is vulnerable to movement by wind or equipment and may become unstable with shifting ground and vibration. A growing excavation and building demolition may alter stability. It is important to be mindful of this potential and to periodically look for unsecured or damaged components supporting the structure. If these conditions occur, they should immediately be brought to the attention of the HSO and construction manager.

Other potentially changing conditions include gases and depth of excavation. As the excavation deepens below the breathing zone, it is possible for gases/vapors denser than air to accumulate. These gases must be monitored before entering the excavation or enclosure. This is especially true at the beginning of each work day after gases have had all night to accumulate. If air monitoring results identify concentrations above their established action levels, localized ventilation may be used to reduce the concentrations to below the action levels prior to the start of work.

5.4 Biological Hazards

General biological hazards present at the Site include, but not limited to, the following:

- Bites or stings from insects (particularly ticks) resulting in skin inflammation, disease, or allergic reaction
- Allergens and toxins from plants and animals, producing dermatitis, rhinitis, or asthma
- Rodent and/or bird droppings inside vacant buildings

6.0 HEALTH AND SAFETY PROTOCOL

6.1 Site Work Hazard Evaluation

Upon review of contaminant levels and physical hazards, exposure routes and the nature of the remediation/excavation/construction tasks, it has been determined that Level D protection will be used to start all FLS/AFF field activities with a contingency to upgrade to Level C protection if warranted. Air monitoring and action levels for the appropriate level of PPE appear in Table 2.

6.2 Training

Knowledge of the safety rules, supplemented by compliance, is essential to safety. New employees will be provided orientation training by qualified personnel having at a minimum the 40-hour OSHA HAZWOPER training and will be furnished information and literature covering the company health and safety policies, rules, and procedures. This orientation training must be provided prior to the employee's visit to the Site. Employees must read the HASP and project-specific Work Plan, which contains the applicable regulations/standards for their job.

Prior to beginning work on-Site, and weekly thereafter, the HSO will lead safety-training sessions and/or "tailgate" training meetings. These meetings will be conducted to provide information and training on new equipment, new procedures, new chemicals, refresher/remedial training in specific areas, or meet annual requirements. Such training may be held in conjunction with the safety briefings/meetings addressed elsewhere in this program. If necessary, the HSO will ensure that employees are scheduled and provided specialized training as required. Examples of specified training include (but are not limited to):

- Safe handling/use of flammables, poisons, or toxics
- Confined space entry (Not anticipated)
- Respirator care/use
- Hazard communication (hazardous chemicals)
- Slip, trip and fall hazards and fall protection
- Lockout/tagout procedures (Not anticipated)
- Scaffold use, and erection/dismantling (Not anticipated)
- Blood-borne Pathogens (Non-Medical)

Specialized training will be documented in the employees' personnel records and/or in a master training record.

6.3 Personal Hygiene

Eating, drinking and the use of tobacco products in the work area are prohibited. The use of alcohol at the work site is prohibited. Field personnel taking prescription or non-prescription medication that could impair function or cause drowsiness should alert the HSO before work begins. Beards or facial hair that could interfere with the use of a respirator are not permitted. Dermal contact with groundwater or soil should be avoided. This includes avoiding walking through puddles, pools, and mud, sitting or leaning on or against drums, equipment, or on the ground. Field personnel should wash their hands before eating, smoking, using the toilet, etc. Field personnel should wash their hands and face and shower (daily) as soon as possible after leaving the site.

6.4 Levels of Personal Protection

All PPE must be worn as required for each job in all operations where there is an exposure to hazardous conditions. A general description and discussion of the levels of protection that will be used for the Site are presented in the succeeding sections.

6.4.1 Level D

Level D applies to work in areas where the possibility of contact with potentially contaminated media exists. The protective equipment required for Level D includes, but is not limited to, the following:

- Work clothes or coveralls
- Safety boots, with steel toe
- Safety glasses or face shield
- Hard hat
- Reflective vest
- Disposable nitrile gloves
- Hearing protection as needed

6.4.2 Level C

Level C is required when the action levels are exceeded per Table 2. Level C protection will include, but is not limited to, the following:

- Protective clothing and other equipment required for Level D
- Full-face air purifying respirator (APR) with the combination cartridges for organic vapors, acid mist, and particulates cartridges. Coated disposable coveralls with hoods, as necessary
- Boot covers

6.5 General Workplace Safety Rules

- Report unsafe conditions, accidents, injuries, or incidents to the HSO and Project Manager—immediately.
- Use eye and/or face protection where there is danger from flying objects or particles, (such as when grinding, chipping, burning and welding, etc.) or from hazardous chemical splashes.
- Dress properly. Loose clothing and jewelry shall not be worn.
- Keep all equipment in safe working condition. Never use defective tools or equipment.
- Report any defective tools or equipment to immediate supervisor.
- Properly care for and be responsible for all PPE.
- Do not leave materials in aisles, walkways, stairways, work areas, roadways, or other points of egress.
- Practice good housekeeping at all times.
- Training on equipment is required prior to unsupervised operation.
- During work, pause every few minutes and assess surrounding conditions—Be alert!
- For personal safety, be cognizant of your surroundings and ensure that equipment is properly secured.

6.6 Construction Equipment Safety Rules

A discussion of health and safety issues related to FLS and AFF employees performing work in the vicinity of common construction elements, such as electrical; compressed gas cylinders; ladders; aerial lifts; cranes; welding and brazing; tools; safety railings and other fall protection; scaffolds; excavations and trenches; motor vehicles and mechanized equipment, is provided in Attachment V.

6.7 Spill Containment Program

The cleanup of a chemical spill should only be done by knowledgeable and experienced personnel. Spill kits, consisting of absorbents and protective equipment should be available to clean up minor spills. A minor chemical spill is one that the FLS and AFF staff is capable of handling safely without the assistance of emergency personnel. All other chemical spills are considered major. For a major spill, contact the HSO.

Procedure for Responding to a Minor Chemical Spill

- Contact HSO to obtain guidance
- Alert people in immediate area of spill
- Wear PPE, minimum level D—**First assess the spill to determine whether you have sufficient protection to continue**
- Upgrade to level C to avoid breathing vapors from spill
- Confine spill to small area using absorbent, debris, soil etc.
- Absorb spill with vermiculite, dry sand, or oil-sorbent pads
- Collect residues, place in DOT-approved containers (labeled) and dispose as chemical waste
- Clean spill area

7.0 INDIVIDUAL SAFETY AND HEALTH PROGRAMS LISTING

The OSHA standards specify various individual programs that may be applicable to work performed on construction sites. Highlights of these programs are provided below, and specific written programs or procedures may be included into this written program, attached, or developed separately.

7.1 Hazard Communication Program

If employees are exposed to or work with hazardous chemicals at the job site, this program is required. Important elements of the written program are required to include a master listing of chemicals, maintaining material safety data sheets on each chemical, and training of employees on the program, the chemicals exposed to, and safety data sheets.

7.2 Confined Space Entry Program

If employees enter a confined space that contains or has the potential to contain an atmospheric or physical hazard, this program is required. Either the ANSI Z117.1-1989 Safety Requirements or Permit-Required Confined Space Program per OSHA (29 CFR 1910.146) must be used as guidance to develop the company's program. Primary elements of the program are identification of applicable confined spaces, testing/monitoring, control or elimination of hazards, protective equipment, entry authorization, attendants, training, and rescue.

No FLS or AFF employee is authorized to enter a confined space without the specified training AND notifying the HSO and project manager.

7.3 Respiratory Protection Program

If employees are exposed to hazardous chemical, dusts, or aerosols above the OSHA Permissible Exposure Limits or ACGIH Threshold Limit Values, and/or employees wear respirators, this program is required. Program elements are written for the selection, maintenance, care, and use of respirators; fit testing, training, and employee evaluation for use.

7.4 Occupational Noise Exposure/Hearing Conservation Program

If employees are exposed to noise levels above 85 decibels on the A scale (85 dBA), protection against the effects of noise and an effective hearing conservation program are required. Such a program would include elements such as written program, noise monitoring, hearing evaluations and follow-on testing, personal protective equipment (hearing protection), and maintenance of medical records.

7.5 Lockout/Tagout Program

If employees deactivate or de-energize electrical controls, equipment, or circuits and are thus exposed to electrical energy, this program is required. Program elements include lockout when possible, tagout when lockout not possible, and the employer providing and controlling lockouts.

7.6 Assured Equipment Grounding Conductor Program

If the employer uses assured equipment grounding verses ground fault circuit interrupters to provide employee electrical grounding protection, this program is required. Program elements include the inclusion of all cord sets, receptacles and cord/plug connected equipment and tools; a written program; quarterly testing; recording of each test by logging, color coding, or other equally effective means; and designation of a competent person to run the program.

7.7 Emergency Response Plan

If employees are engaged in emergency response to a hazardous substance/chemical release, an emergency response plan must be developed and implemented to handle anticipated emergencies. Program elements include a written response plan, identification and training of responding employees, medical surveillance and consultation, and post response operations.

7.8 Dust Suppression Plan

The following techniques have been shown to be effective for the controlling of the generation and mitigation of dust during construction activities:

- Applying water on haul roads
- Wetting equipment and excavation faces
- Spraying water on buckets during excavation and dumping
- Hauling material in properly sealed or watertight containers

- Restricting vehicle speeds to 10 miles per hour (mph)
- Covering excavated areas and material after excavation activity ceases
- Reducing the excavation size and/or number of excavations
- Applying dust suppressants such as calcium chloride, water, or gravel in high vehicle traffic areas
- To evaluate the effectiveness of the dust suppression measures, air-monitoring utilizing real-time dust-monitoring equipment will be performed. The requirements for air monitoring during soil disturbance activities are presented in Section 7.

7.9 Building Access

FLS and AFF employees are prohibited from entering buildings or other structures deemed unsafe and/or structurally unsound. Building 4 has been determined to pose a Class-1 Immediately Hazardous condition for structural reasons by the New York City Department of Buildings (NYC DOB).

The NYC DOB ECB Violation Number 34993699N (2/08/13) reads:

"FAILURE TO MAINTAIN BLDG WALLS OR APPURTENANCES; NOTED: AT EXPOSURE #1 (ORCHARD STREET SIDE) OBSERVED VERTICAL CRACK FROM 1ST FL TO PARAPIT WALL AT ROOF LINE, WALL BULGING, SEPARATION AT CRACK APPROX. 2", BROKEN"

7.10 Site-Specific Health and Safety Guidelines

Site-Specific Health and Safety guidelines are included in Attachment VI.

8.0 AIR QUALITY MONITORING AND ACTION LEVELS

Air quality monitoring equipment will be used during all work to monitor total organic vapors, dust, O2, LEL, H_2S, CO, and mercury. A PID (to monitor total volatile organic concentrations), a particulate monitor, a combustible gas indicator , an oxygen meter, colorimetric tubes, a CO meter, and a Jerome meter will be used during on-Site activities. Air monitoring requirements by field activity is specified in Table 1. The instruments will be calibrated daily or as necessary due to field conditions and the results noted in the project field book. A background level will be established, at a minimum, on a daily basis, and recorded in the field book. The action levels and required responses are listed in the Table 2.

9.0 SITE/WORK AREA MANAGEMENT

Per the OSHA HAZWOPER regulation, site control measures shall be implemented to protect the workers and public. A typical Site work area will consist of an exclusion zone where the actual field activity will take place, a contaminant reduction zone, and a support zone located outside the contaminant reduction and exclusion zones. The HSO will implement these zones based on the work activities that will be performed in each area. The size of the zones will be based on work activities, equipment usage, and air monitoring results. Only 40-hour HAZWOPER-trained personnel will be allowed beyond the support zone.

Levels of personal protection in the exclusion zone will vary depending on air monitoring data, and will be specified by the Site HSO.

Fences, guardrails, and access control devices shall be provided and maintained by the construction contractor throughout the project activities in accordance with 29 CFR 1926. In addition, barricades, warning signs and devices, temporary lighting and other safety measures shall be provided by the construction contractor, as required, to protect site personnel.

9.1 Work Zones

Entry into the work zones begins once a person comes on Site. This approach reflects the dynamic nature of the operations and the need for everyone to be aware of the conditions while on-site. Using the concept of three zones for the Site, the following areas are identified:

Exclusion Zone

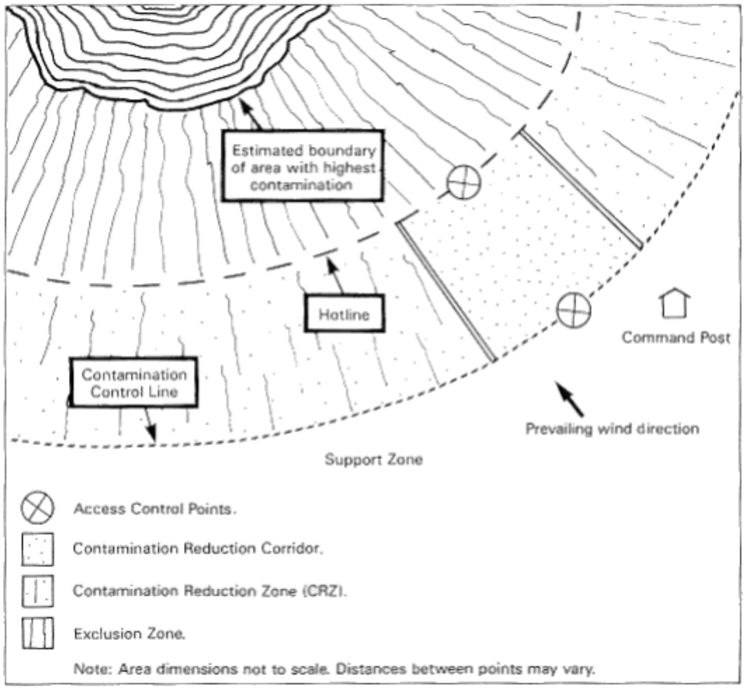
The Exclusion Zone (EZ) will be within a designated area to be determined based on where field activities will take place. No worker shall enter the Exclusion Zone without the required training and PPE. In the event that a worker in the EZ requires a replacement or his/her protective suit or respirator filters, the worker shall exit the EZ and utilize proper decontamination procedures in the CRZ, replace or repair the defective PPE, then re-enter the EZ.

Contamination Reduction Zone

The Contamination Reduction Zone (CRZ) will be within a designated area to be determined based on where field activities will take place. Workers shall be aware of and follow all Site control procedures with respect to entering and exiting the CRZ, to ensure that they are not exposed to contaminants and to minimize the potential for contamination of workers and the spread of contamination outside the EZ. These measures include having workers follow the proper procedures for donning and doffing PPE and washing in the CRZ. The measures also address the decontamination procedures for use when moving equipment between zones. The CRZ shall consist of an area to drop off equipment, plastic bags to dispose of protective clothing, adequate soap and water for workers and equipment decontamination and a means of capturing wash water generated during decontamination.

Support Zone

This area starts at the project/property fence line and extends to the entry to where field work will be conducted. In this area all personnel shall wear Level D PPE. An example of the exclusion zone layout appears below. (Source: https://www.osha.gov/Publications/complinks/OSHG-HazWaste/9-10.pdf.



9.2 Personnel Decontamination

Decontamination (decon) of personnel consists of physically removing soil or contaminants using the correct procedures for washing and removal of PPE. Decon will take place in the designated decontamination zone using the following steps:

Within the CRZ, the following stations will be established for the decontamination of equipment and personnel wearing Level D and Level C protection:

- Station 1: Equipment Drop – equipment used in the exclusion zone is left for use when returning to work after breaks or stored in a designated area at the end of each work day.

- Station 2: Equipment and Personal Protective Equipment Decontamination – If the equipment will be removed from the site, the equipment will be washed or wiped with a mild soap solution (e.g. Alconox or equivalent) and rinsed with clean water and wiped dry. Wash and rinse buckets with brushes should be set up in this station along with containers for trash and water containment for disposal purposes. Plastic sheeting can be used to collect material for containerization and proper disposal.

- Station 3: Respirator Cartridge Change Out – expired respirator cartridges are exchanged for new cartridges and the worker returns to the exclusion zone.

- Station 4: Change Out – removal of boots, gloves, and disposable coveralls. All PPE will be collected and containerized for proper disposal.

- Station 5: Respirator Removal – worker can remove respirator upon arrival at this station. The respirator will receive final cleaning, dried, and properly stored for future use. Workers can then clean their hands with soap and water and proceed to the clean zone.

Level D decontamination stations can be set up in a similar manner as described above with the elimination of Station 3 and Station 5.

9.3 Vehicle Decontamination

For large equipment such as excavators, backhoes, and haul vehicles, a bermed decontamination pad lined with plastic sheeting should be set up to wash the equipment and contain the rinse water prior to leaving the site. A power washer should be used to remove soil and other materials from the entire vehicle before it leaves the containment area. The rinse water should be collected and containerized for disposal.

10.0 EMERGENCY AND CONTINGENCY PLAN

Emergency communications will be maintained during all on-site field activities. The emergency route to the hospital is depicted on Figure 3 and emergency contacts and their phone numbers are presented in Table 3.

A first aid kit will be available on-site at all times for any minor on-site injuries. Emergency medical assistance or ambulance can be reached by calling 911 for more severe injuries.

All OSHA recordable injuries and illnesses will be reported using OSHA Form 301 (Attachment VII).

General Emergency Response Procedures:

Any employee discovering a fire, explosion, or release of hazardous materials, which could potentially harm human health, or the environment, must immediately notify 911 to activate appropriate emergency procedures.

The following steps will be taken to expeditiously secure the appropriate assistance:

- Ascertain pertinent information (location, type of emergency condition, presence of possible victims which may be hurt or trapped nearby to the condition) and immediately contact and provide this information to 911 emergency personnel.
- Identify yourself and give the exact location first, then the type of emergency, and the presence of possible victims which may be hurt or trapped nearby to the condition. Then await the arrival of emergency response police officers, staying a safe distance from the emergency condition if warranted.
- Contact the FLS HSO and Project Manager and notify them of situation while waiting for emergency personnel.
- If possible, have a responsible person nearby to help flag down responding emergency services personnel as they respond.
- Emergency response personnel will assess the reported emergency and advise what appropriate action needs to be taken (i.e., evacuate an area).

Unless specifically trained to handle an emergency of the type you may be reporting, please do not attempt to render assistance in handling the emergency unless ordered to do so by competent authority or emergency services personnel.

Emergency Medical Services

In the event of an injury or illness that requires medical treatment, the HSO will contact emergency services by dialing 911 (ambulance) for the transportation of the individual. In the event ambulance service is not available or the response time is not suitable, the following are driving directions to the hospital:

HOSPITAL

Mt Sinai Hospital of Queens:
2510 30th Ave, Astoria,
On 30th Avenue
Between Crescent Avenue and 29th Street
NY 11102, US

(718) 932-1000 (main line)

- Proceed northeast on Northern Boulevard
- Continue on 31st Street
- Turn left on 30th Street, arrive at destination

Figure 3 provides a map and route to the hospital.

Figures

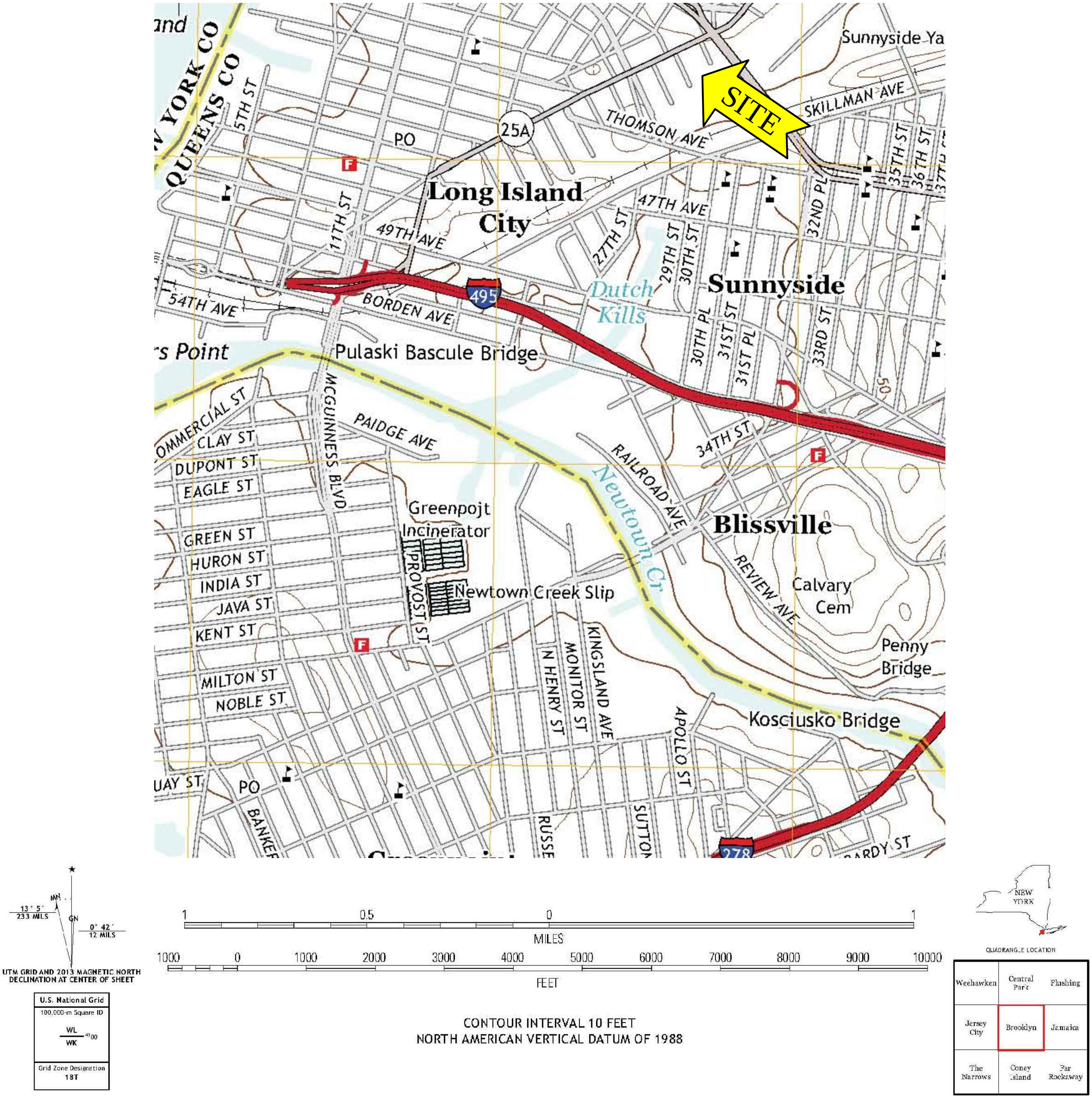
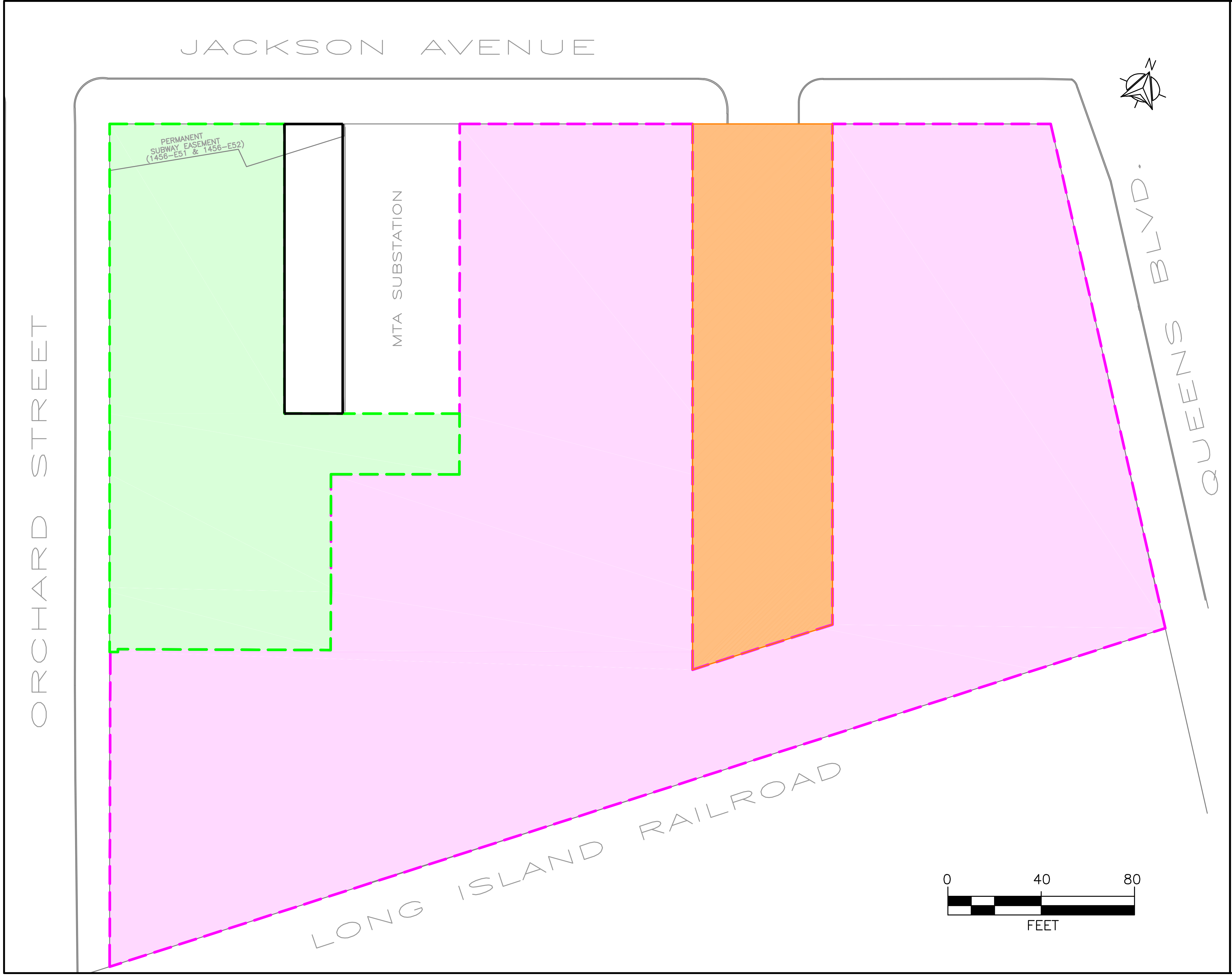


FIGURE 1: SITE LOCATION MAP

Fleming
Lee Shue

SITE: Queens Plaza Off Site Tax Lot 14
Long Island City, NY
CLIENT: LIC Development Owner, L.P.



Fleming Lee Shue
Environmental Management & Consulting

158 West 29th Street, 9th Fl.
New York, NY 10001

Queens Plaza Residential Development

FIGURE 2

SITE LAYOUT

September 2015

Project Number
10112-007

LEGEND

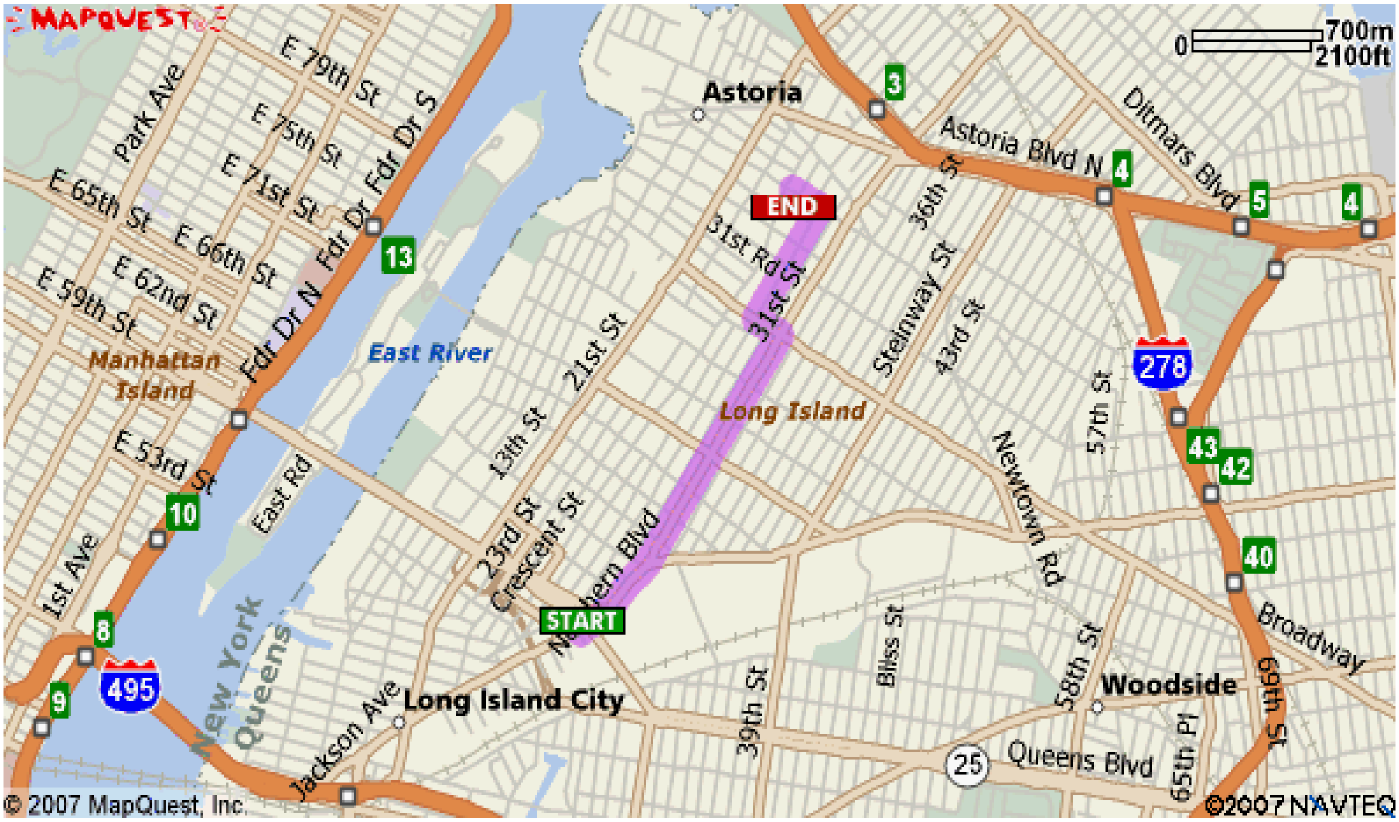
🟩 BCP SITE A

🟪 BCP SITE B

🟧 BCP SITE C

▭ LOT 14

FILE: P:\Project Files\99999 – Tishman\Figures\Lot 14 – Alternatives Analysis\FIG 2 – Site Plan.dwg DATE: 9/11/2015



Mt Sinai Hospital of Queens:
2510 30th Ave, Astoria, NY 11102, US

Directions Distance **Total Est. Time:** 6 minutes **Total Est. Distance:** 1.76 miles

START 1: Start out going NORTHWEST on WEST ST toward JACKSON AVE / NY-25A. <0.1 miles

→ 2: Turn RIGHT onto JACKSON AVE / NY-25A. Continue to follow NY-25A. 0.2 miles

↰ 3: Turn SLIGHT LEFT onto 31ST ST. 0.8 miles

← 4: Turn LEFT onto BROADWAY. <0.1 miles

→ 5: Turn RIGHT onto 29TH ST. 0.3 miles

← 6: Turn LEFT onto 30TH AVE. 0.1 miles

END 7: End at **Mt Sinai Hospital of Queens:** 2510 30th Ave, Astoria, NY 11102, US

Fleming
Lee Shue

FIGURE 3: ROUTE TO THE MOUNT SINAI HOSPITAL OF QUEENS

SITE: Queens Plaza Off Site Tax Lot 14
28-18 Jackson Avenue, Long Island City, Queens, NY
CLIENT: TST LIC Development LLC

Tables

Table 1 – Tasks, Safety Hazards & Safety Requirements

Task/Activity	Hazards	Preventative Measures	Air Monitoring Requirements
Pre-characterization Soil Sampling with Test Pits or Soil Borings	Subsurface utilities, vehicle hazards, trips, falls, materials handling, VOCs, SVOCs, and metals.	Clear utilities beforehand, use normal sampling procedures, exercise caution around equipment and excavations, wet area if necessary to control dust and odors. PPE as required.	PID measurements for VOCs, colorimetric tubes for benzene, particulate monitoring for SVOCs and metals, and Jerome measurements for Mercury (test pits only)
Excavation - Outside	Subsurface utilities, vehicle hazards, trips, falls, materials handling, VOCs, SVOCs, and metals. Falling objects, LNAPL, DNAPL, LEL, noise, vibration	Clear utilities beforehand, exercise caution around equipment and excavations, wet area if necessary to control dust and odors. PPE as required. Check for accumulation of vapors after period of inactivity.	PID measurements for VOCs, colorimetric tubes for benzene, particulate monitoring for SVOCs and metals, Jerome measurements for Mercury, and LEL measurements.
Excavation – Inside Enclosure	Subsurface utilities, vehicle hazards, trips, falls, materials handling, VOCs, SVOCs, and metals. Falling objects, LNAPL, DNAPL, CO, CO_2, LEL, noise, vibration	Clear utilities beforehand, exercise caution around equipment and excavations, wet area if necessary to control dust and odors. PPE as required. Check for accumulation of vapors each morning and after period of inactivity.	PID measurements for VOCs, colorimetric tubes for benzene, particulate monitoring for SVOCs and metals, Jerome measurements for Mercury, and CO, CO_2, LEL measurements.
UST Removal	Subsurface utilities, vehicle hazards, trips, falls, materials handling, VOCs, SVOCs, and metals. Falling objects, LNAPL, DNAPL, LEL, noise	Clear utilities beforehand, exercise caution around equipment and excavations, wet area if necessary to control dust and odors. PPE as required.	PID measurements for VOCs, colorimetric tubes for benzene, particulate monitoring for SVOCs and metals, Jerome measurements for Mercury, and LEL measurements.
Kettle Investigation and Cleaning	Vehicle hazards, trips, falls, materials handling, VOCs, lye, and unknowns	PPE as required with the addition of a face shield to protect against splashing.	PID measurements for VOCs, colorimetric tubes for benzene, and Jerome measurements for Mercury.

LEL - Lower Explosive Limit
PID - Photoionization detector
VOCs - Volatile organic compounds
SVOCs - Semi-volatile organic compounds
LNAPL - Light non-aqueous phase liquid
DNAPL - Dense non-aqueous phase liquid

Table 2 Air Monitoring, Action Levels, PPE

Instrument	Action Level	Response Action
Gas/Vapor		
PID	<0.5 ppm total VOCs in the workers' breathing zone (WBZ)	Continue work in Level D
PID	>0.5 ppm for a sustained period of 5 minutes in the WBZ	Use detector tube to measure benzene concentration
Colorimetric detector tube	> 0.5 ppm for benzene in the WBZ	Discontinue work and allow the work area to vent. Use mechanical ventilation as necessary. If after 15 minutes the benzene concentration is still greater than 0.5 ppm, upgrade to Level C, notify HSO
PID	1 to 10 ppm in the WBZ (no benzene)	Continue work in Level D
	> 10 ppm for a sustained period of 5 minutes in the WBZ (confirmed absence of benzene)	Discontinue work and allow the work area to vent. Use mechanical ventilation as necessary. If after 15 minutes the PID reading is still greater than 10 ppm, upgrade to Level C, notify HSO
	> 100 ppm for a sustained period of 5 minutes in the WBZ	Stop work. Resume work when readings are less than 100 ppm
Combustible Gas Indicator	Less than 20% LEL	Continue work
	Greater than 20% LEL	Stop work. Resume work when less than 20% LEL
Oxygen Monitor	Above 19.5% and less than 23.5%	Continue work
	Outside of this range	Stop work. Resume work when concentration is back in this acceptable range
Carbon Monoxide Monitor	Less than 25 ppm	Continue work
	Above 25 ppm	Stop work. Use mechanical ventilation as necessary. Resume work when less than 25 ppm.
Carbon Dioxide Monitor	<1000 ppm	Continue work
	>1000 ppm	Stop work. Use mechanical ventilation as necessary. Resume work when less than 1000 ppm.
Particulates		
Particulate Monitor	<100 µg/m^3 above background (upwind location)	Continue work, Level D
	> 100 µg/m3 above background for a period of 5 minutes in the WBZ	Stop work. Apply dust suppression measures. Resume work using Level D only if <100 µg/m^3 above background.
	>150 µg/m^3 above background for a sustained period of 5 minutes.	Stop work. Re-evaluate work. Collect air samples for As, Pb, Cd, and PAHs.
Mercury		
Jerome Monitor	<0.025 mg/m^3	Continue work, Level D
	> 0.025 mg/m3 for a period of 5 minutes in the WBZ	Stop work. Allow the work area to vent. Use mechanical ventilation as necessary. Resume work using Level D only if <0.025 mg/m$^{3.}$
	** Should Level C be necessary, contact the CIH as special coveralls and respirator cartridges are required.	

Table 3 – Key Personnel Emergency Phone Numbers

New York City Police Department	911
New York City Fire Department	911
New York University Medical Center 550 1st Avenue New York, NY	(212) 263-7300
Mount Sinai of Queens Hospital 25-10 30th Avenue Astoria, NY	(718) 932-1000
Emergency Medical Service (ambulance)	911
Patrick Shiels, Tishman Speyer	(212) 715-0361
Arnold F. Fleming, P. E., Project Director	(212) 675-3225
Steven Panter, FLS Project Manager	(212) 675-3225
TBD, Site Health and Safety Officer	(212) 675-3225
Tom Eng, CIH	(201) 417-3079
National Response Center	(800) 424-8802
NYSDEC Spill Hotline	(800) 457-7362

Attachment I

HASP ACKNOWLEDGMENT FORM

The following personnel have read the site-specific HASP and are familiar with its provisions.

Print Name	*Signature*	*Company*	*Function*	*Date*

Attachment II

Note: The Site is broken into two sections, BCP Site A and BCP Site B. BCP Site B is broken down further into Operable Units 1 & 2. The summary information is presented in this manner. Refer to Figure 2, Site Plan

Table 7 – Summary of VOCs on BCP Site A, µg/kg

Compound	NDs	Min	Median	90th %	Max
Benzene	94/151	1.1	665	6,440	35,800
Toluene	45/151	0.62	2,250	42,200	195,000
Ethylbenzene	37/151	0.83	3,050	31,200	67,000
Total Xylene	28/151	0.96	11,950	119,500	312,000
BTEX	25/148	0.99	14,4727	192,960	567,300
Methylene chloride	122/151	2	116	4,200	13,000
Total VOCs	110/151	9	13,030	195,154	759,966
Tetrachloroethylene	132/151	2	392	3,300	230,000
Trichloroethylene	13/153	8	368	1,400	2,600

NDs – Number of non-detects among samples (non-detects/no. samples). Min., median, 90th %, and max. for detected results.

Table 8 – Summary of SVOCs on BCP Site A, µg/kg

Compound	NDs	Min	Median	90th %	Max
Naphthalene	17/119	67	111,000	1,500,000	3,320,000
2- Methylnaphthalene	12/83	17	181,000	1,550,000	3,330,000
Benzo(a)pyrene	56/119	16.9	522	2,360	12,000
Benzoaanthracene	43/119	21.5	709	3,420	13,000
Acenaphthene	17/119	21.3	32,200	320,000	707,000
Dibenzofuran	17/119	47	68,900	312,000	780,000
Fluorene	20/119	17.1	19,300	149,000	411,000
Total SVOCs	9/126	11	164,190	2,850,301	8,576,290

Table 9 – Summary of Metals on BCP Site A, mg/kg

Compound	NDs	Min	Median	90th %	Max
Arsenic	20/74	0.48	4	14.8	47
Barium	0/74	10.3	86	290	930
Cadmium	46/74	0.44	0.79	2.5	15.2
Chromium	0/74	3.95	22	41	64
Lead	2/74	2.76	29.8	511	2,190
Mercury	38/74	0.04	0.29	1.6	4.9
Nickel	0/74	2.97	16.7	24	42.7
Selenium	65/74	1.3	2	2.7	2.7
Silver	70/74	0.98	1.0	1.1	1.1
Zinc	0/73	6.36	77	372	6,100

Table 10 – Summary of Pesticides on BCP Site A, µg/kg

Compound	NDs	Min	Median	90th %	Max
Alpha BHC	71/76	10.9	58.2	930	930
Beta BHC	75/76	2.4	2.4	2.4	2.4
Alpha chlordane	36/39	200	580	660	660
Gamma chlordane	21/29	16	178	730	730
44-DDD	43/76	2.3	120	1,300	19,500
44-DDE	60/76	3.1	12.95	350	500
44-DDT	55/76	3.1	52	1,000	1,800
Dieldrin	64/76	5.8	17.5	155	230
Endosulfan II	72/76	2.3	74.5	220	220
Heptachlor epoxide	71/76	43	76	380	380

PCBs: 42 out of 44 samples collected for PBCs were non-detect. The remaining two results measured 99.6 µg/kg and 410 µg/kg.

Attachment III

Attachment III - Health Hazards for Contaminants of Concern

Contaminant	Recognized and Suspected Health Hazards
Creosote	**Recognized** carcinogen **Suspected** respiratory toxicant and skin or sense organ toxicant
Volatile Organic Compounds (VOCs) Including BTEX Benzene, Toulene, Ethylbenzene and Xylene	**Suspected** carcinogen; cardiovascular or blood toxicant; gastrointestinal or liver toxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant
Semi- Volatile Organic Compounds (SVOCs) Including Poly Aromatic Hydrocarbons (PAHs)	**Suspected** carcinogen; cardiovascular or blood toxicant; gastrointestinal or liver toxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant
Arsenic	**Recognized** carcinogen; developmental toxicant **Suspected** cardiovascular or blood toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; respiratory toxicant; skin or sense organ toxicant
Beryllium	**Recognized** carcinogen; developmental toxicant **Suspected** cardiovascular or blood toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; respiratory toxicant; skin or sense organ toxicant
Copper	**Suspected** cardiovascular or blood toxicant; developmental toxicant; gastrointestinal or liver toxicant; kidney toxicant; reproductive toxicant; respiratory toxicant
Chromium	**Suspected** cardiovascular or blood toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; respiratory toxicant; skin or sense organ toxicant
Cyanide	**Suspected** cardiovascular or blood toxicant; endocrine toxicant; neurotoxicant; respiratory toxicant; skin or sense organ toxicant
Iron	**Suspected** cardiovascular or blood toxicant; developmental toxicant; gastrointestinal or liver toxicant; kidney toxicant; reproductive toxicant; respiratory toxicant

Contaminant	Recognized and Suspected Health Hazards
Lead	**Recognized** carcinogen; developmental toxicant; reproductive toxicant
	Suspected cardiovascular or blood toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; respiratory toxicant; skin or sense organ toxicant
Mercury	**Recognized** developmental toxicant
	Suspected cardiovascular or blood toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant
Nickel	**Recognized** skin or sense organ toxicant and respiratory toxicant
Pesticides	**Recognized** developmental toxicant
	Suspected cardiovascular or blood toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant
Polychlorinated Biphenyls	**Recognized** carcinogen, developmental toxicant
	Suspected endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; neurotoxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant
Tetrachloroethylene	**Recognized** carcinogen; developmental toxicant; reproductive toxicant
	Suspected cardiovascular or blood toxicant; developmental toxicant; endocrine toxicant; gastrointestinal or liver toxicant; immunotoxicant; kidney toxicant; neurotoxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant
Zinc	**Suspected** cardiovascular or blood toxicant; developmental toxicant; immunotoxicant; reproductive toxicant; respiratory toxicant; skin or sense organ toxicant

VOC

International Chemical Safety Cards

BENZENE

ICSC: 0015

National Institute for Occupational Safety and Health

NIOSH

UNEP

Cyclohexatriene
Benzol
C_6H_6
Molecular mass: 78.1

ICSC # 0015
CAS # 71-43-2
RTECS # CY1400000
UN # 1114
EC # 601-020-00-8

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive. Risk of fire and explosion: see chemical dangers.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Do NOT use compressed air for filling, discharging, or handling. Use non-sparking handtools.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		AVOID ALL CONTACT!	
•INHALATION	Dizziness. Drowsiness. Headache. Nausea. Shortness of breath. Convulsions. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
•SKIN	MAY BE ABSORBED! Dry skin (further see Inhalation).	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
•EYES		face shield, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain. Sore throat. Vomiting (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer (extra personal protection: complete protective clothing including self-contained breathing apparatus).	Fireproof. Separated from food and feedstuffs, oxidants and halogens.	Do not transport with food and feedstuffs. F symbol T symbol R: 45-11-48/23/24/25 S: 53-45 UN Hazard Class: 3 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0015	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 1999. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

BENZENE

ICSC: 0015

I M P O R T A N T D A T A	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air and may travel along the ground; distant ignition possible. **CHEMICAL DANGERS:** Reacts violently with oxidants and halogens causing fire and explosion hazard. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 10 ppm; 32 mg/m^3 (as TWA) A2 (ACGIH 1991-1992). OSHA PEL: 1910.1028 TWA 1 ppm ST 5 ppm See Appendix F NIOSH REL: Ca TWA 0.1 ppm ST 1 ppm See Appendix A NIOSH IDLH: Potential occupational carcinogen 500 ppm	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation and through the skin. **INHALATION RISK:** A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C; on spraying or dispersion, however, much faster. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the skin and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system. Exposure far above the occupational exposure limit may result in unconsciousness. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin. The substance may have effects on the blood forming organs, liver and immune system. This substance is carcinogenic to humans.

PHYSICAL PROPERTIES	Boiling point: 80°C Melting point: 6°C Relative density (water = 1): 0.9 Solubility in water, g/100 ml at 25°C: 0.18 Vapour pressure, kPa at 20°C: 10 Relative vapour density (air = 1): 2.7	Relative density of the vapour/air-mixture at 20°C (air = 1): 1.2 Flash point: (c.c.) -11°C Auto-ignition temperature: about 500°C Explosive limits, vol% in air: 1.2-8.0 Octanol/water partition coefficient as log Pow: 2.13
ENVIRONMENTAL DATA		

NOTES

Use of alcoholic beverages enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient.

Transport Emergency Card: TEC (R)-7
NFPA Code: H2; F3; R0;

ADDITIONAL INFORMATION

ICSC: 0015 **BENZENE**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

Material Safety Data Sheet

Beryllium, powder, -325 mesh, 99+%

ACC# 99072

Section 1 - Chemical Product and Company Identification

MSDS Name: Beryllium, powder, -325 mesh, 99+%
Catalog Numbers: AC317870000, AC317870050
Synonyms: None.
Company Identification:

Acros Organics N.V.
One Reagent Lane
Fair Lawn, NJ 07410

For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7440-41-7	Beryllium	>99	231-150-7

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: gray-white flakes.
Warning! Cancer hazard. Can be explosive when exposed to heat or flames. Causes eye, skin, and respiratory tract irritation. Inhalation of fumes may cause metal-fume fever.
Target Organs: Lungs.

Potential Health Effects

Eye: Causes eye irritation. May cause conjunctivitis and corneal inflammation.
Skin: Causes skin irritation. May cause contact dermatitis.
Ingestion: May cause gastrointestinal irritation with nausea, vomiting and diarrhea.
Inhalation: Causes respiratory tract irritation. Inhalation of fumes may cause metal fume fever, which is characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count. If heated, dust or fume may cause respiratory tract irritation.
Chronic: Chronic beryllium disease, an immunologically mediated response occurring after a latent period ranging from a few weeks to many years, causes difficult breathing on exertion, weight loss, nonproductive cough, fatigue, chest pain, anorexia, and weakness.

Section 4 - First Aid Measures

Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately.

Skin: Get medical aid immediately. Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes.
Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Dust can be an explosion hazard when exposed to heat or flame. Flammable solid.
Extinguishing Media: Do NOT use carbon dioxide. Do NOT use halogenated agents. Use approved class D extinguishing agents or smother with dry sand, clay, or sodium bicarbonate. DO NOT USE WATER!
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 3; Flammability: 2; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions. Remove all sources of ignition. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Minimize dust generation and accumulation. Avoid contact with eyes, skin, and clothing. Do not breathe dust. Keep away from heat, sparks and flame. Use only with adequate ventilation or respiratory protection.
Storage: Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate ventilation to keep airborne concentrations low.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs

Beryllium	0.002 mg/m3 TWA; 0.01 mg/m3 STEL	4 mg/m3 IDLH	2 ug/m3 TWA; 5 æg/m3 Ceiling

OSHA Vacated PELs: Beryllium: 2 ug/m3 TWA
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Flakes
Appearance: gray-white
Odor: odorless
pH: Not available.
Vapor Pressure: 1.85 mm Hg
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 2970 deg C
Freezing/Melting Point:1287 deg C
Decomposition Temperature: Not available.
Solubility: Not available.
Specific Gravity/Density:1.85 @ 20C
Molecular Formula: Be
Molecular Weight:9.01

Section 10 - Stability and Reactivity

Chemical Stability: Stable at room temperature in closed containers under normal storage and handling conditions.
Conditions to Avoid: Ignition sources, dust generation, excess heat, exposure to flame.
Incompatibilities with Other Materials: Oxidizing agents, phosphorus, lithium, caustics (e.g. ammonia, ammonium hydroxide, calcium hydroxide, potassium hydroxide, sodium hydroxide), carbontetrachloride, chlorinated hydrocarbons, Contact with acids causes evolution of flammable hydrogen gas..
Hazardous Decomposition Products: Hydrogen gas.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 7440-41-7: DS1750000
LD50/LC50:
Not available.

Carcinogenicity:
CAS# 7440-41-7:

- **ACGIH:**
  A1 - Confirmed Human Carcinogen
- **California:**
  carcinogen, initial date 10/1/87
- **NTP:**
  Known carcinogen
- **IARC:**
  Group 1 carcinogen

Epidemiology: Epidemiologic studies have demonstrated a statistically significant increase in lung cancer mortality in beryllium-exposed workers.
Teratogenicity: No information found
Reproductive Effects: No information found
Mutagenicity: No information found
Neurotoxicity: No information found
Other Studies:

Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: CAS# 7440-41-7: waste number P015.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	DOT regulated - small quantity provisions apply (see 49CFR173.4)	BERYLLIUM POWDER
Hazard Class:		6.1
UN Number:		UN1567
Packing Group:		II

Section 15 - Regulatory Information

US FEDERAL

TSCA

CAS# 7440-41-7 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 7440-41-7: 10 lb final RQ (no reporting of releases of this hazardous substance is required

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 7440-41-7: immediate, delayed, fire.

Section 313

This material contains Beryllium (CAS# 7440-41-7, >99%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 7440-41-7 (listed as Beryllium compounds, n.o.s.) is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depletors.

This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

CAS# 7440-41-7 is listed as a Priority Pollutant under the Clean Water Act. CAS# 7440-41-7 is listed as a Toxic Pollutant under the Clean Water Act.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7440-41-7 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

The following statement(s) is(are) made in order to comply with the California Safe Drinking Water Act:

WARNING: This product contains Beryllium, a chemical known to the state of California to cause cancer.

California No Significant Risk Level: CAS# 7440-41-7: 0.1 æg/day NSRL

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

T+

Risk Phrases:

R 25 Toxic if swallowed.
R 26 Very toxic by inhalation.
R 36/37/38 Irritating to eyes, respiratory system and skin.
R 43 May cause sensitization by skin contact.
R 49 May cause cancer by inhalation.
R 48/23 Toxic : danger of serious damage to health by prolonged exposure through inhalation.

Safety Phrases:

S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 53 Avoid exposure - obtain special instructions before use.

WGK (Water Danger/Protection)

CAS# 7440-41-7: No information available.

Canada - DSL/NDSL

CAS# 7440-41-7 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of B4, D2A, D1A.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 7440-41-7 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 1/21/1998
Revision #5 Date: 8/23/2004

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

Material Safety Data Sheet
Chloroform

ACC# 04770

Section 1 - Chemical Product and Company Identification

MSDS Name: Chloroform
Catalog Numbers: AC95232184, S79960, S79960-1, S79960HPLC-2, S79960SPEC-1, S79960SPEC-2, C2974LC, C297POP19, C297POP200, C297POP50, C297RS115, C297RS200, C297RS28, C297RS50, C297SS115, C297SS19, C297SS200, C297SS28, C297SS50, C29820LC, C298FB115, C298FB19, C298FB200, C298FB50, C298J1, C298POP19, C298POP200, C298POP50, C298POPB19, C298POPB200, C298POPB50, C298RB115, C298RB19, C298RB200, C298RB50, C298RB500, C298RS115, C298RS19, C298RS200, C298RS28, C298RS50, C298SS-11, C298SS19, C298SS28, C605-1, C605-4, C606POP19, C606POP200, C606POP50, C606RS115, C606RS200, C606RS28, C606RS50, C606SS115, C606SS19, C606SS200, C606SS28, C606SS50
Synonyms: Formyl Trichloride; Methane Trichloride; Methenyl Trichloride; Methyl Trichloride; Trichlormethan; Trichloroform; Trichloromethane.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
67-66-3	Chloroform	100	200-663-8
25377-72-4	Amylene	<1.0	246-916-6

Hazard Symbols: XN
Risk Phrases: 22 38 40 48/20/22

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear, colorless liquid. May cause central nervous system depression. May cause cardiac disturbances. May cause cancer based on animal studies. This substance has caused adverse reproductive and fetal effects in animals. May be harmful if swallowed. **Caution!** Causes eye and skin irritation. Causes digestive and respiratory tract irritation. Light sensitive.
Target Organs: Blood, kidneys, heart, central nervous system, liver, cardiovascular system, excretory system, reproductive system.

Potential Health Effects
Eye: Causes moderate eye irritation. Contact with liquid causes immediate burning pain, tearing, and

reddening of the conjunctiva.
Skin: Causes mild skin irritation. Prolonged or repeated contact may dry/defat the skin and cause irritation. Absorption of liquid through intact skin is possible and may cause sys temic poisoning if contact with liquid is prolonged.
Ingestion: Causes gastrointestinal irritation with nausea, vomiting and diarrhea. May cause liver damage. May cause cardiac disturbances. Aspiration of material into the lungs may cause chemical pneumonitis, which may be fatal. Possible aspiration hazard. May cause hallucinations and distorted perceptions.
Inhalation: Inhalation of high concentrations may cause central nervous system effects characterized by nausea, headache, dizziness, unconsciousness and coma. May cause cardiac sensitization and possible failure. Inhalation of large amounts may cause respiratory stimulation, followed by respiratory depression, convulsions and possible death due to respiratory paralysis. May be absorbed through the lungs. Causes irritation of the mucous membrane and upper respiratory tract.
Chronic: Possible cancer hazard based on tests with laboratory animals. Prolonged or repeated skin contact may cause dermatitis. May cause reproductive and fetal effects. Effects may be delayed. Laboratory experiments have resulted in mutagenic effects. Toxicity may be increased by exposure to alcohol, steroids, and ketones. Prolonged exposure may cause liver, kidney, and heart damage.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Get medical aid. Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse.
Ingestion: Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Notes to Physician: Causes cardiac sensitization to endogenous catelcholamines which may lead to cardiac arrhythmias. Do NOT use adrenergic agents such as epinephrine or pseudoepinephrine. Persons with liver, kidney, or central nervous system diseases may be at increased risk from exposure to this product. Alcoholic beverage consumption may enhance the toxic effects of this substance. Effects may be delayed.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Substance is nonflammable. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Containers may explode when heated.
Extinguishing Media: Use extinguishing media most appropriate for the surrounding fire. Do NOT get water inside containers. Do NOT use straight streams of water. For small fires, use dry chemical, carbon dioxide, or water spray. For large fires, use water spray, fog or regular foam. Cool containers with flooding quantities of water until well after fire is out.
Flash Point: Not available.
Autoignition Temperature: Not available.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 2; Flammability: 0; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Provide ventilation. Approach spill from upwind.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Avoid contact with eyes, skin, and clothing. Do not breathe dust, vapor, mist, or gas. Do not ingest or inhale. Store protected from light.
Storage: Do not store in direct sunlight. Store in a cool, dry, well-ventilated area away from incompatible substances. Do not store near alkaline substances. Separate from strong mineral acids.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Chloroform	10 ppm TWA	500 ppm IDLH	50 ppm Ceiling; 240 mg/m3 Ceiling
Amylene	none listed	none listed	none listed

OSHA Vacated PELs: Chloroform: 2 ppm TWA; 9.78 mg/m3 TWA Amylene: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear, colorless
Odor: sweet, fruity odor - ethereal odor
pH: Not available.
Vapor Pressure: 160 mm Hg @ 20 deg C
Vapor Density: 4.12 (Air=1)
Evaporation Rate:11.6 (Butyl acetate=1)

Viscosity: 0.58 cps @ 20 deg C
Boiling Point: 60.5-61.5 deg C
Freezing/Melting Point:-63 deg C
Decomposition Temperature: Not available.
Solubility: Slightly soluble.
Specific Gravity/Density:1.492 (Water=1)
Molecular Formula:$CHCl_3$
Molecular Weight:119.366

Section 10 - Stability and Reactivity

Chemical Stability: Stable at room temperature in closed containers under normal storage and handling conditions. Light sensitive.
Conditions to Avoid: High temperatures, incompatible materials, light.
Incompatibilities with Other Materials: Strong oxidizing agents, aluminum, fluorine, magnesium, sodium potassium, lithium, caustics (e.g. ammonia, ammonium hydroxide, calcium hydroxide, potassium hydroxide, sodium hydroxide), dinitrogen tetraoxide, sodium + methanol, potassium-tert-butoxide, chemically active metals, Attacks some forms of plastics, rubbers, and coatings., nitrogen tetroxide, acetone + alkali, disilane, perchloric acid + phosphorus pentoxide, sodium methylate, triisopropylphosphine, sodium methoxide + methanol.
Hazardous Decomposition Products: Hydrogen chloride, carbon monoxide, carbon dioxide, chlorine, phosgene gas.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 67-66-3: FS9100000
CAS# 25377-72-4 unlisted.
LD50/LC50:
CAS# 67-66-3:
Draize test, rabbit, eye: 148 mg;
Draize test, rabbit, eye: 20 mg/24H Moderate;
Draize test, rabbit, skin: 500 mg/24H Mild;
Inhalation, rat: LC50 = 47702 mg/m3/4H;
Oral, mouse: LD50 = 36 mg/kg;
Oral, rat: LD50 = 695 mg/kg;
Skin, rabbit: LD50 = >20 gm/kg;

CAS# 25377-72-4:

Carcinogenicity:
CAS# 67-66-3:
ACGIH: A3 - Animal Carcinogen
California: carcinogen; initial date 10/1/87
NIOSH: potential occupational carcinogen
NTP: Suspect carcinogen
OSHA: Possible Select carcinogen
IARC: Group 2B carcinogen CAS# 25377-72-4: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: Oral, rat: TDLo = 13832 mg/kg/2Y-C (Tumorigenic - Carcinogen ic by RTECS criteria - Blood - leukemia).; Oral, mouse: TDLo = 127 gm/kg/92W-I (Tumorigenic - Carcinogenic by RTECS criteria - Liver - tumors).; Oral, rat: TD = 98 gm/kg/78W-I (Tumorigenic - neoplastic by RTECS

criteria - Kidney, Ureter, Bladder - Kidney tumors and Endocrine - thyroid tumors).; Oral, mouse: TD = 18 gm/kg/17W-I (Tumorigenic - neoplastic by RTECS criteria - Liver - tumor s).;
Teratogenicity: Oral, rat: TDL0 = 1260 mg/kg (female 6-15 day(s) after conception) Effects on Embryo or Fetus - fetotoxicity (except death, e.g., stunted fetus) Specific Developmental Abnormalities - musculoskeletal system.; Inhalation, rat: TCLo = 100 ppm/7H (female 6-15 day(s) after conception) Specific Developmental Abnormalities - gastrointestinal system and homeostasis.; Inhalation, mouse: TCLo = 100 ppm/7H (female 8-15 day(s) after conception) Specific Developmental Abnormalities - craniofacial (including nose and tongue).
Reproductive Effects: Inhalation, rat: TCLo = 30 ppm/7H (female 6-15 day(s) after conception) Fertility - other measures of fertility.; Inhalation, rat: TCLo = 300 ppm/7H (female 6-15 day(s) after conception) Fertility - female fertility index (e.g. # females pregnant per # sperm positive females; # females pregnant per # females mated) and post-implantation mortality (e.g. dead and/or resorbed implants per total number of implants).
Neurotoxicity: No information available.
Mutagenicity: DNA Inhibition: Human, HeLa cell = 19 mmol/L.; Sister Chromatid Exchange: Human, Lymphocyte = 10 mmol/L.; Micronucleus Test: Oral, rat = 4 mmol/kg.; Unscheduled DNA Synthesis: Oral, rat = 1 gm/kg.; Sister Chromatid Exchange: Hamster, Embryo = 100 umol/L.
Other Studies: Open irritation test: Administration onto the skin (rabbit) 10 mg/24H (Mild). Standard Draize Test: Administratio n onto the skin (rabbit) = 500 mg/24H (Mild). Standard D raize Test: Administration into the eye (rabbit) = 20 mg /24H (Moderate).

Section 12 - Ecological Information

Ecotoxicity: Fish: Channel catfish: LC50 = 75 ppm; 96 Hr; Unspecified Rainbow trout: LC50 = 43.8 mg/L; 96 Hr; Static bioassay Fathead Minnow: LC50 = 129.0 mg/L; 96 Hr; Static bioassay (pH = 7.6-8.3) Bluegill/Sunfish: LC50 = 100.0 mg/L; 96 Hr; Static bioassay flea Daphnia: EC50 = 28.9 mg/L; 48 Hr; Static bioassay The majority of the environmental releases from industrial uses are to the atmosphere; releases to water and land will be primarily lost by evaporation and will end up in the atmosphere. Release to the atmosphere may be transported long distances and will photodegrade with a half-life of a few months. Spills and other releases on land will also leach into the groundwater where it will reside for long periods of time.
Environmental: Chloroform will not be expected to bioconcentrate into the food chain but contamination of food is likely due to its use as an extractant and its presence in drinking water.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: CAS# 67-66-3: waste number U044.

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	CHLOROFORM				CHLOROFORM
Hazard Class:	6.1				6.1(9.2)
UN Number:	UN1888				UN1888

Packing Group:	III				II

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 67-66-3 is listed on the TSCA inventory.
CAS# 25377-72-4 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 67-66-3: Effective Date: 6/1/87; Sunset Date: 6/1/97
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA

CERCLA Hazardous Substances and corresponding RQs
CAS# 67-66-3: 10 lb final RQ; 4.54 kg final RQ
SARA Section 302 Extremely Hazardous Substances
CAS# 67-66-3: 10,000 lb TPQ
SARA Codes
CAS # 67-66-3: acute, chronic. CAS # 25377-72-4: acute, flammable.
Section 313
This material contains Chloroform (CAS# 67-66-3, 100%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
Clean Air Act:
CAS# 67-66-3 is listed as a hazardous air pollutant (HAP). This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
CAS# 67-66-3 is listed as a Hazardous Substance under the CWA. CAS# 67-66-3 is listed as a Priority Pollutant under the Clean Water Act. CAS# 67-66-3 is listed as a Toxic Pollutant under the Clean Water Act.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 67-66-3 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
CAS# 25377-72-4 can be found on the following state right to know lists: New Jersey.
The following statement(s) is(are) made in order to comply with the California Safe Drinking Water Act: WARNING: This product contains Chloroform, a chemical known to the state of California to cause cancer. California No Significant Risk Level: CAS# 67-66-3: 20 ug/day NSRL (oral); 40 ug/day NSRL (inhalation)

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols:
XN
Risk Phrases:
R 22 Harmful if swallowed.
R 38 Irritating to skin.
R 40 Limited evidence of a carcinogenic effect.

R 48/20/22 Harmful : danger of serious damage to health by prolonged exposure through inhalation and if swallowed.

Safety Phrases:
S 36/37 Wear suitable protective clothing and gloves.

WGK (Water Danger/Protection)
CAS# 67-66-3: 3
CAS# 25377-72-4: No information available.
Canada - DSL/NDSL
CAS# 67-66-3 is listed on Canada's DSL List.
CAS# 25377-72-4 is listed on Canada's DSL List.
Canada - WHMIS
This product has a WHMIS classification of D2A, D1B.
Canadian Ingredient Disclosure List
CAS# 67-66-3 is listed on the Canadian Ingredient Disclosure List.
Exposure Limits
CAS# 67-66-3: OEL-ARAB Republic of Egypt:TWA 10 ppm (50 mg/m3) OEL-AUSTRALIA:TWA 10 ppm (50 mg/m3);Carcinogen OEL-AUSTRIA:TWA 10 ppm (50 mg/m3) OEL-BELGIUM:TWA 10 ppm (49 mg/m3);Carcinogen JAN9 OEL-CZECHOSLOVAKIA:TWA 10 mg/m3;STEL 20 mg/m3 OEL-DENMARK:TWA 2 ppm (10 mg/m3); Carcinogen OEL-FINLAND:TWA 10 ppm (50 mg/m3);STEL 20 ppm;Skin;CAR OEL-FRANCE:TWA 5 ppm (25 mg/m3);STEL 50 ppm (250 mg/m3);CAR OEL-GERMANY :TWA 10 ppm (50 mg/m3);Carcinogen JAN9 OEL-HUNGARY:STEL 10 mg/m3 OEL-INDIA:TWA 10 ppm (50 mg/m3);Carcinogen OEL-JAPAN:TWA 50 ppm (240 mg/m3);Carcinogen OEL-THE NETHERLANDS:TWA 10 ppm (50 mg/m3) OEL-THE PHILIPPINES:TWA 50 ppm (240 mg/m3) OEL-POLAND:TWA 50 mg/m3 OEL-RUSSIA:TWA 50 ppm OEL-SWEDEN:TWA 2 ppm (10 mg/m3);STEL 5 ppm (25 mg/m3);CAR OEL-SWITZERLAND:TWA 10 ppm (50 mg/m3);STEL 20 ppm (100 mg/m3) OEL-THAILAND:TWA 50 ppm (240 mg/m3) OEL-TURKEY:TWA 50 ppm (240 mg/m3) OEL-UNITED KINGDOM:TWA 2 ppm (9.9 mg/m3);Skin OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGIH TLV

Section 16 - Additional Information

MSDS Creation Date: 6/09/1999
Revision #7 Date: 9/11/2002

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

5 M

International Chemical Safety Cards

CHROMIUM

ICSC: 0029

Chrome
Cr (metal)
Atomic mass: 52.0

ICSC # 0029
CAS # 7440-47-3
RTECS # GB4200000

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible if in very fine powder. Gives off irritating or toxic fumes (or gases) in a fire.	No open flames if in powder form.	In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION	Finely dispersed particles form explosive mixtures in air.	Prevent deposition of dust; closed system, dust explosion-proof electrical equipment and lighting.	
EXPOSURE		PREVENT DISPERSION OF DUST! STRICT HYGIENE!	
•INHALATION	Cough.	Local exhaust or breathing protection.	Fresh air, rest.
•SKIN	Redness.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
•EYES	Redness.	Face shield.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION		Do not eat, drink, or smoke during work.	Rinse mouth.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Vacuum spilled material. Carefully collect remainder, then remove to safe place (extra personal protection: P2 filter respirator for harmful	Fireproof. Separated from strong oxidants.	R: S:

particles).

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0029	

International Chemical Safety Cards

CHROMIUM

ICSC: 0029

I M P O R T A N T D A T A	**PHYSICAL STATE; APPEARANCE:** STEEL GREY LUTROUS METAL. **PHYSICAL DANGERS:** Dust explosion possible if in powder or granular form, mixed with air. **CHEMICAL DANGERS:** Reacts violently with strong oxidants such as hydrogen peroxide, causing fire and explosion hazard. Reacts with diluted hydrochloric and sulfuric acids. Incompatible with alkalis and alkali carbonates. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: ppm; 0.5 mg/m^3 (as TWA) (ACGIH 1994-1995). OSHA PEL*: TWA 1 mg/m^3 See Appendix C *Note: The PEL also applies to insoluble chromium salts. NIOSH REL: TWA 0.5 mg/m^3 See Appendix C NIOSH IDLH: 250 mg/m^3 (as Cr)	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its aerosol and by ingestion. **INHALATION RISK:** Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly when dispersed. **EFFECTS OF SHORT-TERM EXPOSURE:** **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact may cause skin sensitization.
PHYSICAL PROPERTIES	Boiling point: 2642°C Melting point: 1900°C	Relative density (water = 1): 7.14 Solubility in water: none
ENVIRONMENTAL DATA		

NOTES

Explosive limits are unknown in literature. Depending on the degree of exposure, periodic medical examination is indicated.

ADDITIONAL INFORMATION

ICSC: 0029	**CHROMIUM**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

ALDRICH CHEMICAL CO -- DIELDRIN, TECH., CA. 90%, 29121-8 -- 6810-00N037359

==================== Product Identification ====================

Product ID:DIELDRIN, TECH., CA. 90%, 29121-8
MSDS Date:01/07/1992
FSC:6810
NIIN:00N037359
MSDS Number: BQRWJ
=== Responsible Party ===
Company Name:ALDRICH CHEMICAL CO
Box:355
City:MILWAUKEE
State:WI
ZIP:53201
Country:US
Info Phone Num:414-273-3850
Emergency Phone Num:414-273-3850
CAGE:60928
=== Contractor Identification ===
Company Name:ALDRICH CHEMICAL CO INC
Address:1001 WEST ST PAUL AVE
Box:355
City:MILWAUKEE
State:WI
ZIP:53233
Country:US
Phone:414-273-3850
CAGE:60928

============ Composition/Information on Ingredients ============

Ingred Name:1,4:5,8-DIMETHANONAPHTHALENE, 1,2,3,4,10,10-HEXACHLORO-6, 7-EPOXY- 1,4,4A,5,6,7,8,8A-OCTAHYDRO, ENDO, EXO-; (ING 2)
CAS:60-57-1
RTECS #:IO1750000
Fraction by Wt: 90%
OSHA PEL:0.25 MG/M3, S
ACGIH TLV:0.25 MG/M3, S
EPA Rpt Qty:1 LB
DOT Rpt Qty:1 LB

Ingred Name:ING 1: (DIELDRIN) (SARA III)
RTECS #:9999999ZZ

==================== Hazards Identification ====================

LD50 LC50 Mixture:LD50 (ORAL,RAT): 38300 UG/KG.
Routes of Entry: Inhalation:YES Skin:YES Ingestion:NO
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE:MAY BE FATAL IF INHALED, SWALLOWED, OR ABSORBED THROUGH SKIN. MAY CAUSE IRRITATION. CHRONIC: CARCINOGEN. MAY ALTER GENETIC MATERIAL. OVEREXPOSURE MAY CAUSE REPRODUCTIVE DISORDER(S) BASED ON TEST S WITH LABORATORY ANIMALS. TARGET ORGANS: CENTRAL NERVOUS SYSTEM, LIVER, BLOOD. OVEREXPOSURE CAN CAUSE (EFTS OF OVEREXP)
Explanation of Carcinogenicity:NOT RELEVANT.
Effects of Overexposure:HLTH HAZ: MALAISE, HEADACHE, NAUSEA, VOMITING, DIZZINESS, TREMORS, CLONIC AND TONIC CONVULSIONS, COMA, RESPIRATORY FAILURE.
Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

===================== First Aid Measures =====================

First Aid:EYES: IMMEDIATELY FLUSH WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES. SKIN: IMMEDIATELY FLUSH WITH COPIOUS AMOUNTS OF

WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES. INHALATION: REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. INGESTION: WASH OUT MOUTH W/WATER PROVIDED PERSON IS CONSCIOUS. CALL PHYS.

==================== Fire Fighting Measures ====================

Extinguishing Media:WATER SPRAY, CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.
Fire Fighting Procedures:WEAR NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT .
Unusual Fire/Explosion Hazard:EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

================= Accidental Release Measures =================

Spill Release Procedures:EVACUATE AREA. WEAR NIOSH/MSHA APPROVED SCBA, RUBBER BOOTS AND HEAVY RUBBER GLOVES. SWEEP UP, PLACE IN BAG AND HOLD FOR WASTE DISPOSAL. AVOID RAISING DUST. VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.
Neutralizing Agent:NONE SPECIFIED BY MANUFACTURER.

==================== Handling and Storage ====================

Handling and Storage Precautions:KEEP TIGHTLY CLOSED. STORE IN A COOL DRY PLACE.
Other Precautions:HIGHLY TOX.CARCIN. MUTAGEN. REPROD HAZ.MAY CAUSE CANCER.MAY CAUSE INHERITABLE GENETIC DMG. READILY ABSORB THRU SKIN. AVOID PRLNGD/RPTD EXPOS. DO NOT BRTH DUST. DO NOT GET IN EYES,ON SKIN,ON CLTHG.VERY TOX BY INHAL,IN CONT W/SKIN & (SUPDAT)

============ Exposure Controls/Personal Protection ============

Respiratory Protection:WEAR APPROPRIATE NIOSH/MSHA APPROVED RESPIRATOR.
Ventilation:USE ONLY IN A CHEMICAL FUME HOOD.
Protective Gloves:CHEMICAL-RESISTANT GLOVES.
Eye Protection:CHEM WORK GOG W/FULL LNGTH FCSHLD
Other Protective Equipment:OTHER PROTECTIVE CLOTHING. SAFETY SHOWER AND EYE BATH.
Work Hygienic Practices:WASH THOROUGHLY AFTER HANDLING.
Supplemental Safety and Health
OTHER PRECAUTIONS: IF SWALLOWED. IF YOU FEEL UNWELL, SEEK MEDICAL ADVICE (SHOW THE LABEL WHERE POSSIBLE).

================= Physical/Chemical Properties =================

Melt/Freeze Pt:M.P/F.P Text:>289F,>143C
Vapor Density:13.2
Appearance and Odor:ORANGE-TAN POWDER.

================ Stability and Reactivity Data ================

Stability Indicator/Materials to Avoid:YES
STRONG OXIDIZING AGENTS.
Stability Condition to Avoid:NONE SPECIFIED BY MANUFACTURER.
Hazardous Decomposition Products:TOXIC FUMES OF CARBON MONOXIDE, CARBON DIOXIDE, HYDROGEN CHLORIDE GAS.

=================== Disposal Considerations ===================

Waste Disposal Methods:DISSOLVE OR MIX MATERIAL WITH COMBUSTIBLE SOLVENT AND BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCURBBER. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS (FP N).

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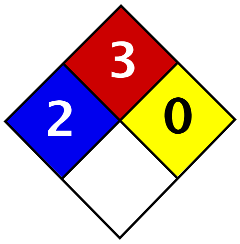

Health	**2**
Fire	**3**
Reactivity	**0**
Personal Protection	**H**

Material Safety Data Sheet
Ethylbenzene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethylbenzene

Catalog Codes: SLE2044

CAS#: 100-41-4

RTECS: DA0700000

TSCA: TSCA 8(b) inventory: Ethylbenzene

CI#: Not available.

Synonym: Ethyl Benzene; Ethylbenzol; Phenylethane

Chemical Name: Ethylbenzene

Chemical Formula: C_8H_{10}

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ethylbenzene	100-41-4	100

Toxicological Data on Ingredients: Ethylbenzene: ORAL (LD50): Acute: 3500 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, permeator).

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (irritant, sensitizer).
CARCINOGENIC EFFECTS: Classified 2B (Possible for human.) by IARC.
MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to central nervous system (CNS).
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention.

Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 432°C (809.6°F)

Flash Points:
CLOSED CUP: 15°C (59°F). (Tagliabue.) OPEN CUP: 26.667°C (80°F) (Cleveland) (CHRIS, 2001)
CLOSED CUP: 12.8 C (55 F) (Bingham et al, 2001; NIOSH, 2001)
CLOSED CUP: 21 C (70 F) (NFPA)

Flammable Limits: LOWER: 0.8% - 1.6%UPPER: 6.7% - 7%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances: Highly flammable in presence of open flames and sparks, of heat.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Slightly explosive in presence of heat.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water.
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Vapor may travel considerable distance to source of ignition and flash back. Vapors may form explosive mixtures with air. When heated to decomposition it emits acrid smoke and irritating fumes.

Special Remarks on Explosion Hazards: Vapors may form explosive mixtures in air.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Flammable liquid.
Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Avoid contact with eyes. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Sensitive to light. Store in light-resistant containers.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 100 STEL: 125 (ppm) from OSHA (PEL) [United States]
TWA: 435 STEL: 545 from OSHA (PEL) [United States]
TWA: 435 STEL: 545 (mg/m3) from NIOSH [United States]
TWA: 100 STEL: 125 (ppm) from NIOSH [United States]
TWA: 100 STEL: 125 (ppm) from ACGIH (TLV) [United States]
TWA: 100 STEL: 125 (ppm) [United Kingdom (UK)]
TWA: 100 STEL: 125 (ppm) [Belgium]
TWA: 100 STEL: 125 (ppm) [Finland]
TWA: 50 (ppm) [Norway]
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Sweetish. Gasoline-like. Aromatic.

Taste: Not available.

Molecular Weight: 106.16 g/mole

Color: Colorless.

pH (1% soln/water): Not available.

Boiling Point: 136°C (276.8°F)

Melting Point: -94.9 (-138.8°F)

Critical Temperature: 617.15°C (1142.9°F)

Specific Gravity: 0.867 (Water = 1)

Vapor Pressure: 0.9 kPa (@ 20°C)

Vapor Density: 3.66 (Air = 1)

Volatility: 100% (v/v).

Odor Threshold: 140 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 3.1

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility:
Easily soluble in diethyl ether.
Very slightly soluble in cold water or practically insoluble in water.
Soluble in all proportions in Ethyl alcohol.
Soluble in Carbon tetrachloride, Benzene.
Insoluble in Ammonia.
Slightly soluble in Chloroform.
Solubility in Water: 169 mg/l @ 25 deg. C.; 0.014 g/100 ml @ 15 deg. C.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ingnition sources (flames, sparks, static), incompatible materials, light

Incompatibility with various substances: Reactive with oxidizing agents.

Corrosivity: Not considered to be corrosive for metals and glass.

Special Remarks on Reactivity:
Can react vigorously with oxidizing materials.
Sensitive to light.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Inhalation.

Toxicity to Animals: Acute oral toxicity (LD50): 3500 mg/kg [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 2B (Possible for human.) by IARC.
MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.
May cause damage to the following organs: central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of ingestion, of inhalation.
Slightly hazardous in case of skin contact (irritant, permeator).

Special Remarks on Toxicity to Animals:
Lethal Dose/Conc 50% Kill:
LD50 [Rabbit] - Route: Skin; Dose: 17800 ul/kg
Lowest Published Lethal Dose/Conc:
LDL[Rat] - Route: Inhalation (vapor); Dose: 4000 ppm/4 H

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data.
May cause cancer based on animals data. IARC evidence for carcinogenicity in animals is sufficient. IARC evidence of carcinogenicity in humans inadequate.
May affect genetic material (mutagenic).

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Can cause mild skin irritation. It can be absorbed through intact skin.
Eyes: Contact with vapor or liquid can cause severe eye irritation depending on concentration. It may also cause conjunctivitis. At a vapor exposure level of 85 - 200 ppm , it is mildly and transiently irritating to the eyes; 1000 ppm causes further irritation and tearing; 2000 ppm results in immediate and severe irritation and tearing; 5,000 ppm is intolerable (ACGIH, 1991; Clayton and Clayton, 1994). Standard draize test for eye irritation using 500 mg resulted in severe irritation (RTECS)
Inhalation: Exposure to high concentrations can cause nasal, mucous membrane and respiratory tract irritation and can also result in chest constriction and, trouble breathing, respiratory failure, and even death. It can also affect behavior/Central Nervous System. The effective dose for CNS depression in experimental animals was 10,000 ppm (ACGIH, 1991). Symptoms of CNS depression include headache, nausea, weakness, dizziness, vertigo, irritability, fatigue, lightheadedness, sleepiness, tremor, loss of coordination, judgement and conciousness, coma, and death. It can also cause pulmonary edema. Inhalation of 85 ppm can produce fatigue, insomnia, headache, and mild irritation of the respiratory tract (Haley & Berndt, 1987).
Ingestion: Do not drink, pipet or siphon by mouth. May cause gastroinestinal/digestive tract irritation with Abdominal pain, nausea, vomiting. Ethylbenzene is a pulmonary aspiration hazard. Pulmonary aspiration of even small amounts of the liquid may cause fatal pneumonitis. It may also affect behavior/central nervous system with

Section 12: Ecological Information

Ecotoxicity:
Ecotoxicity in water (LC50): 14 mg/l 96 hours [Fish (Trout)] (static). 12.1 mg/l 96 hours [Fish (Fathead Minnow)] (flow-through)]. 150 mg/l 96 hours [Fish (Blue Gill/Sunfish)] (static). 275 mg/l 96 hours [Fish (Sheepshead Minnow)]. 42.3 mg/l 96 hours [Fish (Fathead Minnow)](soft water). 87.6mg/l 96 hours [Shrimp].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Ethylbenzene UNNA: 1175 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Ethylbenzene
Illinois toxic substances disclosure to employee act: Ethylbenzene
Illinois chemical safety act: Ethylbenzene
New York release reporting list: Ethylbenzene
Rhode Island RTK hazardous substances: Ethylbenzene
Pennsylvania RTK: Ethylbenzene
Minnesota: Ethylbenzene
Massachusetts RTK: Ethylbenzene
Massachusetts spill list: Ethylbenzene
New Jersey: Ethylbenzene
New Jersey spill list: Ethylbenzene
Louisiana spill reporting: Ethylbenzene
California Director's List of Hazardous Substances: Ethylbenzene
TSCA 8(b) inventory: Ethylbenzene
TSCA 4(a) proposed test rules: Ethylbenzene
TSCA 8(d) H and S data reporting: Ethylbenzene: Effective Date: 6/19/87; Sunset Date: 6/19/97
SARA 313 toxic chemical notification and release reporting: Ethylbenzene

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F).
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).
CLASSE D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R11- Highly flammable.
R20- Harmful by inhalation.
S16- Keep away from sources of ignition - No smoking.
S24/25- Avoid contact with skin and eyes.
S29- Do not empty into drains.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References:
-Manufacturer's Material Safety Data Sheet.
-Fire Protection Guide to Hazardous Materials, 13th ed., Nationial Fire Protection Association (NFPA)
-Registry of Toxic Effects of Chemical Substances (RTECS)
-Chemical Hazard Response Information System (CHRIS)
-Hazardous Substance Data Bank (HSDB)
-New Jersey Hazardous Substance Fact Sheet
-Ariel Global View
-Reprotext System

Other Special Considerations: Not available.

Created: 10/09/2005 05:28 PM

Last Updated: 10/09/2005 05:28 PM

Material Safety Data Sheet

CREOSOTE

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	CREOSOTE
OTHER/GENERIC NAMES:	Coal Tar Creosote, KMG-B Coal Tar Creosote Creosote Oil
PRODUCT USE:	Wood preservative
COMPANY:	KMG-Bernuth, Inc. 10611 Harwin, Suite 402 Houston, Texas 77036 Telephone: 713-988-9252
U. S. EPA Registration Nos.	61470-1 61483-7, 61483-8 61483-9, 61483-10

IN CASE OF EMERGENCY CALL:
(24 Hours/Day, 7 Days/Week)

CHEMTREC: 1 800 424 9300

2. COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENT NAME	CAS NUMBER	WEIGHT %
Creosote *	8001-58-9	100

* Mixture of 2, 3, & 4-ringed polynuclear aromatic hydrocarbons, including some substituted compounds

Trace impurities and additional material names not fisted above may also appear in Section 15. These materials may be listed for local “Right-To-Know" compliance and for other reasons.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Creosote is a brown to black oily liquid with a penetrating smoky odor. Vapor causes moderate to severe irritation of eyes, nose, throat and respiratory tract. Liquid can cause burning and itching with reddening of the skin, which is accentuated by sunlight.

POTENTIAL-HEALTH HAZARDS

SKIN:	Contact with skin can result in irritation, which when not washed off or when accentuated by sunlight, can result in minor burns.
EYES:	Overexposure to product vapors can result in irritation. Eye contact with product will result in irritation, which in the absence of recommended first aid can result in effects ranging from minor burns to severe corneal injury, including keratitis, conjunctivitis and corneal abrasion.

INHALATION:	Overexposure to vapor may result in irritation to respiratory tract. Prolonged exposure in significant excess of permissible air concentrations can result in acute toxic effects, such as dizziness, respiratory difficulty, convulsions and possible cardiovascular collapse.
INGESTION:	Irritation of the gastrointestinal tract followed by nausea and vomiting, abdominal discomfort. rapid pulse etc. Cardiovascular collapse may occur.
DELAYED EFFECTS:	Prolonged and repeated skin exposure over many years in the absence of recommended hygiene practices may lead to changes in skin pigmentation, benign skin growths and may, in some cases, result in skin cancer. Additionally, inhalation may present a lung cancer hazard.

Ingredients found on one of the OSHA designated carcinogen lists me listed below.

INGREDIENT NAME	NTB STATUS	JARC STATUS	OSHA LIST
Creosote	Carcinogen	2A - Probable	–

4. FIRST AID MEASURES

SKIN:	Wash thoroughly with waterless hand cleaners, olive oil or soap and water. Avoid solvents.
EYES:	Flush eyes immediately with large amounts of water or olive oil for at least 15 minutes. Call a physician
INHALATION:	Remove to fresh air. If not breathing, give artificial respiration; preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician.
INGESTION:	If conscious. first induce vomiting, then take 2 tablespoons of activated charcoal (USP-drug grade) in water. Get immediate medical attention. Do not induce vomiting, or give anything by mouth to an unconscious person.
ADVICE TO PHYSICIAN:	No additional instructions.

5. FIREFIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINTS:	> 93º C (> 200º F) / > 93º C (> 200º F)
FLASH POINT METHOD:	Closed Cup / Open Cup
AUTOIGNITION TEMPERATURE:	336º C (637º F)
UPPER FLAME LIMIT (volume 0/6 in air):	Not Determined
LOWER FLAME LIMIT (volume % In air):	Not Determined
FLAME PROPAGATION RATE (solids):	Not Applicable
OSHA FLAMMABILITY CLASS:	Not Determined

EXTINGUISHING MEDIA: Water/fog, carbon dioxide, foam, dry chemicals, sand or steam.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Water/fog is recommended for the control of unconfined oil fires, but water may cause frothing or eruption in closed tank.

SPECIAL FIRE FIGHTING PRECAUTIONS/INSTRUCTIONS: Self-contained breathing apparatus (SCBA) and full protective clothing should be worn when fumes and/or smoke are present.

6. ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR OTHER RELEASE: (Always wear recommended personal protective equipment)

Avoid breathing vapors and contact with skin and eyes. Avoid sources of ignition (sparks or open flame). Contain the spill or leak with solids, such as sand, earth, etc. Contaminated materials must be handled and managed as RCRA Hazardous Waste and treated before disposal in approved facilities. Do not allow to enter into sewers or waterways.

Spills and releases may have to be reported to Federal and/or local authorities. See Section 15.

7. HANDLING AND STORAGE

NORMAL HANDLING: (Always wear recommended personal protective equipment)

Wear clothing closed at the neck, long sleeves and non-porous type gloves, eg. neoprene, butyl rubber, nitrile, poly-vinyl alcohol (PVA), polyvinyl chloride (PVC).

STORAGE RECOMMENDATIONS: Recommended temperature for storage is about 140º F.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use in areas with adequate natural or local exhaust ventilation.

PERSONAL PROTECTIVE EQUIPMENT

SKIN PROTECTION:	Avoid skin contact whenever possible by using non-porous type gloves. For outdoor work use a waterproof sunscreen (SPF 25 or greater); reapply every 90 minutes while in direct sun. For exposed skin, use protective creams (for example: MSA's Fend AE-2, Kerodex 51, Jergens SBS-46).
EYE PROTECTION:	Safety glasses, goggles and/or face shield.
RESPIRATORY PROTECTION:	Not required for properly ventilated areas. Use a NIOSH approved respirator with suitable organic vapor cartridge as necessary to control exposures above the TLV of PEL.
ADDITIONAL RECOMMENDATIONS:	Do not take contaminated work clothing home. It is recommended that a complete soap and water shower and/or steam bath be taken at the end of each working day.

MATERIAL SAFETY DATA SHEET
CREOSOTE

EXPOSURE GUIDELINES

INGREDIENT NAME	ACGIH TLV	OSHA PEL	OTHER LIMIT
Creosote (measured as Coal Tar Pitch Volatiles, CTPV	0.2 mg/m³	0.2 mg/ m³	–

HAZARDOUS INGREDIENTS	CAS NUMBER	% BY WT.	EXPOSURE LIMIT		(PPM; MG/M3)
Coal Tar Distillate	65996-92-1		OSHA-TWA	-	*
Indene	95-13-6	<10	ACGIH-TWA	10	48
			OSHA-TWA	10	45
Naphthalene	91-20-3	<15	ACGIH-TWA	10	52
			ACGIH-STEL	15	79
			OSHA-TWA	10	50
			OSHA-STEL	15	75
			NIOSH-TWA	10	50
			NIOSH-STEL	15	75
Biphenyl	92-52-4	<5	ACGIH-TWA	0.2	1.3
			OSHA-TWA	0.2	1
Benzene	71-43-2	<1	ACGIH-TWA	10	32**, #
			OSHA-TWA	1	***
			OSHA-STEL	5	-
			NIOSH-TWA	0.1	-
			NIOSH-STEL	1	-
Alkylnaphthalene		<10	none		
Phenanthrene	85-01-8	9-13	NONE		
Benz (a) anthracene	56-55-3	1.6	NONE		
Benzo (a) phenanthrene	218-01-9	1.7	NONE		
Benzo (b) fluoranthene+	205-99-2		NONE		
Benzo (k) fluoranthene+	207-08-9		NONE		
Benzo (j) fluoranthene+	205-82-3		NONE		
7, 12-Dimethylbenz (a) anthracene	57-97-6	2.43	NONE		
Indeno (1,2,3-cd) pyrene	193-39-5	0.25	NONE		
Benzo (a) pyrene	50-32-8	0.92	NONE		
Dibenzo (a,h) anthracene	53-70-3	0.09	NONE		
Benzo (g,h,i) perylene+	191-24-2		NONE		
7-H Dibenzo (c,g) carbazole	194-59-2	0.18	NONE		
Dibenzo (a,l) pyrene	191-30-0	0.02	NONE		
1-Nitropyrene	5522-43-0	0.24	NONE		
Dibenz (a,j) acridine	224-42-0	0.06	NONE		
Dibenz (a,h) acridine	226-36-8	0.04	NONE		

------SARA TITLE III SECTION 313 CHEMICALS------
(SEE SECTION V11 FOR CAS NUMBERS AND PERCENTAGES)

Naphthalene
Biphenyl
Benzene
Phenanthrene / Benz (a) anthracene
Benzo (a) phenanthrene
Benzo (b) fluoranthrene / Benzo (k) fluoranthrene
Benzo (j) fluoranthrene
Benzo (a) pyrene
Dibenzo (a,h) anthracene
Indeno)1,2,3-cd) pyrene
1-Nitropyrene
7,12-Dimethylbenz (a) anthracene
7-H Dibenzo (c,g) carbazole / Benzo (g,h,i) perylene
Dibenzo (a,l) pyrene
Dibenz (a,j) acridine
Dibenz (a,h) acridine

OTHER EXPOSURE LIMITS FOR POTENTIAL DECOMPOSITION PRODUCTS: None

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Dark brown to black oily liquid
PHYSICAL STATE:	Liquid
MOLECULAR WEIGHT:	130-210
CHEMICAL FORMULA:	Mixture of organic compounds
ODOR:	Penetrating smoky odor
SPECIFIC GRAVITY (water=1.0):	1.03-1.18 (Avg.: 9.1 lbs/ gal)
SOLUBILITY IN WATER (weight %):	Insoluble
pH:	Not Determined
BOILING POINT:	194 - 400º C
MELTING POINT:	Not Determined
VAPOR PRESSURE (in mm Hg):	at 100º C - 80 mm; at 125º C - 225 mm; at 150º C - 370 mm
VAPOR DENSITY (air = 1.0):	< 1
EVAPORATION RATE:	< 1 COMPARED TO: Butyl Acetate –1
% VOLATILES:	Not Determined
FLASH POINT:	Closed cup: > 93º C (>200º F) Open cup: > 93º C (>200º F)

(Flash point method and additional flammability data are found in Section 5.)

10. STABILITY AND REACTIVITY

STABILITY (CONDITIONS TO AVOID): Product stable under normal conditions.
Due to its low vapor pressure and extremely low evaporation rate, the volatility rate at 20º C is almost zero. Upon heating, at extremely high temperatures, hydrocarbons will be emitted and some degradation will take place. Avoid loading or unloading near open flame.

INCOMPATIBILITIES: Mixing chlorosulfonic acid and creosote oil in a closed container can cause an increase in temperature and pressure (NFPA 491M, 1991)

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose under normal conditions of use. When heated to extreme temperatures creosote emits acrid smoke.

HAZARDOUS POLYMERIZATION: Will not occur

11. TOXICOLOGICAL INFORMATION

IMMEDIATE (ACUTE) EFFECTS: Oral LD_{50}; 725 mg/kg (rat); 433 mg/kg (mouse)

DELAYED (SUBCHRONIC AND CHRONIC) EFFECTS: Several studies in mice have shown the formation of both local (i.e. skin) and distant (i.e. lung) tumor formation after dermal exposure to creosote. [Poel & Kammer. 1957; Roe et al, 1958]

OTHER DATA: Has caused mutations in *S. typhimurium* strains TA98. TA100, TA1537, TA1538 and mouse lymphoma cell L5178y. [Fed Reg., 1978; Bos et al, 1983] Death from large doses of creosote appears due primarily to cardiovascular collapse. Fatalities have occurred 14-36 hours after the ingestion of creosote (about 7g for adults; about 1 or 2g for children). [Clayton & Clayton, 3rd ed., 1981]

12. ECOLOCICAL INFORMATION

TL$_{50}$, *Carassius auratus* (goldfish); 3.51 ppm/24 hours [60:40 mixture of creosote & coal tar]
TL$_{50}$, *Lepomis macrochirus* (bluegill); 4.42 ppm/24 hours [60:40 mixture of creosote & coal tar]
TL$_{50}$, *Salnio gairdner* (rainbow trout); 3.72 ppm/24 hours [60:40 mixture of creosote & coal tar]
LD$_{50}$, *Colinus virginianus* (bobwhite quail); 1260 ppm/8 days [60:40 mixture of creosote & coal tar]
LD$_{50}$, *Anas platyrhynchos* (mallard duck); 10,388 ppm/8 days [60:40 mixture of creosote & coal tar]

13. DISPOSAL CONSIDERATIONS

RCRA

Is the unused product a RCRA hazardous waste if discarded? YES
If yes, the RCRA ID number is: U051

OTHER DISPOSAL CONSIDERATIONS:

Other waste code designations for creosote containing wastes appear in the December 6, 1990 *Federal Register* as F034; Wastewater's, process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that use creosote formulations. This listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and/or pentachloraphenol. Please consult with the appropriate state regulatory authorities to determine when the F034 designation is effective in the given state.

Creosote-containing waste may also be characteristic hazardous wastes, even if not meeting the U051, K001, or F034 waste code designation.

The information offered here is for the product as shipped. Use and/or alterations to the product such as mixing with other materials may significantly change the characteristics of the material and alter the RCRA classification and the proper disposal method.

14. TRANSPORT INFORMATION

US DOT HAZARD CLASS:	Environmentally Hazardous Substance, Liquid, N.O.S. (Creosote). 9
US DOT ID NUMBER:	UN 3082
US DOT SHIPPING NAME:	RQ, Environmentally Hazardous Substance, Liquid, N.O.S. (Creosote), 9, UN3082, III

For additional information on shipping regulations affecting this material, contact the number found in Section 1.

I5. REGULATORY INFORMATION

TOXIC SUBSTANCES CONTROL ACT (TSCA)

TSCA INVENTORY STATUS: Listed on EPA's TSCA Inventory
OTHER TSCA ISSUES: Substance of unknown or variable composition

SARA TITLE III/CERCLA

"Reportable Quantities" (RQs) and/or "Threshold Planning Quantities" (TPQs) exist for the following ingredients.

INGREDIENT NAME	WEIGHT %	SARA/CERCLA RQ (LB)	SARA EHS TPQ (LB)
Creosote	100 %	1	None

Spills or releases resulting in the loss of any ingredient at or above its RQ requires immediate notification to the National Response Center [(800) 424-8802], State Emergency Response Commission and to your Local Emergency Planning Committee.

SECTION 311 HAZARD CLASS: Immediate, Delayed, Fire

SARA 313 TOXIC CHEMICALS:
The following ingredients are SARA 313 "Toxic Chemicals". CAS numbers and weight percents an found in Section 2.

INGREDIENT NAME	WEIGHT	COMMENT
Creosote	100%	de minimus concentration is 0.1%

STATE-RIGHT-TO-KNOW

In addition to the ingredients found In Section 2, the following are listed for state right-to-know purposes.

INGREDIENT NAME	WEIGHT	COMMENT
None		

ADDITIONAL REGULATORY INFORMATION: For some applications, Creosote is also regulated as a "Restricted Use" pesticide under the Federal Insecticide, Fungicide. and Rodenticide Act (FIFRA).

WHMIS CLASSIFICATION (CANADA): Class D, Division 2, Subdivision A, very toxic material

FOREIGN INVENTORY STATUS: Listed on the EINECS Inventory - ID# 2322875
Listed on Canadian Inventory Domestic Substance List (DSL)

16. OTHER INFORMATION

CURRENT ISSUE DATE: March 2003
PREVIOUS ISSUE DATE: January 2002

CHANGES TO MSDS FROM PREVIOUS ISSUE DATE ARE DUE TO THE FOLLOWING:

Updated DOT transportation information
Updated to include 16-section ANSI format for Material Safety Data Sheets

OTHER INFORMATION: NFPA Hazard Ratings:
Health (Blue): 2
Flammability (Red): 2
Reactivity (Yellow): 0

REFERENCES:

1. ACGIH (1995): *"1995-1996 Threshold Limit Values...."*
2. USDOL/OSHA General Industry 29 CFR 1910.1000 Coal Tar Pitch Volatile (CTPV) Permissible Exposure Limit
3. USEPA 40 CFR Parts 112; 261; 268; 300
4. USDOT 49 CFR Part 172
5. USEPA(1986) *"Evaluation of the Potential Carcinogenicity of Creosote (8001-58-9)"*, Prepared by the Carcinogen Assessment Group, Office of Health and Environmental Assessment, Washington, DC for the Office of Emergency and Remedial Response and the Office of Solid Waste and Emergency Response, Washington, DC
6. National Fire Prevention Association (1991): *"Fire Protection Guide on Hazardous Materials"*, 10th ed. NFPA:Quincy, MA, pg 325M-29, 491M.
7 USEPA (1980) *"Health and Environmental Effects of Creosote"*, EPA # 53, pg 53-12
8. Clayton & Clayton, eds (1981): *"Patty's Industrial Hygiene & Toxicology, Volume 2A, 2B, 2C Toxicology"*, 3rd ed. John Wiley & Sons, New York, NY
9. NIOSH (1977): *"Criteria for a recommended standard...Occupational Exposure to Coal Tar Products"*, USDHEW/NIOSH Publication # 78-107
10. Poel, W.E. and Kammer, A.G. (1957): *"Experimental carcinogenicity of coal-tar fractions: The carcinogenicity of creosote oils"* J NATL CANCER INST 18(1):41-55
11. Roe, F.J.C., Bosch, D., Boutwell, R.K. (1958): *The carcinogenicity of creosote oil: The induction of lung tumors in mice"* CANCER RES 18:1176-1178
12. Bos, R.P., Hulshof, C.T.J., Theuws, J.L.G., Hendershon, P.Th. (1983): *"Mutagenicity of creosote in the Salmonella/microsome assay"* MUT RES 119:21-25
13. FEDERAL REGISTER (1978), Vol 43 #200; October 18th, page 48199
14. IARC (1987): *Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man"*, World Health Organization (WHO): Geneva p S7 177
15. NTP (1994): *"National Toxicology Program's 7th Annual Report on Carcinogens 1994 - Summary"*

METAL

MATERIAL SAFETY DATA SHEET

ALDON CORPORATION

221 Rochester Street
Avon, New York 14414-9409
(585) 226-6177

MSDS No.: LL0070 LL0079 LL0080 LL0081 LL0082 LL0085 LL0086
Effective Date: March 29, 2005

SECTION I NAME

Product	Lead Metal
Chemical Synonyms	N/A
Formula	Pb
Unit Size	up to 2.5 Kg.
C.A.S. No.	7439-92-1

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC
800-424-9300
Day 585-226-6177

NFPA

Health	3
Fire	0
Reactivity	0

HMIS *

HAZARD RATING

MINIMAL	SLIGHT	MODERATE	SERIOUS	SEVERE
0	1	2	3	4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Lead metal, shot, granular, sheet, foil	99+%	See Section V.
CAUTION! MAY BE HARMFUL OR FATAL IF SWALLOWED		
OR INHALED AS FUMES OR DUST.		

SECTION III PHYSICAL DATA

Melting Point (°F)	Approx. 327.4°C (621°F)	Specific Gravity (H_2O = 1)	11.34 (20/4°C)
Boiling Point (°F)	1753°C (3187°F)	Percent Volatile by Volume (%)	0% at ambient temp.
Vapor Pressure (mm Hg)	N/A	Evaporation Rate (=1)	Non-volatile (N/A).
Vapor Density (Air=1)	N/A		
Solubility in Water	Insoluble.		
Appearance & Odor	Bluish, silvery, gray soft metal, granular, shot, sheet, foil; no odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)		Flammable Limits in Air % by Volume		Lower	Upper
	Non-flammable (N/A).		N/A	---------	---------

Extinguisher Media Dry chemical or carbon dioxide should be used on surrounding fire. Do not use water on fires where molten metal is present.

SPECIAL FIREFIGHTING PROCEDURES

In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective clothing.

UNUSUAL FIRE AND EXPLOSION HAZARDS

When heated emits toxic fumes of lead which can react vigorously with oxidizing materials.

D.O.T. Non Regulated.

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V HEALTH HAZARD DATA

LL0070

Threshold Limited Value Lead as inorganic compounds, as Pb: TWA 0.05 mg/m^3 (ACGIH 2001).

Effects of Overexposure **SKIN:** Not absorbed through skin. **EYES:** No specific hazard known. Contact may cause transient irritation. **INGESTION:** May produce anorexia, vomiting, malaise, convulsions due to increased intracranial pressure. **INHALATION:** Of dust or fumes can cause lead poisoning. Target organs: Lungs, kidneys.

Emergency and First Aid Procedures **INGESTION:** Call physician or Poison Control Center immediately. Induce vomiting only if advised by appropriate medical personnel. Never give anything by mouth to an unconscious person. **EYES:** Check for and remove contact lenses. Flush thoroughly with water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get immediate medical attention. **SKIN:** Remove contaminated clothing. Flush thoroughly with mild soap and water. If irritation occurs, get medical attention. **INHALATION:** Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI REACTIVITY DATA

Stability			Conditions to Avoid
	Unstable		High temperatures to produce fumes.
	Stable	X	

Incompatibility (Materials to Avoid) Strong oxidizing materials.

Hazardous Decomposition Products When heated, emits toxic fumes of lead.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	Not applicable.
	X	

SECTION VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled Carefully sweep up without producing dust and recycle for use or place in a suitable container for disposal.

Waste Disposal Method Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Dispose of in an approved chemical landfill or contract with a licensed waste disposal service.

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type) None should be needed in normal laboratory use at room temperature. If dusty conditions prevail, work in ventilation hood or wear a NIOSH/MSHA-approved dust mask or respirator.

Ventilation	Local Exhaust	None needed.	Special	No.
	Mechanical (General)	None needed.	Other	No.

Protective Gloves	Recommended - leather.	**Eye Protection**	Chemical safety glasses.

Other Protective Equipment Smock, apron, eye wash station, lab coat, ventilation hood.

SECTION IX SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing Store in a cool, dry place away from fire hazards. Wash thoroughly after handling. Remove and wash contaminated clothing.

Keep container tightly closed when not in use.

Other Precautions Read label on container before using. Do not wear contact lenses when working with chemicals. For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Lead can react violently with oxidizing materials. Water may become trapped within surface cracks which may cause an explosion when the metal is molten.

Revision No. 9	Date 03/29/05	Approved Michael Raszeja	Chemical Safety Coordinator MR

The information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees. * Hazardous Materials Industrial Standards. Printed on recycled paper.

8M

METAL

10 M

Material Safety Data Sheet
Mercury

ACC# 14020

Section 1 - Chemical Product and Company Identification

MSDS Name: Mercury
Catalog Numbers: S40672B, S41542, S41599, S41599B, S41599E, S41599G, S41599J, S41599K, S41599M, S41600P, S41600S, S41600W, S41630A, S41630B, S41630C, S41631, S41631A, S41631B, S41631C, S41645, S45245, S46981, S50443, S71966, S71967, S71968, S78777, 13501, M139-1LB, M139-5LB, M140-14LB, M140-1LB, M140-5LB, M141-1LB, M141-6LB, NC9534278
Synonyms: Colloidal mercury; Hydrargyrum; Metallic mercury; Quick silver; Liquid silver.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7439-97-6	Mercury	100	231-106-7

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: silver liquid.
Danger! Corrosive. Harmful if inhaled. May be absorbed through intact skin. Causes eye and skin irritation and possible burns. May cause severe respiratory tract irritation with possible burns. May cause severe digestive tract irritation with possible burns. May cause central nervous system effects. Inhalation of fumes may cause metal-fume fever. May cause liver and kidney damage. Possible sensitizer. This substance has caused adverse reproductive and fetal effects in animals.
Target Organs: Blood, kidneys, central nervous system, liver, brain.

Potential Health Effects
Eye: Exposure to mercury or mercury compounds can cause discoloration on the front surface of the lens, which does not interfere with vision. Causes eye irritation and possible burns. Contact with mercury or mercury compounds can cause ulceration of the conjunctiva and cornea.
Skin: May be absorbed through the skin in harmful amounts. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. Causes skin irritation and possible burns. May cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.
Ingestion: May cause severe and permanent damage to the digestive tract. May cause perforation

of the digestive tract. May cause effects similar to those for inhalation exposure. May cause systemic effects.

Inhalation: Causes chemical burns to the respiratory tract. Inhalation of fumes may cause metal fume fever, which is characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count. May cause central nervous system effects including vertigo, anxiety, depression, muscle incoordination, and emotional instability. Aspiration may lead to pulmonary edema. May cause systemic effects. May cause respiratory sensitization.

Chronic: May cause liver and kidney damage. May cause reproductive and fetal effects. Effects may be delayed. Chronic exposure to mercury may cause permanent central nervous system damage, fatigue, weight loss, tremors, personality changes. Chronic ingestion may cause accumulation of mercury in body tissues. Prolonged or repeated exposure may cause inflammation of the mouth and gums, excessive salivation, and loosening of the teeth.

Section 4 - First Aid Measures

Eyes: Get medical aid immediately. Do NOT allow victim to rub eyes or keep eyes closed. Extensive irrigation with water is required (at least 30 minutes).

Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.

Ingestion: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately. Wash mouth out with water.

Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

Notes to Physician: The concentration of mercury in whole blood is a reasonable measure of the body-burden of mercury and thus is used for monitoring purposes. Treat symptomatically and supportively. Persons with kidney disease, chronic respiratory disease, liver disease, or skin disease may be at increased risk from exposure to this substance.

Antidote: The use of d-Penicillamine as a chelating agent should be determined by qualified medical personnel. The use of Dimercaprol or BAL (British Anti-Lewisite) as a chelating agent should be determined by qualified medical personnel.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Water runoff can cause environmental damage. Dike and collect water used to fight fire. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion.

Extinguishing Media: Substance is nonflammable; use agent most appropriate to extinguish surrounding fire. Use water spray, dry chemical, carbon dioxide, or appropriate foam.

Flash Point: Not applicable.

Autoignition Temperature: Not applicable.

Explosion Limits, Lower: Not available.

Upper: Not available.

NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Minimize dust generation and accumulation. Keep container tightly closed. Do not get on skin or in eyes. Do not ingest or inhale. Use only in a chemical fume hood. Discard contaminated shoes. Do not breathe vapor.
Storage: Keep container closed when not in use. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from metals. Store protected from azides.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use only under a chemical fume hood.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Mercury	0.025 mg/m3 TWA; Skin - potential significant contribution to overall exposure by the cutaneous r oute	0.05 mg/m3 TWA (vapor) 10 mg/m3 IDLH	0.1 mg/m3 Ceiling (vapor)

OSHA Vacated PELs: Mercury: 0.05 mg/m3 TWA (vapor)
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: silver
Odor: odorless
pH: Not available.

Vapor Pressure: 0.002 mm Hg @ 25C
Vapor Density: 7.0
Evaporation Rate: Not available.
Viscosity: 15.5 mP @ 25 deg C
Boiling Point: 356.72 deg C
Freezing/Melting Point:-38.87 deg C
Decomposition Temperature: Not available.
Solubility: Insoluble.
Specific Gravity/Density:13.59 (water=1)
Molecular Formula: Hg
Molecular Weight:200.59

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: High temperatures, incompatible materials.
Incompatibilities with Other Materials: Oxygen, sulfur, acetylene, ammonia, chlorine dioxide, azides, chlorates, nitrates, sulfuric acid, halogens, rubidium, calcium, 3-bromopropyne, ethylene oxide, lithium, methylsilane + oxygen, peroxyformic acid, tetracarbonylnickel + oxygen, copper, copper alloys, boron diiodophosphide, metals, nitromethane, sodium carbide, aluminum, lead, iron, metal oxides.
Hazardous Decomposition Products: Mercury/mercury oxides.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 7439-97-6: OV4550000
LD50/LC50:
Not available.

Carcinogenicity:
CAS# 7439-97-6: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: Intraperitoneal, rat: TDLo = 400 mg/kg/14D-I (Tumorigenic - equivocal tumorigenic agent by RTECS criteria - tumors at site of application).
Teratogenicity: Inhalation, rat: TCLo = 1 mg/m3/24H (female 1-20 day(s) after conception) Effects on Embryo or Fetus - fetotoxicity (except death, e.g., stunted fetus).
Reproductive Effects: Inhalation, rat: TCLo = 890 ng/m3/24H (male 16 week(s) pre-mating) Paternal Effects - spermatogenesis (incl. genetic material, sperm morphology, motility, and count).; Inhalation, rat: TCLo = 7440 ng/m3/24H (male 16 week(s) pre-mating) Fertility - post-implantation mortality (e.g. dead and/or resorbed implants per total number of implants).
Mutagenicity: Cytogenetic Analysis: Unreported, man = 150 ug/m3.
Neurotoxicity: The brain is the critical organ in humans for chronic vapor exposure; in severe cases, spontaneous degeneration of the brain cortex can occur as a late sequela to past exposure.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: Fish: Rainbow trout: LC50 = 0.16-0.90 mg/L; 96 Hr; UnspecifiedFish: Bluegill/Sunfish: LC50 = 0.16-0.90 mg/L; 96 Hr; UnspecifiedFish: Channel catfish: LC50 = 0.35 mg/L; 96 Hr; UnspecifiedWater flea Daphnia: EC50 = 0.01 mg/L; 48 Hr; Unspecified In aquatic systems, mercury appears to bind to dissolved matter or fine particulates, while the transport of mercury bound to dust particles in the atmosphere or bed sediment particles in rivers and lakes is generally less substantial. The conversion, in aquatic environments, of inorganic mercury cmpd to methyl mercury implies that recycling of mercury from sediment to water to air and back could be a rapid process.

Environmental: Mercury bioaccumulates and concentrates in food chain (concentration may be as much as 10,000 times that of water). Bioconcentration factors of 63,000 for freshwater fish and 10,000 for salt water fish have been found. Much of the mercury deposited on land, appears to revaporize within a day or two, at least in areas substantially heated by sunlight.

Physical: All forms of mercury (Hg) (metal, vapor, inorganic, or organic) are converted to methyl mercury. Inorganic forms are converted by microbial action in the atmosphere to methyl mercury.

Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

RCRA P-Series: None listed.

RCRA U-Series:

CAS# 7439-97-6: waste number U151.

Section 14 - Transport Information

	US DOT	**Canada TDG**
Shipping Name:	MERCURY	MERCURY
Hazard Class:	8	8
UN Number:	UN2809	UN2809
Packing Group:	III	III

Section 15 - Regulatory Information

US FEDERAL

TSCA

CAS# 7439-97-6 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 7439-97-6: 1 lb final RQ; 0.454 kg final RQ

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 7439-97-6: acute, chronic.

Section 313

This material contains Mercury (CAS# 7439-97-6, 100%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 7439-97-6 (listed as Mercury compounds) is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.
CAS# 7439-97-6 is listed as a Priority Pollutant under the Clean Water Act. CAS# 7439-97-6 is listed as a Toxic Pollutant under the Clean Water Act.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7439-97-6 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

WARNING: This product contains Mercury, a chemical known to the state of California to cause developmental reproductive toxicity.
California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

T N

Risk Phrases:

R 23 Toxic by inhalation.
R 33 Danger of cumulative effects.
R 50/53 Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety Phrases:

S 1/2 Keep locked up and out of reach of children.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 7 Keep container tightly closed.
S 60 This material and its container must be disposed of as hazardous waste.
S 61 Avoid release to the environment. Refer to special instructions/safety data sheets.

WGK (Water Danger/Protection)

CAS# 7439-97-6: 3

Canada - DSL/NDSL

CAS# 7439-97-6 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of D2A, E.

Canadian Ingredient Disclosure List

CAS# 7439-97-6 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 6/15/1999
Revision #7 Date: 1/20/2005

11 M

International Chemical Safety Cards

NICKEL

ICSC: 0062

NICKEL
(powder)
Ni
Molecular mass: 58.7

CAS # 7440-02-0
RTECS # QR5950000
ICSC # 0062
EC # 028-002-00-7

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Flammable as dust. Toxic fumes may be released in a fire.		Water in large amounts, foam, dry sand, NO carbon dioxide.
EXPLOSION	Finely dispersed particles form explosive mixtures in air.	Prevent deposition of dust; closed system, dust explosion-proof electrical equipment and lighting.	
EXPOSURE		PREVENT DISPERSION OF DUST! STRICT HYGIENE!	
• INHALATION		Local exhaust or breathing protection.	Fresh air, rest.
• SKIN		Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• EYES		Safety spectacles or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• INGESTION		Do not eat, drink, or smoke during work.	

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Vacuum spilled material. Carefully collect remainder, then remove to safe place (extra personal protection: P2 filter respirator for harmful particles).	Separated from strong acids.	Xn symbol R: 40-43 S: (2-)22-36

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0062

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993

International Chemical Safety Cards

NICKEL

ICSC: 0062

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** ODOURLESS SILVERY METALLIC SOLID IN VARIOUS FORMS. **PHYSICAL DANGERS:** Dust explosion possible if in powder or granular form, mixed with air. **CHEMICAL DANGERS:** Reacts violently, in powder form, with titanium powder and potassium perchlorate, and oxidants such as ammonium nitrate, causing fire and explosion hazard. Reacts slowly with non-oxidizing acids and more rapidly with oxidizing acids. Toxic gases and vapours (such as nickel carbonyl) may be released in a fire involving nickel. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: ppm; 1 mg/m^3 (as TWA) (ACGIH 1993-1994).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of the dust and by ingestion. **INHALATION RISK:** Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly when dispersed. **EFFECTS OF SHORT-TERM EXPOSURE:** Inhalation of the fumes may cause pneumonitis. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation exposure may cause asthma. Lungs may be affected by repeated or prolonged exposure. The substance may have effects on the nasal sinuses , resulting in inflammation and ulceration.
PHYSICAL PROPERTIES	Boiling point: 2730°C Melting point: 1455°C	Relative density (water = 1): 8.9 Solubility in water: none
ENVIRONMENTAL DATA		

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of asthma often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential. Anyone who has shown symptoms of asthma due to this substance should avoid all further contact with this substance.

ADDITIONAL INFORMATION

ICSC: 0062 **NICKEL**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

Material Safety Data Sheet

PAH Contaminated Soil

ACC# 17974

Section 1 - Chemical Product and Company Identification

MSDS Name: PAH Contaminated Soil
Catalog Numbers: SRS103100
Synonyms: API separator sludge
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
Not available	Soil	78-99	unlisted
120-12-7	Anthracene	0-2	204-371-1
129-00-0	Pyrene	0-2	204-927-3
132-64-9	Dibenzofuran	0-2	205-071-3
205-99-2	Benzo(b)fluoranthene	0-2	205-911-9
206-44-0	Fluoranthene	0-2	205-912-4
208-96-8	Acenaphthylene	0-2	205-917-1
218-01-9	1,2-benzphenanthrene	0-2	205-923-4
50-32-8	Benzo(a)pyrene	0-2	200-028-5
56-55-3	1,2-Benzanthracene	0-2	200-280-6
83-32-9	Acenaphthene	0-2	201-469-6
85-01-8	Phenanthrene	0-2	201-581-5
86-73-7	Fluorene	0-2	201-695-5
87-86-5	Pentachlorophenol	0-2	201-778-6
91-20-3	Naphthalene	0-2	202-049-5
91-57-6	2-methylnaphthalene	0-2	202-078-3

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: not available solid.
Warning! May cause allergic skin reaction. Causes eye and skin irritation. May cause cancer based on animal studies.
Target Organs: Eyes, skin.

Potential Health Effects
Eye: May cause eye irritation.
Skin: May cause skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material.
Ingestion: May cause gastrointestinal irritation with nausea, vomiting and diarrhea. Naphthalene can cause cataracts, optical neuritis, and cornea injuries. Ingestion of large quantities may cause severe hemolytic anemia and
Inhalation: Causes respiratory tract irritation. May cause effects similar to those described for ingestion.
Chronic: May cause cancer according to animal studies. Prolonged exposure to respirable crystalline quartz may cause delayed lung injury/fibrosis (silicosis).

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.
Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: Not published.

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions.

Section 7 - Handling and Storage

Handling: Wash hands before eating. Use with adequate ventilation. Avoid contact with skin and eyes. Keep container tightly closed. Avoid ingestion and inhalation.
Storage: Store in a cool, dry place.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate ventilation to keep airborne concentrations low.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Soil	none listed	none listed	none listed
Anthracene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (as benzene soluble fraction) (listed under Coal tar pitches).
Pyrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (as benzene soluble fraction) (listed under Coal tar pitches).
Dibenzofuran	none listed	none listed	none listed
Benzo(b)fluoranthene	none listed	none listed	none listed
Fluoranthene	none listed	none listed	none listed
Acenaphthylene	none listed	none listed	none listed
1,2-benzphenanthrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (as benzene soluble fraction) (listed under Coal tar pitches).

Benzo(a)pyrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (as benzene soluble fraction) (listed under Coal tar pitches).
1,2-Benzanthracene	none listed	none listed	none listed
Acenaphthene	none listed	none listed	none listed
Phenanthrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (as benzene soluble fraction) (listed under Coal tar pitches).
Fluorene	none listed	none listed	none listed
Pentachlorophenol	0.5 mg/m3 TWA; Skin - potential significant contribution to overall exposure by the cutaneous route	0.5 mg/m3 TWA 2.5 mg/m3 IDLH	0.5 mg/m3 TWA
Naphthalene	10 ppm TWA; 15 ppm STEL; Skin - potential significant contribution to overall exposure by the cutaneous route	10 ppm TWA; 50 mg/m3 TWA 250 ppm IDLH	10 ppm TWA; 50 mg/m3 TWA
2-methylnaphthalene	none listed	none listed	none listed

OSHA Vacated PELs: Soil: No OSHA Vacated PELs are listed for this chemical. Anthracene: No OSHA Vacated PELs are listed for this chemical. Pyrene: No OSHA Vacated PELs are listed for this chemical. Dibenzofuran: No OSHA Vacated PELs are listed for this chemical. Benzo(b)fluoranthene: No OSHA Vacated PELs are listed for this chemical. Fluoranthene: No OSHA Vacated PELs are listed for this chemical. Acenaphthylene: No OSHA Vacated PELs are listed for this chemical. 1,2-benzphenanthrene: No OSHA Vacated PELs are listed for this chemical. Benzo(a)pyrene: No OSHA Vacated PELs are listed for this chemical. 1,2-Benzanthracene: No OSHA Vacated PELs are listed for this chemical. Acenaphthene: No OSHA Vacated PELs are listed for this chemical. Phenanthrene: No OSHA Vacated PELs are listed for this chemical. Fluorene: No OSHA Vacated PELs are listed for this chemical. Pentachlorophenol: 0.5 mg/m3 TWA Naphthalene: 10 ppm TWA; 50 mg/m3 TWA 2-methylnaphthalene: No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin: Wear appropriate gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance: not available
Odor: none reported
pH: Not available.
Vapor Pressure: Not applicable.
Vapor Density: Not available.
Evaporation Rate: Not applicable.
Viscosity: Not applicable.
Boiling Point: Not available.
Freezing/Melting Point: Not available.
Decomposition Temperature: Not available.
Solubility: Insoluble in water.
Specific Gravity/Density: Not available.
Molecular Formula: Mixture
Molecular Weight: Not available.

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: High temperatures.
Incompatibilities with Other Materials: None reported.
Hazardous Decomposition Products: No data available.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 120-12-7: CA9350000
CAS# 129-00-0: UR2450000; UR2450100
CAS# 132-64-9: HP4430000
CAS# 205-99-2: CU1400000
CAS# 206-44-0: LL4025000
CAS# 208-96-8: AB1254000; AB1254200
CAS# 218-01-9: GC0700000
CAS# 50-32-8: DJ3675000
CAS# 56-55-3: CV9275000
CAS# 83-32-9: AB1000000
CAS# 85-01-8: SF7175000
CAS# 86-73-7: LL5670000
CAS# 87-86-5: SM6300000; SM6314000; SM6321000
CAS# 91-20-3: QJ0525000
CAS# 91-57-6: QJ9635000
LD50/LC50:
CAS# 120-12-7:

Oral, mouse: LD50 = 4900 mg/kg;

CAS# 129-00-0:
Draize test, rabbit, skin: 500 mg/24H Mild;
Inhalation, rat: LC50 = 170 mg/m3;
Inhalation, rat: LC50 = 170 mg/m3;
Oral, mouse: LD50 = 800 mg/kg;
Oral, rat: LD50 = 2700 mg/kg;

CAS# 132-64-9:

CAS# 205-99-2:

CAS# 206-44-0:
Oral, rat: LD50 = 2 gm/kg;
Skin, rabbit: LD50 = 3180 mg/kg;

CAS# 208-96-8:
Oral, mouse: LD50 = 1760 mg/kg;

CAS# 218-01-9:

CAS# 50-32-8:

CAS# 56-55-3:

CAS# 83-32-9:

CAS# 85-01-8:
Oral, mouse: LD50 = 700 mg/kg;
Oral, rat: LD50 = 1.8 gm/kg;

CAS# 86-73-7:

CAS# 87-86-5:
Draize test, rabbit, eye: 100 uL/24H Mild;
Inhalation, mouse: LC50 = 225 mg/m3;
Inhalation, mouse: LC50 = 225 mg/m3;
Inhalation, rat: LC50 = 355 mg/m3;
Inhalation, rat: LC50 = 200 mg/m3;
Inhalation, rat: LC50 = 335 mg/m3;
Oral, mouse: LD50 = 36 mg/kg;
Oral, mouse: LD50 = 117 mg/kg;
Oral, mouse: LD50 = 30 mg/kg;
Oral, rabbit: LD50 = 200 mg/kg;
Oral, rat: LD50 = 27 mg/kg;
Oral, rat: LD50 = 27 mg/kg;
Oral, rat: LD50 = 50 mg/kg;
Skin, rat: LD50 = 96
CAS# 91-20-3:
Draize test, rabbit, eye: 100 mg Mild;
Inhalation, rat: LC50 = >340 mg/m3/1H;
Oral, mouse: LD50 = 316 mg/kg;
Oral, rat: LD50 = 490 mg/kg;
Skin, rabbit: LD50 = >20 gm/kg;
Skin, rat: LD50 = >2500 mg/kg;

CAS# 91-57-6:
Oral, rat: LD50 = 1630 mg/kg;

Carcinogenicity:
CAS# 120-12-7:

- **ACGIH:** A1 - Confirmed Human Carcinogen (as benzene soluble aerosol) (listed as 'Coal tar pitches').
- **California:** Not listed.
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 129-00-0:

- **ACGIH:** A1 - Confirmed Human Carcinogen (as benzene soluble aerosol) (listed as 'Coal tar pitches').
- **California:** Not listed.
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 132-64-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 205-99-2:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 7/1/87
- **NTP:** Suspect carcinogen
- **IARC:** Group 2B carcinogen

CAS# 206-44-0: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 208-96-8: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 218-01-9:

- **ACGIH:** A3 - Confirmed animal carcinogen with unknown relevance to humans
- **California:** carcinogen, initial date 1/1/90
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 50-32-8:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 7/1/87
- **NTP:** Suspect carcinogen
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 56-55-3:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 7/1/87
- **NTP:** Suspect carcinogen
- **IARC:** Group 2A carcinogen

CAS# 83-32-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 85-01-8:

- **ACGIH:** A1 - Confirmed Human Carcinogen (as benzene soluble aerosol) (listed as 'Coal tar pitches').

- **California:** Not listed.
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 86-73-7: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 87-86-5:

- **ACGIH:** A3 - Confirmed animal carcinogen with unknown relevance to humans
- **California:** carcinogen, initial date 1/1/90
- **NTP:** Not listed.
- **IARC:** Not listed.

CAS# 91-20-3:

- **ACGIH:** Not listed.
- **California:** carcinogen, initial date 4/19/02
- **NTP:** Suspect carcinogen
- **IARC:** Group 2B carcinogen

CAS# 91-57-6: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information available.
Teratogenicity: No information available.
Reproductive Effects: No information available.
Mutagenicity: No information available.
Neurotoxicity: No information available.
Other Studies:

Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series:
CAS# 206-44-0: waste number U120.
CAS# 218-01-9: waste number U050.
CAS# 50-32-8: waste number U022.
CAS# 56-55-3: waste number U018.
CAS# 91-20-3: waste

Section 14 - Transport Information

	US DOT	Canada TDG

Shipping Name:	Not regulated as a hazardous material	No information available.
Hazard Class:		
UN Number:		
Packing Group:		

Section 15 - Regulatory Information

US FEDERAL

TSCA

Soil is not listed on the TSCA inventory. It is for research and development use only.
CAS# 120-12-7 is listed on the TSCA inventory.
CAS# 129-00-0 is listed on the TSCA inventory.
CAS# 132-64-9 is listed on the TSCA inventory.
CAS# 205-99-2 is not listed on the TSCA inventory. It is for research and development use only.
CAS# 206-44-0 is listed on the TSCA inventory.
CAS# 208-96-8 is listed on the TSCA inventory.
CAS# 218-01-9 is listed on the TSCA inventory.
CAS# 50-32-8 is listed on the TSCA inventory.
CAS# 56-55-3 is listed on the TSCA inventory.
CAS# 83-32-9 is listed on the TSCA inventory.
CAS# 85-01-8 is listed on the TSCA inventory.
CAS# 86-73-7 is listed on the TSCA inventory.
CAS# 87-86-5 is listed on the TSCA inventory.
CAS# 91-20-3 is listed on the TSCA inventory.
CAS# 91-57-6 is listed on the TSCA inventory.

Health & Safety Reporting List

CAS# 129-00-0: Effective 6/1/87, Sunset 6/1/97 CAS# 91-20-3: Effective 6/1/87, Sunset 6/1/97

Chemical Test Rules

CAS# 91-20-3: Testing required by manufacturers, processors

Section 12b

CAS# 91-20-3: Section 4

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 120-12-7: 5000 lb final RQ; 2270 kg final RQ CAS# 129-00-0: 5000 lb final RQ; 2270 kg final RQ CAS# 132-64-9: 100 lb final RQ; 45.4 kg final RQ CAS# 205-99-2: 1 lb final RQ; 0.454 kg final RQ CAS# 206-44-0: 100 lb final RQ; 45.4 kg final RQ CAS# 208-96-8: 5000 lb final RQ; 2270 kg final RQ CAS# 218-01-9: 100 lb final RQ; 45.4 kg final RQ CAS# 50-32-8: 1 lb final RQ; 0.454 kg final RQ CAS# 56-55-3: 10 lb final RQ; 4.54 kg final RQ CAS# 83-32-9: 100 lb final RQ; 45.4 kg final RQ CAS# 85-01-8: 5000 lb final RQ; 2270 kg final RQ CAS# 86-73-7: 5000 lb final RQ; 2270 kg final RQ CAS# 87-86-5: 10 lb final RQ; 4.54 kg final RQ CAS# 91-20-3: 100 lb final RQ; 45.4 kg final RQ

SARA Section 302 Extremely Hazardous Substances

CAS# 129-00-0: 1000 lb TPQ (lower threshold); 10000 lb TPQ (upper threshold)

SARA Codes

CAS # 120-12-7: acute.
CAS # 129-00-0: acute, chronic.
CAS # 206-44-0: acute.

CAS # 50-32-8: acute, chronic.
CAS # 56-55-3: chronic.
CAS # 83-32-9: acute.
CAS # 85-01-8: acute.
CAS # 91-20-3: acute, chronic, flammable.
CAS # 91-57-6: acute.

Section 313

This material contains Anthracene (CAS# 120-12-7, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains Dibenzofuran (CAS# 132-64-9, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains Benzo(b)fluoranthene (CAS# 205-99-2, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Fluoranthene (CAS# 206-44-0, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains 1,2-benzphenanthrene (CAS# 218-01-9, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Benzo(a)pyrene (CAS# 50-32-8, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains 1,2-Benzanthracene (CAS# 56-55-3, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Phenanthrene (CAS# 85-01-8, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains Pentachlorophenol (CAS# 87-86-5, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Naphthalene (CAS# 91-20-3, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 132-64-9 is listed as a hazardous air pollutant (HAP).

CAS# 87-86-5 is listed as a hazardous air pollutant (HAP).
CAS# 91-20-3 is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 87-86-5 is listed as a Hazardous Substance under the CWA. CAS# 91-20-3 is listed as a Hazardous Substance under the CWA. CAS# 120-12-7 is listed as a Priority Pollutant under the Clean Water Act. CAS# 129-00-0 is listed as a Priority Pollutant under the Clean Water Act. CAS# 205-99-2 is listed as a Priority Pollutant under the Clean Water Act. CAS# 206-44-0 is listed as a Priority Pollutant under the Clean Water Act. CAS# 208-96-8 is listed as a Priority Pollutant under the Clean Water Act. CAS# 218-01-9 is listed as a Priority Pollutant under the Clean Water Act. CAS# 50-32-8 is listed as a Priority Pollutant under the Clean Water Act. CAS# 56-55-3 is listed as a Priority Pollutant under the Clean Water Act. CAS# 83-32-9 is listed as a Priority Pollutant under the Clean Water Act. CAS# 85-01-8 is listed as a Priority Pollutant under the Clean Water Act. CAS# 86-73-7 is listed as a Priority Pollutant under the Clean Water Act. CAS# 87-86-5 is listed as a Priority Pollutant under the Clean Water Act. CAS# 91-20-3 is listed as a Priority Pollutant under the Clean Water Act. CAS# 206-44-0 is listed as a Toxic Pollutant under the Clean Water Act. CAS# 83-32-9 is listed as a Toxic Pollutant under the Clean Water Act. CAS# 87-86-5 is listed as a Toxic Pollutant under the Clean Water Act. CAS# 91-20-3 is listed as a Toxic Pollutant under the Clean Water Act.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 120-12-7 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, (listed as Coal tar pitches), Massachusetts.

CAS# 129-00-0 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, (listed as Coal tar pitches), Massachusetts.

CAS# 132-64-9 can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.

CAS# 205-99-2 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 206-44-0 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Massachusetts.

CAS# 208-96-8 can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.

CAS# 218-01-9 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 50-32-8 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 56-55-3 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 83-32-9 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Massachusetts.

CAS# 85-01-8 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, (listed as Coal tar pitches), Massachusetts.

CAS# 86-73-7 can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.

CAS# 87-86-5 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 91-20-3 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 91-57-6 is not present on state lists from CA, PA, MN, MA, FL, or NJ.

California Prop 65

WARNING: This product contains Benzo(b)fluoranthene, a chemical known to the state of California to cause cancer. WARNING: This product contains 1,2-benzphenanthrene, a chemical known to the state of California to cause cancer. WARNING: This product contains Benzo(a)pyrene, a chemical known to the state of California to cause cancer. WARNING: This product contains 1,2-Benzanthracene, a chemical known to the state of California to cause cancer. WARNING: This product contains Pentachlorophenol, a chemical known to the state of California to cause cancer. WARNING: This product contains Naphthalene, a chemical known to the state of California to cause cancer.

California No Significant Risk Level: CAS# 205-99-2: 0.096 æg/day NSRL (oral) CAS# 218-01-9: 0.35 æg/day NSRL (oral) CAS# 50-32-8: 0.06 æg/day NSRL CAS# 56-55-3: 0.033 æg/day NSRL (oral) CAS# 87-86-5: 40 æg/day NSRL

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

Not available.

Risk Phrases:

Safety Phrases:

WGK (Water Danger/Protection)

CAS# 120-12-7: 2
CAS# 129-00-0: No information available.
CAS# 132-64-9: No information available.
CAS# 205-99-2: No information available.
CAS# 206-44-0: No information available.
CAS# 208-96-8: No information available.
CAS# 218-01-9: No information available.
CAS# 50-32-8: No information available.
CAS# 56-55-3: No information available.
CAS# 83-32-9: No information available.
CAS# 85-01-8: No information available.
CAS# 86-73-7: No information available.
CAS# 87-86-5: 3
CAS# 91-20-3: 2
CAS# 91-57-6: No information available.

Canada - DSL/NDSL

CAS# 120-12-7 is listed on Canada's DSL List.
CAS# 129-00-0 is listed on Canada's DSL List.
CAS# 132-64-9 is listed on Canada's DSL List.
CAS# 218-01-9 is listed on Canada's DSL List.
CAS# 50-32-8 is listed on Canada's DSL List.
CAS# 83-32-9 is listed on Canada's DSL List.
CAS# 85-01-8 is listed on Canada's DSL List.
CAS# 86-73-7 is listed on Canada's DSL List.
CAS# 87-86-5 is listed on Canada's DSL List.
CAS# 91-20-3 is listed on Canada's DSL List.
CAS# 91-57-6 is listed on Canada's DSL List.
CAS# 206-44-0 is listed on Canada's NDSL List.
CAS# 208-96-8 is listed on Canada's NDSL List.
CAS# 56-55-3 is listed on Canada's NDSL List.

Canada - WHMIS

This product has a WHMIS classification of D2A.

Canadian Ingredient Disclosure List

CAS# 120-12-7 is listed on the Canadian Ingredient Disclosure List.
CAS# 129-00-0 is listed on the Canadian Ingredient Disclosure List.
CAS# 205-99-2 is listed on the Canadian Ingredient Disclosure List.
CAS# 206-44-0 is listed on the Canadian Ingredient Disclosure List.
CAS# 208-96-8 is not listed on the Canadian Ingredient Disclosure List.
CAS# 218-01-9 is listed on the Canadian Ingredient Disclosure List.
CAS# 50-32-8 is listed on the Canadian Ingredient Disclosure List.
CAS# 56-55-3 is listed on the Canadian Ingredient Disclosure List.
CAS# 83-32-9 is listed on the Canadian Ingredient Disclosure List.
CAS# 85-01-8 is listed on the Canadian Ingredient Disclosure List.
CAS# 86-73-7 is not listed on the Canadian Ingredient Disclosure List.
CAS# 87-86-5 is not listed on the Canadian Ingredient Disclosure List.
CAS# 91-20-3 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 9/02/1997
Revision #3 Date: 3/18/2003

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PCB

International Chemical Safety Cards

POLYCHLORINATED BIPHENYL (AROCLOR 1254)

ICSC: 0939

Chlorobiphenyl (54% chlorine)
Chlorodiphenyl (54% chlorine)
PCB
Molecular mass: 327 (average)

ICSC # 0939
CAS # 11097-69-1
RTECS # TQ1360000
UN # 2315
EC # 602-039-00-4

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible. Gives off irritating or toxic fumes (or gases) in a fire.		Powder, carbon dioxide.
EXPLOSION			
EXPOSURE		PREVENT GENERATION OF MISTS! STRICT HYGIENE!	
•INHALATION		Ventilation.	Fresh air, rest. Refer for medical attention.
•SKIN	MAY BE ABSORBED! Dry skin. Redness.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
•EYES		Safety goggles, face shield.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Headache. Numbness.	Do not eat, drink, or smoke during work.	Rest. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING

Consult an expert! Collect leaking liquid in sealable containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT let this chemical enter the environment. (Extra personal protection: complete protective clothing including self-contained breathing apparatus).	Separated from food and feedstuffs. Cool. Dry. Keep in a well-ventilated room.	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs. Severe marine pollutant. Note: C Xn symbol R: 33-50/53 S: 2-35-60-61 UN Hazard Class: 9 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0939	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2000. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

POLYCHLORINATED BIPHENYL (AROCLOR 1254)

ICSC: 0939

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** LIGHT YELLOW VISCOUS LIQUID. **PHYSICAL DANGERS:** **CHEMICAL DANGERS:** The substance decomposes in a fire producing irritating and toxic gases. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: ppm; 0.5 mg/m^3 A3 (skin) (ACGIH 1999). OSHA PEL: TWA 0.5 mg/m^3 skin NIOSH REL: Ca TWA 0.001 mg/m^3 See Appendix A *Note: The REL also applies to other PCBs. NIOSH IDLH: Potential occupational carcinogen 5 mg/m^3	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its aerosol, through the skin and by ingestion. **INHALATION RISK:** A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver. Animal tests show that this substance possibly causes toxic effects upon human reproduction.
PHYSICAL PROPERTIES	Relative density (water = 1): 1.5 Solubility in water: none	Vapour pressure, Pa at 25°C: 0.01 Octanol/water partition coefficient as log

	Pow: 6.30 (estimated)
ENVIRONMENTAL DATA	In the food chain important to humans, bioaccumulation takes place, specifically in water organisms. It is strongly advised not to let the chemical enter into the environment.

NOTES

Changes into a resinous state (pour point) at 10°C. Distillation range: 365°-390°C.

Transport Emergency Card: TEC (R)-914

ADDITIONAL INFORMATION

ICSC: 0939 **POLYCHLORINATED BIPHENYL (AROCLOR 1254)**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

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VOC

Material Safety Data Sheet
Tetrachloroethylene

ACC# 22900

Section 1 - Chemical Product and Company Identification

MSDS Name: Tetrachloroethylene
Catalog Numbers: C182 20, C182 4, C182-20, C182-4, C18220, C1824, O4586 4, O4586-4, O45864
Synonyms: Ethylene tetrachloride; Tetrachlorethylene; Perchloroethylene; Perchlorethylene
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
127-18-4	Tetrachloroethylene	99.0+	204-825-9

Hazard Symbols: XN N
Risk Phrases: 40 51/53

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear, colorless liquid. Irritant. May cause severe eye and skin irritation with possible burns. May cause central nervous system depression. May cause liver and kidney damage. May cause reproductive and fetal effects. May cause cancer based on animal studies. **Caution!** May cause respiratory tract irritation.
Target Organs: Kidneys, central nervous system, liver.

Potential Health Effects
Eye: Contact with eyes may cause severe irritation, and possible eye burns.
Skin: May cause severe irritation and possible burns.
Ingestion: May cause central nervous system depression, kidney damage, and liver damage. Symptoms may include: headache, excitement, fatigue, nausea, vomiting, stupor, and coma. May cause gastrointestinal irritation with nausea, vomiting and diarrhea.
Inhalation: Inhalation of vapor may cause respiratory tract irritation. May cause central nervous system effects including vertigo, anxiety, depression, muscle incoordination, and emotional instability.
Chronic: Possible cancer hazard based on tests with laboratory animals. Prolonged or repeated skin contact may cause defatting and dermatitis. May cause respiratory tract cancer. May cause

adverse nervous system effects including muscle tremors and incoordination. May cause liver and kidney damage. May cause reproductive and fetal effects.

Section 4 - First Aid Measures

Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Get medical aid if irritation develops or persists. Wash clothing before reuse. Flush skin with plenty of soap and water.
Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Containers may explode in the heat of a fire. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas.
Extinguishing Media: Substance is noncombustible; use agent most appropriate to extinguish surrounding fire. For small fires, use dry chemical, carbon dioxide, or water spray. For large fires, use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Cool containers with flooding quantities of water until well after fire is out.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 2; Flammability: 0; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Flush down the spill with a large amount of water. Remove all sources of ignition. Use a spark-proof tool. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Do not reuse this container. Avoid breathing vapors from heated material. Avoid contact with skin and eyes. Keep container tightly closed. Keep away from flames

and other sources of high temperatures that may cause material to form vapors or mists.
Storage: Keep away from heat and flame. Store in a cool, dry place. Keep containers tightly closed.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Tetrachloroethylene	25 ppm TWA; 100 ppm STEL	150 ppm IDLH	100 ppm TWA; 200 ppm Ceiling

OSHA Vacated PELs: Tetrachloroethylene: 25 ppm TWA; 170 mg/m3 TWA
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear, colorless
Odor: sweetish odor
pH: Not available.
Vapor Pressure: 15.8 mm Hg
Vapor Density: 5.2
Evaporation Rate:9 (ether=100)
Viscosity: 0.89 mPa s 20 deg C
Boiling Point: 121 deg C
Freezing/Melting Point:-22.3 deg C
Decomposition Temperature:150 deg C
Solubility: Nearly insoluble in water.
Specific Gravity/Density:1.623
Molecular Formula:C_2Cl_4
Molecular Weight:165.812

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: Incompatible materials, excess heat.
Incompatibilities with Other Materials: Strong bases, metals, liquid oxygen, dinitrogen tetroxide.

Hazardous Decomposition Products: Hydrogen chloride, phosgene, carbon monoxide, carbon dioxide.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 127-18-4: KX3850000
LD50/LC50:
CAS# 127-18-4:
Draize test, rabbit, eye: 162 mg Mild;
Draize test, rabbit, eye: 500 mg/24H Mild;
Draize test, rabbit, skin: 810 mg/24H Severe;
Draize test, rabbit, skin: 500 mg/24H Mild;
Inhalation, mouse: LC50 = 5200 ppm/4H;
Inhalation, rat: LC50 = 34200 mg/m3/8H;
Oral, mouse: LD50 = 8100 mg/kg;
Oral, rat: LD50 = 2629 mg/kg;
Carcinogenicity:
CAS# 127-18-4:
ACGIH: A3 - Animal Carcinogen
California: carcinogen; initial date 4/1/88
NIOSH: potential occupational carcinogen
NTP: Suspect carcinogen
OSHA: Possible Select carcinogen
IARC: Group 2A carcinogen
Epidemiology: Epidemiologic studies have given inconsistent results. Studi es have shown that tetrachloroethylene has not caused canc er in exposed workers. The studies have serious weakne sses such as mixed exposures. In tests with rats and mice, i t appeared that tissue destruction or peroxisome prolifera tion rather than genetic mechanisms were the cause of the observed increases in normally occurring cancers. The oral mouse TDLo that was tumorigenic was 195 gm/kg/50W-I.
Teratogenicity: Has caused musculoskeletal abnormalities. Has caused morphological transformation at a dose of 97mol/L in a study using rat embryos.
Reproductive Effects: Has caused behavioral, biochemical, and metabolic effects on newborn rats when the mother was exposed to the TCLo of 900 ppm/7H at 7-13 days after conception. A dose of 300 ppm/7H 6-15 days after conception caused post-implantation mortality.
Neurotoxicity: No information available.
Mutagenicity: Not mutagenic in Escherichia coli. No mutagenic effects were seen in rat liver after exposure at 200 ppm for 10 weeks. No chromosome changes were seen in the bone marrow cells of exposed mice.
Other Studies: A case of 'obstructive jaundice' in a 6-week old infant has been attributed to tetrachloroethylene in breast milk.

Section 12 - Ecological Information

Ecotoxicity: Fish: Rainbow trout: LC50 = 5.28 mg/L; 96 Hr.; Static Condition, 12 degrees C Fathead Minnow: LC50 = 18.4 mg/L; 96 Hr.; Flow-through condition Bluegill/Sunfish: LC50 = 12.9 mg/L; 96 Hr.; Static Condition ria: Phytobacterium phosphoreum: EC50 = 120.0 mg/L; 30 minutes; Microtox test No data available.

Environmental: In soil, substance will rapidly evaporate. In water, it will evaporate. In air, it can be expected to exist in the vapor phase.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: CAS# 127-18-4: waste number U210.

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	TETRACHLOROETHYLENE				TETRACHLOROETHYLENE
Hazard Class:	6.1				6.1
UN Number:	UN1897				UN1897
Packing Group:	III				III

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 127-18-4 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 127-18-4: Effective Date: 6/1/87; Sunset Date: 6/1/97
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA

CERCLA Hazardous Substances and corresponding RQs
CAS# 127-18-4: 100 lb final RQ; 45.4 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 127-18-4: acute.
Section 313
This material contains Tetrachloroethylene (CAS# 127-18-4, 99 0%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:
CAS# 127-18-4 is listed as a hazardous air pollutant (HAP). This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.

Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA. CAS# 127-18-4 is listed as a Priority Pollutant under the Clean Water Act. CAS# 127-18-4 is listed as a Toxic Pollutant under the Clean Water Act.

OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.

STATE
CAS# 127-18-4 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

The following statement(s) is(are) made in order to comply with the California Safe Drinking Water Act: WARNING: This product contains Tetrachloroethylene, a chemical known to the state of California to cause cancer. California No Significant Risk Level: CAS# 127-18-4: 14 ug/day NSRL

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:
XN N

Risk Phrases:
R 40 Limited evidence of a carcinogenic effect.
R 51/53 Toxic to aquatic organisms; may cause long-term adverse effects in the aquatic environment.

Safety Phrases:
S 23 Do not inhale gas/fumes/vapour/spray.
S 36/37 Wear suitable protective clothing and gloves.
S 61 Avoid release to the environment. Refer to special instructions/Safety data sheets.

WGK (Water Danger/Protection)
CAS# 127-18-4: 3

Canada - DSL/NDSL
CAS# 127-18-4 is listed on Canada's DSL List.

Canada - WHMIS
This product has a WHMIS classification of D1B, D2A.

Canadian Ingredient Disclosure List
CAS# 127-18-4 is listed on the Canadian Ingredient Disclosure List.

Exposure Limits
CAS# 127-18-4: OEL-ARAB Republic of Egypt:TWA 5 ppm (35 mg/m3);Skin OEL-AUSTRALIA:TWA 50 ppm (335 mg/m3);STEL 150 ppm;CAR OEL-BELGIUM:TWA 50 ppm (339 mg/m3);STEL 200 ppm (1368 mg/m3) OEL-CZECHOSLOVAKIA:TWA 250 mg/m3;STEL 1250 mg/m3 OEL-DENMARK:TWA 30 ppm (200 mg/m3);Skin OEL-FINLAND:TWA 50 ppm (335 mg/m3);STEL 75 ppm (520 mg/m3);Skin OEL-FRANCE:TWA 50 ppm (335 mg/m3) OEL-GERMANY:TWA 50 ppm (345 mg/m3);Carcinogen OEL-HUNGARY:STEL 50 mg/m3;Skin;Carcinogen OEL-JAPAN:TWA 50 ppm (340 mg/m3) OEL-THE NETHERLANDS:TWA 35 ppm (240 mg/m3);Skin OEL-THE PHILIPPINES:TWA 100 ppm (670 mg/m3) OEL-POLAND:TWA 60 mg/m3 OEL-RUSSIA:TWA 50 ppm;STEL 10 mg/m3 OEL-SWEDEN:TWA 10 ppm (70 mg/m3);STEL 25 ppm (170 mg/m3) OEL-SWITZERLAND:TWA 50 ppm (345 mg/m3);STEL 100 ppm;Skin OEL-THAILAND:TWA 100 ppm;STEL 200 ppm OEL-UNITED KINGDOM:TWA 50 ppm (335 mg/m3);STEL 15 ppm OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA

check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

Section 16 - Additional Information

MSDS Creation Date: 6/17/1999
Revision #3 Date: 3/18/2003

MSDS Number: **T3913** * * * * * *Effective Date:* ***10/05/06*** * * * * * *Supercedes:* ***08/03/04***

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

MSDS *Material Safety Data Sheet*

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: **Mallinckrodt Baker, Inc.**
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS
J.T.Baker

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

TOLUENE

1. Product Identification

Synonyms: Methylbenzene; Toluol; Phenylmethane
CAS No.: 108-88-3
Molecular Weight: 92.14
Chemical Formula: C6H5-CH3
Product Codes:
J.T. Baker: 5375, 5812, 9336, 9351, 9364, 9456, 9457, 9459, 9460, 9462, 9466, 9472, 9476
Mallinckrodt: 4483, 8092, 8604, 8608, 8610, 8611, V560

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Toluene	108-88-3	100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. VAPOR HARMFUL. FLAMMABLE LIQUID AND VAPOR. MAY AFFECT LIVER, KIDNEYS, BLOOD SYSTEM, OR CENTRAL NERVOUS SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate (Life)
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe (Life)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
Inhalation may cause irritation of the upper respiratory tract. Symptoms of overexposure may include fatigue, confusion, headache, dizziness and drowsiness. Peculiar skin sensations (e. g. pins and needles) or numbness may be produced. Very high concentrations may cause unconsciousness and death.

Ingestion:
Swallowing may cause abdominal spasms and other symptoms that parallel over-exposure from inhalation. Aspiration of material into the lungs can cause chemical pneumonitis, which may be fatal.

Skin Contact:
Causes irritation. May be absorbed through skin.

Eye Contact:
Causes severe eye irritation with redness and pain.

Chronic Exposure:
Reports of chronic poisoning describe anemia, decreased blood cell count and bone marrow hypoplasia. Liver and kidney damage may occur. Repeated or prolonged contact has a defatting action, causing drying, redness, dermatitis. Exposure to toluene may affect the developing fetus.

Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired liver or kidney function may be more susceptible to the effects of this substance. Alcoholic beverage consumption can enhance the toxic effects of this substance.

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4. First Aid Measures

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. CALL A PHYSICIAN IMMEDIATELY.

Ingestion:
Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately. If vomiting occurs, keep head below hips to prevent aspiration into lungs.

Skin Contact:
In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician immediately.

Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Flash point: 7C (45F) CC
Autoignition temperature: 422C (792F)
Flammable limits in air % by volume:
lel: 1.1; uel: 7.1
Flammable liquid and vapor!
Dangerous fire hazard when exposed to heat or flame. Vapors can flow along surfaces to distant ignition source and flash back.

Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Contact with strong oxidizers may cause fire or explosion. Sensitive to static discharge.

Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Water may be used to flush spills away from exposures and to dilute spills to non-flammable mixtures.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full

facepiece operated in the pressure demand or other positive pressure mode. Water spray may be used to keep fire exposed containers cool.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
Toluene:
- OSHA Permissible Exposure Limit (PEL):
200 ppm (TWA); 300 ppm (acceptable ceiling conc.); 500 ppm (maximum conc.).
- ACGIH Threshold Limit Value (TLV):
50 ppm (TWA) skin, A4 - Not Classifiable as a Human Carcinogen.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face organic vapor respirator may be worn for up to ten times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece organic vapor respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Aromatic benzene-like.
Solubility:
0.05 gm/100gm water @ 20C (68F).
Specific Gravity:
0.86 @ 20C / 4 C
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
111C (232F)
Melting Point:
-95C (-139F)
Vapor Density (Air=1):
3.14
Vapor Pressure (mm Hg):
22 @ 20C (68F)
Evaporation Rate (BuAc=1):
2.24

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Heat, flame, strong oxidizers, nitric and sulfuric acids, chlorine, nitrogen tetraoxide; will attack some forms of plastics, rubber, coatings.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Toxicological Data:
Oral rat LD50: 636 mg/kg; skin rabbit LD50: 14100 uL/kg; inhalation rat LC50: 49 gm/m3/4H; Irritation data: skin rabbit, 500 mg, Moderate; eye rabbit, 2 mg/24H, Severe. Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
Has shown some evidence of reproductive effects in laboratory animals.

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--------\Cancer Lists\---------------------------------------------------
                                       ---NTP Carcinogen---
Ingredient                             Known    Anticipated    IARC Category
------------------------------------   -----    -----------    -------------
Toluene (108-88-3)                      No          No              3
```

12. Ecological Information

Environmental Fate:
When released into the soil, this material may evaporate to a moderate extent. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released into water, this material may evaporate to a moderate extent. When released into water, this material may biodegrade to a moderate extent. When released into the air, this material may be moderately degraded by reaction

with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life of less than 1 day. This material is not expected to significantly bioaccumulate. This material has a log octanol-water partition coefficient of less than 3.0. Bioconcentration factor = 13.2 (eels).

Environmental Toxicity:

This material is expected to be toxic to aquatic life. The LC50/96-hour values for fish are between 10 and 100 mg/l.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: TOLUENE
Hazard Class: 3
UN/NA: UN1294
Packing Group: II
Information reported for product/size: 390LB

International (Water, I.M.O.)

Proper Shipping Name: TOLUENE
Hazard Class: 3
UN/NA: UN1294
Packing Group: II
Information reported for product/size: 390LB

15. Regulatory Information

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  --------\Chemical Inventory Status - Part 1\---------------------------------
  Ingredient                                       TSCA  EC   Japan  Australia
  -----------------------------------------------  ----  ---  -----  ---------
  Toluene (108-88-3)                                Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\---------------------------------
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Toluene (108-88-3)                                Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\----------------
                                             -SARA 302-    ------SARA 313------
  Ingredient                                 RQ    TPQ     List  Chemical Catg.
  -----------------------------------------  ---   -----   ----  --------------
  Toluene (108-88-3)                         No    No      Yes         No

  --------\Federal, State & International Regulations - Part 2\----------------
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Toluene (108-88-3)                         1000       U220       No
```

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Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  Yes
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Pure / Liquid)
```

WARNING:

THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 3[Y]E
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **2** Flammability: **3** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. VAPOR HARMFUL. FLAMMABLE LIQUID AND VAPOR. MAY AFFECT LIVER, KIDNEYS, BLOOD SYSTEM, OR CENTRAL NERVOUS SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Keep away from heat, sparks and flame.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Avoid breathing vapor.
Avoid contact with eyes, skin and clothing.
Label First Aid:
Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If vomiting occurs, keep head below hips to prevent aspiration into lungs. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician immediately.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 5.
Disclaimer:
****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS *Material Safety Data Sheet*

From: **Mallinckrodt Baker, Inc.**
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS
J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

XYLENES

1. Product Identification

Synonyms: Dimethyl benzene, xylol, methyltoluene
CAS No.: 1330-20-7
Molecular Weight: 106.17
Chemical Formula: $C_6H_4(CH_3)_2$
Product Codes:
J.T. Baker: 5377, 5813, 9483, 9489, 9490, 9493, 9494, 9499, 9516, X516
Mallinckrodt: 8664, 8668, 8671, 8672, 8802, V052

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
m-Xylene	108-38-3	40 - 65%	Yes
o-Xylene	95-47-6	15 - 20%	Yes
p-Xylene	106-42-3	< 20%	Yes
Ethyl Benzene	100-41-4	15 - 25%	Yes

3. Hazards Identification

Emergency Overview

DANGER! HARMFUL OR FATAL IF SWALLOWED. VAPOR HARMFUL. AFFECTS CENTRAL NERVOUS SYSTEM. CAUSES SEVERE EYE IRRITATION. CAUSES IRRITATION TO SKIN AND RESPIRATORY TRACT. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. CHRONIC EXPOSURE CAN CAUSE ADVERSE LIVER, KIDNEY, AND BLOOD EFFECTS. FLAMMABLE LIQUID AND VAPOR.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate (Life)

Flammability Rating: 2 - Moderate
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
Inhalation of vapors may be irritating to the nose and throat. Inhalation of high concentrations may result in nausea, vomiting, headache, ringing in the ears, and severe breathing difficulties which may be delayed in onset. Substernal pain, cough, and hoarseness are also reported. High vapor concentrations are anesthetic and central nervous system depressants.
Ingestion:
Ingestion causes burning sensation in mouth and stomach, nausea, vomiting and salivation. Minute amounts aspirated into the lungs can produce a severe hemorrhagic pneumonitis with severe pulmonary injury or death.
Skin Contact:
Skin contact results in loss of natural oils and often results in a characteristic dermatitis. May be absorbed through the skin.
Eye Contact:
Vapors cause eye irritation. Splashes cause severe irritation, possible corneal burns and eye damage.
Chronic Exposure:
Chronic inhalation can cause headache, loss of appetite, nervousness and pale skin. Repeated or prolonged skin contact may cause a skin rash. Repeated exposure of the eyes to high concentrations of vapor may cause reversible eye damage. Repeated exposure can damage bone marrow, causing low blood cell count. May damage the liver and kidneys.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems, or impaired liver, kidney, blood, or respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician immediately.
Ingestion:
Aspiration hazard. If swallowed, vomiting may occur spontaneously, but DO NOT INDUCE. If vomiting occurs, keep head below hips to prevent aspiration into lungs. Never give anything by mouth to an unconscious person. Call a physician immediately.
Skin Contact:
Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Flash point: 29C (84F) CC
Autoignition temperature: 464C (867F)
Flammable limits in air % by volume:

lel: 1.0; uel: 7.0
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Contact with strong oxidizers may cause fire. Sealed containers may rupture when heated. Sensitive to static discharge.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Water spray may be used to keep fire exposed containers cool, dilute spills to nonflammable mixtures, protect personnel attempting to stop leak and disperse vapors.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Vapors can flow along surfaces to distant ignition source and flash back.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product. Do Not attempt to clean empty containers since residue is difficult to remove. Do not pressurize, cut, weld, braze, solder, drill, grind or expose such containers to heat, sparks, flame, static electricity or other sources of ignition: they may explode and cause injury or death.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
100 ppm (TWA) xylene
100 ppm (TWA) ethylbenzene
-ACGIH Threshold Limit Value (TLV):
xylene: 100 ppm (TWA) 150 ppm (STEL), A4 - Not classifiable as a human carcinogen.
ethyl benzene: 100 ppm (TWA) 125 ppm (STEL), A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details. Use explosion-proof equipment.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face organic vapor respirator may be worn for up to ten times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece organic vapor respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

The following physical data is for xylene.
Appearance:
Clear, colorless liquid.
Odor:
Characteristic odor.
Solubility:
Insoluble in water.
Specific Gravity:
0.86 @ 20C/4C
pH:
Not applicable.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
137 - 140C (279 - 284F)
Melting Point:
-25C (-13F)
Vapor Density (Air=1):
3.7
Vapor Pressure (mm Hg):
8 @ 20C (68F)
Evaporation Rate (BuAc=1):
0.7

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Involvement in a fire causes formation of carbon monoxide and unidentified organic components.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong oxidizing agents and strong acids.
Conditions to Avoid:

Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Toxicological Data:
Xylene: oral rat LD50: 4300 mg/kg; inhalation rat LC50: 5000 ppm/4H; skin rabbit LD50: > 1700 mg/kg; Irritation eye rabbit: 87 mg mild (Std. Draize); irritation skin rabbit 500 mg/24 moderate (Std. Draize); investigated as a tumorigen, mutagen, reproductive effector.
Ethyl benzene: oral rat LD50: 3500 mg/kg; skin rabbit LD50: 17800 uL/kg; investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
May cause teratogenic effects.

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--------\Cancer Lists\------------------------------------------------------
                                       ---NTP Carcinogen---
Ingredient                             Known    Anticipated    IARC Category
------------------------------------   -----    -----------    -------------
m-Xylene (108-38-3)                     No          No              3
o-Xylene (95-47-6)                      No          No              3
p-Xylene (106-42-3)                     No          No              3
Ethyl Benzene (100-41-4)                No          No             2B
```

12. Ecological Information

Environmental Fate:
Following data for xylene: When released into the soil, this material may evaporate to a moderate extent. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released into water, this material may evaporate to a moderate extent. When released into water, this material may biodegrade to a moderate extent. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life of less than 1 day. This material is not expected to significantly bioaccumulate. (mixed xylenes: octanol / water partition coefficient 3.1 - 3.2; bioconcentration factor = 1.3, eels)
Environmental Toxicity:
For xylene: This material is expected to be slightly toxic to aquatic life. The LC50/96-hour values for fish are between 10 and 100 mg/l.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: RQ, XYLENES
Hazard Class: 3
UN/NA: UN1307
Packing Group: III
Information reported for product/size: 398LB

International (Water, I.M.O.)

Proper Shipping Name: XYLENES
Hazard Class: 3
UN/NA: UN1307
Packing Group: III
Information reported for product/size: 398LB

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
m-Xylene (108-38-3)	Yes	Yes	Yes	Yes
o-Xylene (95-47-6)	Yes	Yes	Yes	Yes
p-Xylene (106-42-3)	Yes	Yes	Yes	Yes
Ethyl Benzene (100-41-4)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
m-Xylene (108-38-3)	Yes	Yes	No	Yes
o-Xylene (95-47-6)	Yes	Yes	No	Yes
p-Xylene (106-42-3)	Yes	Yes	No	Yes
Ethyl Benzene (100-41-4)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
m-Xylene (108-38-3)	No	No	Yes	No
o-Xylene (95-47-6)	No	No	Yes	No
p-Xylene (106-42-3)	No	No	Yes	No
Ethyl Benzene (100-41-4)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------------

		-RCRA-	-TSCA-
Ingredient	CERCLA	261.33	8(d)
m-Xylene (108-38-3)	1000	No	No
o-Xylene (95-47-6)	1000	No	No
p-Xylene (106-42-3)	100	No	Yes
Ethyl Benzene (100-41-4)	1000	No	No

```
Chemical Weapons Convention:  No     TSCA 12(b):  Yes    CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Mixture / Liquid)
```

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 3[Y]
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **2** Flammability: **3** Reactivity: **0**

Label Hazard Warning:
DANGER! HARMFUL OR FATAL IF SWALLOWED. VAPOR HARMFUL. AFFECTS CENTRAL NERVOUS SYSTEM. CAUSES SEVERE EYE IRRITATION. CAUSES IRRITATION TO SKIN AND RESPIRATORY TRACT. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. CHRONIC EXPOSURE CAN CAUSE ADVERSE LIVER, KIDNEY, AND BLOOD EFFECTS. FLAMMABLE LIQUID AND VAPOR.
Label Precautions:
Keep away from heat, sparks and flame.
Avoid contact with eyes, skin and clothing.
Keep container closed.
Use only with adequate ventilation.
Avoid breathing vapor.
Wash thoroughly after handling.
Label First Aid:
Aspiration hazard. If swallowed, vomiting may occur spontaneously, but DO NOT INDUCE. If vomiting occurs, keep head below hips to prevent aspiration into lungs. Never give anything by mouth to an unconscious person. Call a physician immediately. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****

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****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

METAL

13 M

MSDS Number: **Z0858** * * * * * *Effective Date:* ***05/07/03*** * * * * * *Supercedes:* ***11/02/01***

MSDS *Material Safety Data Sheet*

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS

J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

ZINC METAL POWDER

1. Product Identification

Synonyms: Powdered zinc; blue powder; CI77945; CI Pigment Black 16
CAS No.: 7440-66-6
Molecular Weight: 65.37
Chemical Formula: Zn
Product Codes:
J.T. Baker: 4282
Mallinckrodt: 8681

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Zinc	7440-66-6	96 - 97%	Yes
Zinc Oxide	1314-13-2	0 - 3%	Yes
Lead	7439-92-1	0 - 0.3%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. MAY FORM COMBUSTIBLE DUST CONCENTRATIONS IN AIR. WATER REACTIVE. MAY AFFECT THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM (lead component).

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 2 - Moderate

Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; CLASS D EXTINGUISHER
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
No adverse effects expected but dust may cause mechanical irritation. The effects may be expected to resemble those of inhaling an inert dust; possible difficulty in breathing, sneezing, coughing. When heated, the fumes are highly toxic and may cause fume fever.

Ingestion:
Extremely large oral dosages may produce gastrointestinal disturbances, due both to mechanical effects and the possibility of reaction with gastric juice to produce zinc chloride. Pain, stomach cramps and nausea could occur in aggravated cases.

Skin Contact:
May cause irritation.

Eye Contact:
May cause irritation.

Chronic Exposure:
No adverse health effects expected.

Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.

Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.

Skin Contact:
Wipe off excess material from skin then immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

5. Fire Fighting Measures

Fire:
Autoignition temperature: ca. 460C (ca. 860F)
The listed autoignition temperature is for Zinc powder (layer); dust cloud is ca. 680C (1255F). Zinc powder is not pyrophoric but will burn in air at elevated temperatures. Bulk dust in damp state may heat spontaneously and ignite on exposure to air. Releases flammable hydrogen gas upon contact with acids or alkali hydroxides. Contact with strong oxidizers may cause fire.

Explosion:
Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Fire Extinguishing Media:
Smother with a suitable dry powder (sodium chloride, magnesium oxide, Met-L-X).

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Remove all sources of ignition and provide mild ventilation in area of spill. Substance may be pyrophoric and self-ignite. Clean-up personnel require protective clothing, goggles and dust/mist respirators. Sweep or vacuum up the spill in a manner that does not disperse zinc powder in the air and place the zinc in a closed container for recovery or disposal.
US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None for Zinc metal.
-OSHA Permissible Exposure Limit (PEL):
10 mg/m3 (TWA), for zinc oxide fume
-ACGIH Threshold Limit Value (TLV):
10 mg/m3 (TWA), Inhalable fraction, A4 Not classifiable as a human carcinogen for zinc oxide.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a full facepiece particulate respirator (NIOSH type N100 filters) may be worn for up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids. glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Gray or bluish-gray powder.
Odor:
Odorless.

Solubility:
Insoluble in water.
Density:
7.14
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
907C (1665F)
Melting Point:
419C (786F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1 @ 487C (909F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Moist zinc dust can react exothermically and ignite spontaneously in air.
Hazardous Decomposition Products:
Hydrogen in moist air, zinc oxide with oxygen at high temperature. Zinc metal, when melted, produces zinc vapor which oxidizes and condenses in air to form zinc fume.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Zinc powder can react violently with water, sulfur and halogens. Dangerous or potentially dangerous with strong oxidizing agents, lower molecular weight chlorinated hydrocarbons, strong acids and alkalis.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Zinc: Irritation skin, human: 300 ug/3D-I mild; investigated as a mutagen.

```
--------\Cancer Lists\------------------------------------------------------
                                          ---NTP Carcinogen---
Ingredient                                Known    Anticipated    IARC Category
------------------------------------      -----    -----------    -------------
Zinc (7440-66-6)                           No          No              None
Zinc Oxide (1314-13-2)                     No          No              None
Lead (7439-92-1)                           No          No              2B
```

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

```
 --------\Chemical Inventory Status - Part 1\---------------------------------
 Ingredient                                       TSCA  EC   Japan  Australia
 -----------------------------------------------  ----  ---  -----  ---------
 Zinc (7440-66-6)                                  Yes  Yes   No       Yes
 Zinc Oxide (1314-13-2)                            Yes  Yes   Yes      Yes
 Lead (7439-92-1)                                  Yes  Yes   Yes      Yes

 --------\Chemical Inventory Status - Part 2\---------------------------------
                                                         --Canada--
 Ingredient                                       Korea  DSL   NDSL  Phil.
 -----------------------------------------------  -----  ---   ----  -----
 Zinc (7440-66-6)                                  Yes   Yes   No     Yes
 Zinc Oxide (1314-13-2)                            Yes   Yes   No     Yes
 Lead (7439-92-1)                                  Yes   Yes   No     Yes

 --------\Federal, State & International Regulations - Part 1\----------------
                                            -SARA 302-    ------SARA 313------
 Ingredient                                 RQ    TPQ     List  Chemical Catg.
 -----------------------------------------  ---   -----   ----  --------------
 Zinc (7440-66-6)                           No    No      Yes        No
 Zinc Oxide (1314-13-2)                     No    No      No    Zinc compoun
 Lead (7439-92-1)                           No    No      Yes        No

 --------\Federal, State & International Regulations - Part 2\----------------
                                                      -RCRA-    -TSCA-
 Ingredient                                 CERCLA    261.33     8(d)
 -----------------------------------------  ------    ------    ------
 Zinc (7440-66-6)                           1000      No         No
 Zinc Oxide (1314-13-2)                     No        No         No
 Lead (7439-92-1)                           10        No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: No   Fire: Yes Pressure: No
Reactivity: Yes         (Mixture / Solid)
```

WARNING:
THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 4Y
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **1** Reactivity: **1** Other: **Water reactive**

Attachment IV

Attachment IV – Heat Stress / Cold Stress

1.0 HEAT STRESS

Excessive exposure to a hot environment can bring about a variety of heat-induced disorders. The four main types of heat stress related illnesses: heat rash, heat cramps, heat exhaustion, and heat stroke, are discussed below.

1.1 Heat Rash

Heat rash also know as prickly heat, is likely to occur in hot, humid environments where sweat is not readily removed from the surface of the skin by evaporation and the skin remains wet most of the time. The sweat ducts become plugged, and a skin rash soon appears. When the rash is extensive or when it is complicated by an infection, prickly heat can be very uncomfortable and may reduce a worker's performance. The worker can prevent this condition by resting in a cool place part of each day and by regularly bathing and drying the skin.

1.2 Heat Cramps

Heat cramps are painful spasms of the muscles that occur among those who sweat profusely in heat, drink large quantities of water, but do not adequately replace the body's salt loss. Drinking large quantities of water tends to dilute the body's fluids, while the body continues to lose salt. Shortly thereafter, the low salt level in the muscles causes painful cramps. The affected muscles may be part of the arms, legs or abdomen, but tired muscles (those used to perform the work) are usually the ones most susceptible to cramps. Cramps may occur during or after work hours and may be relieved by taking salted liquids by mouth, such as the variety of sports drinks on the market.

CAUTION SHOULD BE EXERCISED BY PEOPLE WITH HEART PROBLEMS OR THOSE ON LOW SODIUM DIETS WHO WORK IN HOT ENVIRONMENTS. THESE PEOPLE SHOULD CONSULT A PHYSICIAN ABOUT WHAT TO DO UNDER THESE CONDITIONS.

1.3 Heat Exhaustion

Heat exhaustion includes several clinical disorders having symptoms that may resemble the early symptoms of heat stroke. Heat exhaustion is caused by the loss of large amounts of fluid by sweating, sometimes with excessive loss of salt. A worker suffering from this condition still sweats but experiences extreme weakness or fatigue, giddiness, nausea, or headache. In more serious cases, the victim may vomit or lose consciousness. The skin is clammy and moist, the complexion is pale or flushed, and the body temperature is normal or only slightly elevated.

A summary of the key symptoms of heat exhaustion is as follows:

- Clammy skin
- Confusion
- Dizziness
- Fainting

- Fatigue
- Heat Rash
- Light-headedness
- Nausea
- Profuse sweating
- Slurred Speech
- Weak Pulse

In most cases, treatment involves having the victim rest in a cool place and drink plenty of fluids. Victims with mild cases of heat exhaustion usually recover spontaneously with this treatment. Those with severe cases may require extended care for several days. There are no known permanent effects.
AS WITH HEAT CRAMPS, CERTAIN PERSONS SHOULD CONSULT WITH THEIR PHYSICIAN ABOUT WHAT TO DO UNDER THESE CONDITIONS.

1.4 Heat Stroke

This is the most serious of health problems associated with working in hot environments. It occurs when the body's temperature regulatory system fails and sweating becomes inadequate. The body's only effective means of removing excess heat is compromised with little warning to the victim that a crisis stage has been reached.

A heat stroke victim's skin is hot, usually dry, red or spotted. Body temperature is usually 105oF or higher, and the victim is mentally confused, delirious, perhaps in convulsions, or unconscious. Unless the victim receives quick and appropriate treatment, death can occur.

A summary of the key symptoms of heatstroke is as follows:

- Confusion
- Convulsions
- Incoherent Speech
- Staggering Gait
- Unconsciousness
- Sweating stops
- Hot skin, high temperature (yet extremities may feel chilled)

Any person with signs or symptoms of heat stroke requires immediate hospitalization. However, first aid should be immediately administered. This includes moving the victim to a cool area, thoroughly soaking the clothing with water, and vigorously fanning the body to increase cooling. Further treatment at a medical facility should include continuation of the cooling process and the monitoring of complications that often accompany the heat stroke. Early recognition and treatment of heat stroke are the only means of preventing permanent brain damage or death.

1.5 Preparing for the Heat

Humans, to a large extent, are capable of adjusting to heat. This acclimation to heat, under normal circumstances, usually takes about 5 to 7 days, during which time the body will undergo a series of changes that will make continued exposure to heat more tolerable.

On the first day of exposure, body temperature, pulse rate, and general discomfort will be higher. With each succeeding day of exposure, all of these responses will gradually decrease, while the sweat rate will increase. When the body does become acclimated to the heat, the worker will find it possible to perform work with less strain and distress.

A gradual exposure to heat gives the body time to become accustomed to higher temperatures, such as those encountered in chemical protective clothing.

1.6 Protecting Against Heat Stress

There are several methods that can be used to reduce heat stress:

- Limit duration of work periods
- Use protective clothing with cooling devices
- Enforce the use of the "Buddy System"
- Consume electrolyte solutions prior to suiting up
- Monitor workers for pulse recovery rates, body fluid loss, body weight loss, and excess fatigue
- Screen for heat stress susceptible candidates in your medical surveillance program
- Have all personnel know the signs and symptoms of heat stress

2.0 COLD STRESS

Persons working outdoors in temperatures at or below freezing may be frostbitten. Extreme cold for a short time may cause severe injury to the surface of the body, or result in profound generalized cooling, causing death. Areas of the body that have high surface-area-to-volume ratio such as fingers, toes, and ears, are the most susceptible. Two factors influence the development of a cold injury, ambient temperature and the velocity of the wind. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For instance, 10 degrees Fahrenheit with a wind of 15 miles per hour (mph) is equivalent in chilling effect to still air at minus 18 degrees Fahrenheit.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is perspiration soaked.

2.1 Frostbite

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost Nip or Initial Frostbite: characterized by suddenly blanching or whitening of skin.
- Superficial Frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep Frostbite: tissues are cold, pale, and solid; extremely serious injury.

2.2 Hypothermia

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages:

- Shivering
- Apathy, listlessness, sleepiness, and (sometimes rapid cooling of the body to less than 95°F)
- Unconsciousness, glassy stage, slow pulse, and slow respiratory rate
- Freezing of the extremities
- Death

Thermal socks, long cotton or thermal underwear, hard hat liners and other cold weather gear can aid in the prevention of hypothermia. Blankets and warm drinks (other than caffeinated coffee) are also recommended.

Measures shall be taken to keep workers from getting wet, such as issuance of rain gear. Workers whose cloths become wet shall be given the opportunity to dry off and change clothes.

Attachment V

Attachment V - Construction Equipment Safety Rules

1.0 ELECTRICAL

1. Live electrical parts shall be guarded against accidental contact by cabinets, enclosure, location, or guarding. Cabinet covers will be replaced.

2. Working and clear space around electric equipment and distribution boxes will be kept clear and assessable.

3. Circuit breakers, switch boxes, etc. will be legibly marked to indicate their purpose.

4. All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. If the prime contractor has not provided this protection with GFCI receptacles at the temporary service drop, employees will ensure portable GFCI protection is provided. (Employers may wish to use assured equipment grounding conductor program in lieu of this GFCI protection.) This requirement is in addition to any other electrical equipment grounding requirement or double insulated protection.

5. All extension cords will be three-wire (grounded) type and designed for hard or extra hard usage (Type S, ST, SO, STO, or SJ, SJO, SJT, SJTO).

6. Ground prongs will not be removed.

7. Cords and strain relief devices/clamps will be in good condition.

8. All lamps for general illumination will have the bulbs protected against breakage.

9. Electrical cords will not suspend temporary lights unless cords and lights are designed for such suspension. Flexible cords used for temporary and portable lights will be designed for hard or extra hard usage.

10. Employees will not work in such close (able to contact) proximity to any part of an electric power circuit unless the circuit is de-energized, grounded, or guarded by insulation.

11. Equipment or circuits that are de-energized will be locked out and tagged out. The tags will plainly identify the equipment or circuits being worked on.

2.0 COMPRESSED GAS CYLINDERS

1. All gas cylinders will have their contents clearly marked on the outside of each cylinder.

2. Cylinders must be transported, stored, and secured in an upright position. They will never be left laying on the ground or floor, nor used as rollers or supports.

3. Cylinder valves must be protected with caps and closed when not in use.

4. All leaking or defective cylinders must be removed from service promptly, tagged as inoperable and placed in an open space removed from the work area.

5. Oxygen cylinders and fittings will be kept away from oil or grease.

6. When cylinders are hoisted, they will be secured in a cradle, sling-board, or pallet. Valve protection caps will not be used for lifting cylinders from one vertical level to another.

3.0 LADDERS

1. A competent person to identify any unsafe conditions will periodically inspect ladders.

2. Those ladders with structural defects will be removed from service, and repaired or replaced.

3. Straight ladders used on other than stable, level, and dry surfaces must be tied off, held, or secured for stability.

4. Portable ladder side rails will extend at least three feet above the upper landing to which the ladder is used to gain access.

5. The top or top step of a stepladder will not be used as a step.

4.0 AERIAL LIFTS

1. Aerial lifts include cherry pickers, extensible boom platforms, aerial ladders, articulating boom platforms, vertical towers, and any combinations of the above.

2. Only authorized and trained persons will operate aerial lifts.

3. Lift controls will be tested each day before use.

4. Safety harness will be worn when elevated in the aerial lift.

5. Lanyards will be attached to the boom or basket.

6. Employees will not belt off to adjacent poles, structures, or equipment while working from an aerial lift.

7. Employees will always stand firmly on the floor of the basket, and will not sit or climb on the edge of the basket.

8. Planks, ladders, or other devices will not be used for work position or additional working height.

9. Brakes will be set and outriggers will be used.

10. The aerial lift truck will not be moved with the boom elevated and employees in the `basket, unless the equipment is specifically designed for such.

5.0 CRANES

1. A competent person prior to each use/during use to make sure it is in safe operating condition will inspect all cranes. Also, a certification record of monthly inspections to include date, inspector signature, and crane identifier will be maintained.

2. A thorough annual inspection of hoisting machinery will be made by a competent person, or by a government or private agency, and records maintained.

3. Loads will never be swung over the heads of workers in the area.

4. Employees will never ride hooks, concrete buckets, or other material loads being suspended or moved by cranes.

5. Hand signals to crane operators will be those prescribed by the applicable ANSI standard to the type of crane in use.

6. Tag lines must be used to control loads and keep workers away.

7. Loads, booms, and rigging will be kept at least 10 feet from energized electrical lines rated 50 KV or lower unless the lines are de-energized. For lines rated greater that 50 KV follow OSHA Rules and Regulations, 1926.550(a)(15).

8. Cranes will always be operated on firm, level surfaces, or use mats/pads, particularly for near-capacity lifts.

9. Accessible areas within the swing radius of the rear of the rotating superstructure of the crane, either permanently or temporarily mounted, will be barricaded in such a manner as to prevent employees from being struck or crushed by the crane.

10. If suspended personnel platforms are to be lifted with a crane, reference 1926.550(g) for general and specific requirements.

11. Rigging equipment (chains, slings, wire rope, hooks, other attachments, etc.) will be inspected prior to use on each shift to ensure it is safe. Defective rigging and equipment will be removed from service.

12. Job or shop hooks or other makeshift fasteners using bolts, wire, etc. will not be used.

13. Wire rope shall be taken out of service when one of the following conditions exist:

    - In running ropes, 6 random distributed broken wires in one lay or 3 broken wires in one strand or one lay.
    - Wear of one-third the original diameter of outside individual wires.
    - Kinking, crushing, bird caging, heat damage, or any other damage resulting in distortion of the rope structure.
    - In standing ropes, more than two broken wires in one lay in sections beyond end connections, or more than one broken wire at an end connection.

6.0 WELDING and BRAZING

1. Combustible material will be cleared from the area around cutting or welding operations.

2. Welding helmets and goggles will be worn for eye protection and to prevent flash burns.

3. Eye protection to guard against slag while chipping, grinding and dressing of welds will be worn.

4. Only electrode holders specifically designed for arc welding will be used.

5. All parts subject to electrical current will be fully insulated against the maximum voltage encountered to ground.

6. A ground return cable shall have a safe current carrying capacity equal to, or exceeding, the specified maximum output capacity of the arc-welding unit that it services.

7. Cables, leads, hoses, and connections will be placed so that there are no fire or tripping hazards.

7.0 TOOLS

1. Take special precautions when using power tools.

2. Defective tools will be removed form service.

3. Electric power tools will be the grounded-type or double insulated.

4. Power tools will be turned off and motion stopped before setting tool down.

5. Tools will be disconnected from power source before changing drills, blades or bits, or attempting repair or adjustment. Never leave a running tool unattended.

6. Power saws, table saws, and radial arm saws will have operational blade guards installed and used.

7. Unsafe/defective hand tools will not be used. These include sprung jaws on wrenches, mushroomed head of chisels/punches, and cracked/broken handles of any tool.

8. Portable abrasive grinders will have guards installed covering the upper and back portions of the abrasive wheel. Wheel speed ratings will never be less than the grinder RPM speed.

9. Compressed air will not be used for cleaning purposes except when pressure is reduced to less than 30 psi by regulating or use of a safety nozzle, and then only with effective chip guarding and proper personal protective equipment.

10. Abrasive blasting nozzles will have a valve that must be held open manually.

11. Only trained employees will operate powder-actuated tools.

12. Any employee furnished tools of any nature must meet all OSHA and ANSI requirements.

8.0 SAFETY RAILINGS AND OTHER FALL PROTECTION

1. All open sided floors and platforms six feet or more above adjacent floor/ground level will be guarded by a standard railing (top and mid rail, toeboard if required).

2. A stairway or ladder will be provided at any point of access where there is a break in elevation of 19 inches or more.

3. All stairways of four or more risers or greater than 30 inches high will be guarded by a handrail or stair rails

4. When a floor hole or opening (greater than two inches in its least dimension) is created during a work activity, through which a worker can fall, step into, or material can fall through, a cover or a safety guardrail must be installed immediately.

5. Safety nets will be provided when workplaces are more than 25 feet above the ground, water, or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, safety lines, or safety belts, is impractical.

6. Safety harnesses, lanyards, lines, and lifelines may be used in lieu of other fall protection systems to provide the required fall protection.

7. Adjustment of lanyards must provide for not more than a six-foot fall, and all tie off points must be at least waist high.

8.1 Scaffolds

1. Scaffolds will be erected, moved, dismantled, or altered only under the supervision of a competent person qualified in scaffold erection, moving, dismantling, or alteration.

2. Standard guardrails (consisting of top-rail and mid-rail) will be installed on all open sides and ends of scaffold platforms and/or work levels more than ten feet above the ground, floor, or lower level.

3. Scaffolds four to ten feet in height with a minimum horizontal dimension in any direction less than 45 inches will have standard railings installed on all open sides/ends.

4. Platforms at all working levels will be fully planked. Planking will be laid tight with no more than one inch space between them, overlap at least 12 inches, and extend over end supports 6 - 12 inches.

5. The front edge of all platforms will be no more than 14 inches from the face of the work, except plastering/lathing may be 18 inches.

6. Mobile scaffolds will be erected no more than a maximum height of four times their minimum base dimension.

7. Scaffolds will not be overloaded beyond their design loadings.

8. Scaffold components should not be used as tie-off/anchor points for fall protection devices.

9. Portable ladders, hook-on ladders, attachable ladders, integral prefabricated scaffold frames, walkways, or direct access from another scaffold or structure will be used for access when platforms are more than two feet above or below a point of access.

10. Cross braces will not be used as a mean of access to scaffolds.

11. Scaffolds will not be erected, used, dismantled, altered, or moved such that they or any conductive material handled on them might come closer to exposed and energized power lines than the following:

    - Three feet from insulated lines of less than 300 volts;
    - Ten feet plus for any other insulated or un-insulated lines.

8.2 Excavations and Trenches

1. Any excavation or trench five feet or more in depth will be provided cave-in protection through shoring, sloping, benching, or the use of hydraulic shoring, trench shields, or trench boxes.

2. Trenches less than five feet in depth and showing potential of cave-in will also be provided cave-in protection. Specific requirements of each system are dependent upon the soil classification as determined by a competent person.

3. A competent person will inspect each excavation/trench daily prior to start of work, after every rainstorm or other hazard-increasing occurrence, and as needed throughout the shift.

4. Means of egress will be provided in trenches four feet or more in depth so as to require no more than 25 feet of lateral travel for each employee in the trench.

5. Spoil piles and other equipment will be kept at least two feet from the edge of the trench or excavation.

9.0 MOTOR VEHICLES AND MECHANIZED EQUIPMENT

1. All vehicles and equipment will be checked at the beginning of each shift, and during use, to make sure it is in safe operating condition.

2. All equipment left unattended at night adjacent to highways in normal use shall have lights or reflectors, or barricades with lights or reflectors, to identify the location of the equipment.

3. When equipment is stopped or parked, parking brakes shall be set. Equipment on inclines shall have wheels chocked as well as having parking brakes set.

4. Operators shall not use earth-moving or compaction equipment having an obstructed rear view unless vehicle has an audible reverse signal alarm, or is backed only when observer says it is safe to do so.

5. All vehicles shall have in operable condition:

    - Horn (bi-directional equipment)
    - Seats, firmly secured, for the number of persons carried. Passengers must ride in seats.
    - Seat belts properly installed.
    - Service, parking and emergency brake system.
    - All vehicles with cabs will be equipped with windshields with safety glass.
    - All material handling equipment will equipped with rollover protective structures.

10.0 MISCELLANEOUS

1. All protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the impalement hazard.

2. Enclosed chutes will be used when material, trash, and debris are dropped more than 20 feet outside the exterior walls of a building. A substantial gate will be provided near the discharge end of the chute, and guardrails at the chute openings into which workers drop material.

3. Only trained employees will service large truck wheels. A cage or other restraining device plus an airline assembly consisting of a clip-on chuck, gauge, and length of hose will be used to inflate any large truck tires.

4. Only trained employees will operate forklifts and other industrial trucks.

Attachment VI

EXHIBIT 4

OWNER REQUIRED SAFETY PERFORMANCE STANDARDS

Safety Addendum to Contract Specifications

This document is intended to highlight various safety requirements applicable to the Project, and shall not be construed to waive, or release the construction manager, general contractor and subcontractors (all tiers) from responsibility for compliance with, any and all safety requirements and conditions of federal (including but not limited to OSHA CFR 1926 and 1910), state and local laws, codes, ordinances, regulations and government orders applicable to the Project. Specifically, this Attachment does not purport or attempt to cover all of the safety requirements of local codes, ordinances, regulations and government orders, and construction manager, contractor and subcontractors shall have the specific responsibility to review, understand and incorporate such requirements into the performance of work at the Project.

All safety requirements of any federal, state or local agency with jurisdiction concerning the Project shall be deemed to be included in the Contract Sum of General Contractor ("GC") and/or Construction Manager ("CM") and any subcontractor of any tier, and change orders for the cost of complying with safety requirements stated herein, or required by applicable federal, state or local law, shall not be valid and shall not be considered.

The safety and health requirements attached hereto (the "Requirements") shall be part of the Contract, and shall be followed by all contractors while performing work on site. The Requirements shall be treated as contract requirements, and any material breach of the Requirements shall be grounds for termination under applicable provisions of the Contract Documents. The Requirements specifically include required elements of a site specific safety and health plan which must be developed and implemented by the construction manager, general contractor and the subcontractors.

It will be a condition of the Contract, and shall be made a condition of each subcontract entered into pursuant to the Contract, that the Owner and its affiliated entities or agents are assuming no liability relating to their receipt and review of the GC/CM safety plans or activities. Safety remains the responsibility of the GC/CM and their subcontractors (all tiers), as Owner shall retain no control over the Project work areas. As to the Owner, the GC/CM shall be fully responsible for compliance with all safety requirements applicable to the Project, and for any liability arising out of any failure to comply with such safety requirements.

These Requirements include "best practices" that are standards or requirements that may exceed applicable federal, state or local safety requirements or provide consistency in their application. These Requirements only identify minimum requirements, and do not replace any existing local, state, federal or governing agency requirements. The most stringent requirement, whether found in these Requirements or in applicable federal, state or local law will always apply if a conflict in safety requirements exists. In addition, the Construction Manager and general contractor, and all subcontractors of any tier, shall comply with the safety or Project requirements of any insurance carrier supplying insurance for the Project, as part of the Contract Sum.

The GC/CM shall represent the Owner on all matters of project safety management as it relates to the superintendence of the work on the Project, but under no circumstances shall be considered an agent of the Owner for purposes of complying with or implementing safety requirements.

By the terms of this Contract, the GC/CM agree to impose upon themselves and their subcontractors (all tiers) the following minimum mandatory safety requirements:

1. GC/CM must provide a full time **[part time – Modify as appropriate]** designated on-site safety manager, unless otherwise required by the law, with no other duties other than superintendence of the safety program, with full authority to stop work and remove any person for violation of the project safety program. The safety manager will allocate 100% of his time toward implementing and enforcing the project safety program. The resume of the on-site safety manager shall be submitted for review and reasonable approval of the Owner. GC/CM shall staff additional safety personnel, as necessary, to maintain the effectiveness and integrity of the safety program.

2. Prior to the mobilization, GC/CM shall submit for review a Site Specific Safety Program that includes all of the safety provisions set forth in these Requirements, or otherwise noted in the Contract Documents. The written safety program shall be used as a guideline and direction for the Contractor's and subcontractors' activities. The program and all sections must be project and site specific. This program must meet these Requirements, all applicable federal, state and local legal requirements and include the following minimal provisions: (a) worksite safety policy and mission statement; (b) assigned responsibilities among management supervisors and employees; (c) a system for daily and weekly documented self inspections, including inspections of job sites, materials, work performance and equipment; (d) a thorough accident and injury reporting and investigation process to identify root cause and prevent incident re-occurrence; (e) a safety employee orientation program; (f) a subcontractor orientation program; (f) a safety training program including weekly tool box talks, job hazard analysis, and additional formal training, as required, including but not limited to, fall protection, confined spaces, scaffolding, ladders, excavation safety, lockout/tag out, personnel protective equipment, at a minimum; (g) an employee disciplinary policy; (h) a subcontractor disciplinary

policy including monetary fine system and/or charge back system; (i) include all relevant OSHA subparts; (j) a fire prevention and control program; (k) a task and site specific fall protection program when exposures of 6 feet or greater exist; (l) a hazard communication program; (m) a site specific respiratory protection program; (n) an emergency action plan with contacts, emergency evacuation plan, and notification plan; (o) a property and public protection plan; (p) a site security plan addressing employees, public, venders, suppliers subcontractors, visitors, and control of delivery of equipment and materials to and from the job site. GC/CM must require all subcontractors to submit site specific health and safety programs for review, as well as acknowledgement of compliance with the GC/CM project specific program. GC/CM shall monitor the effectiveness of all subcontractor safety programs by requiring submission of all relevant documentation for review, frequent un-announced attendance at subcontractor safety meetings and site inspections.

3. Require each GC/CM supervisor who works more than 1 hour on the project to possess a federal OSHA 30 Hour Card issued not more than 3 years previously.

4. Require at least one subcontractor supervisor who works more than 1 hour on the project to possess a federal OSHA 10 Hour Card issued not more than 3 years previously.

5. GC/CM shall verbally inform the Owner's Representative at first knowledge of any accident involving property damage or personal injury occurring on the Project and shall provide a written investigation report within 24 hours of having knowledge of such incidents. GC/CM shall establish criteria to ensure that all subcontractors report all incidents immediately to the GC/CM for review and follow-up.

6. GC/CM shall request submission of names of OSHA defined "competent persons" from all subcontractors for all applicable OSHA subparts. Persons shall have the ability to identify hazards and have the authority to stop applicable work.

7. GC/CM and all tier subcontractors shall conduct weekly documented safety meetings for their employees on the job site. Attendees and minutes of the meetings shall be documented. Topics shall include site specific information. Representation of all subcontractor tiers is required at the GC/CM meeting. Subcontractors shall also be required to conduct their own meetings with their own employees. Contractors shall submit meeting schedules to the GC/CM to allow un-announced attendance to their meetings. The GC/CM shall submit subcontractor meeting schedules to the Owner's Representative to allow un-announced attendance at their meetings.

8. GC/CM shall also confirm in writing follow-up and status of any third party, insurance carrier or owner representative safety report identifying site safety recommendations.

9. GC/CM shall implement and enforce a mandatory hard-hat policy for all phases of the Project. Hard hats shall meet ANSI Standard 2.89.1-1969.

10. GC/CM shall ensure that approved safety glasses are available and provided to all employees of all subcontractors on the job-site. GC/CM shall ensure that individual persons have, on person, safety glasses at all times. Safety glasses will be utilized and worn as per OSHA requirements, at a minimum. GC/CM shall ensure that all other protective apparel necessary for the work of any personnel be available at appropriate times, including noise protection, hand protection and protection as to particle or air contaminants, or hazardous chemicals, as may be required by CFR 1926.101 and related provisions.

11. GC/CM shall ensure that the use of horizontal debris netting is installed and maintained not more than two stories below the stripping floor on concrete structures or the utmost finished concrete floor on steel frame structures. Netting shall project outward horizontally a minimum of 10 feet.

12. GC/CM shall ensure that vertical perimeter debris netting is established and maintained at all elevated levels where there is exposure to the public or adjacent property. Vertical safety netting shall have a height not less then 60 inches. The top edge and intermediate height of nets shall be mounted securely to a non-corrosive wire cable capable of withstanding a load of at least 200 pounds applied to any direction except upward. Netting shall be brought to deck level and securely fastened and have openings not over one inch in greatest dimension. This shall be accomplished by utilizing a zero cable or equivalent means.

13. GC/CM shall ensure that sidewalk sheds are provided and adequately designed for the protection of pedestrians, adjacent property and/or site workers adjacent to and/or entering/leaving the building. A sidewalk shed shall be erected when a structure higher than forty feet is to be constructed and the horizontal distance from the structure being built to the inside edge of the permanent or temporary walkway is equal to one half or less of the height of the structure. A sidewalk shed shall be erected regardless of the height of the structure or the horizontal distance between the structure and the sidewalk when material or debris is to be moved by a hoist, crane, derrick or chute or the building or structure is to be demolished.

14. GC/CM shall ensure that procedures are in place to prevent storage of materials at the edge of unprotected floors, roof, etc. so as to minimize materials from blowing or falling off of the building or other structures. GC/CM shall ensure that storage of materials within 10 feet of a perimeter edge is prohibited unless secondary means of securing such materials, and permission from the GC/CM, is obtained. GC/CM shall ensure that procedures are in place to secure all materials stored on the roof at the end of each work

day to minimize materials from blowing or falling off of the building or other structures during non-working hours.

15. GC/CM shall implement and enforce a scaffolding tagging system to identify scaffolds that have been inspected, are deficient or areas where additional means of fall protection should be provided. Inspections shall be made by "competent persons", as defined by OSHA, before each work shift.

16. GC/CM shall ensure that operations rendering signs, signals, and barricades insufficient for the necessary protection on or adjacent to a highway or street, will utilize trained flagmen or other appropriate traffic control.

17. Hot work permits must be issued, submitted by contractors and reviewed by the GC/CM for all welding, cutting and/or brazing operations involving renovations to existing structures.

18. GC/CM shall ensure a fire watch is conducted during the initial hot work and one hour after for final inspection.

19. GC/CM shall develop and implement a project specific safety orientation for all new persons performing work on the Project. No person shall perform any work on this Project until completing such orientation. Contractor orientation shall be presented to the Owner's Representative for review and shall include the following, at a minimum: (a) first aid; (b) emergency facilities; (c) fire protection and prevention; (d) housekeeping; (e) illumination; (f) sanitation; (g) personal protective equipment requirements; (h) fall protection; (i) ladder safety; (j) confined space awareness; (k) lockout/tag out; (l) disciplinary policy; (m) drug/alcohol policy; (n) accident reporting; (o) include site tour; and (p) material handling. GC/CM shall develop a means of tracking individuals who have completed the new employee orientation and shall develop a means of readily identifying such individuals (i.e. hard hat tags) on the Project. GC/CM is responsible for the implementation and presentation of the orientation program to all employees, subcontractors and subcontractor employees.

20. GC/CM shall conduct and document a subcontractor safety orientation prior to engaging in work activity on the Project premises. The orientation program shall meet or exceed project safety plan and Owner requirements. GC/CM must ensure that the orientation is delivered, tracked and maintained. The orientation should be provided to the senior supervisor and/or project manager responsible for the project specific staff.

21. GC/CM shall require all subcontractors to submit a written job hazard analysis ("JHA") for new work and all work of a critical nature. Contractor shall not allow work to proceed until such JHA has been reviewed and approved by the GC/CM safety manager

or designated representative. Subcontractors should communicate the final approved JHA to the entire crew and update such analysis as conditions or scope changes.

22. GC/CM shall ensure mandatory substance abuse testing for all contractors, subcontractor and any sub-tier subcontractor employees in a post-accident situation. GC/CM shall perform substance abuse testing for all contractor, subcontractor and any sub-tier subcontractor employees where reasonable suspicion exists. GC/CM shall prohibit any person failing to pass such substance abuse test from performing work on the Project. Such substance abuse testing shall be conducted within the parameters of accepted industry standards and recognized best practices. Service vendors and material delivery personnel are exempted from this provision. A written substance abuse program shall be developed and submitted.

23. GC/CM and their subcontractors (all tiers) shall implement and enforce a 6 ft. 100% fall protection program for all crafts, trades and activities except steel erection activities that fall under OSHA Subpart R standards and crane operations falling under Subpart N. GC/CM shall be required to ensure the following requirements are initiated:
    a. In addition to OSHA steel erection fall protection requirements covered under subpart R, the following shall apply to all steel erection activities including connecting, work other than connecting, and decking:
        i. All steel workers including deckers and connectors must be required to wear a full body harness and lanyard when a fall exposure of 6 feet or greater exists. Workers shall be provided with documented fall protection training.
        ii. Where existing OSHA Subpart R requirements do not require mandatory fall protection, a positive fall protection system shall still be immediately available and provided as an option for use to all employees exposed to a fall exposure of 6 feet or greater.

    When such requirement is more stringent than that required by the local safety authority, such costs shall be considered by contractors and subcontractors of all tiers at time of bid.

24. GC/CM shall prohibit the use of controlled access zones, warning line systems, controlled decking zones or safety monitoring systems as a means of personal fall protection unless a positive means of fall protection is also provided. Comply also with OSHA 1926.550 and 1926.760 for workers involved in crane operations and steel erection operations respectively.

25. Prior to mobilization, GC/CM shall submit for review a task and Site Specific Fall Protection Program that addresses task and/or activity specific exposures to include, but may not be limited to, unloading areas, stairways, leading edges, elevator shafts, perimeter fall protection, floor openings, etc.

26. GC/CM shall ensure that a third party annual crane inspection shall have been conducted and documented within the last 30 days prior to commencement of operations.

27. GC/CM shall require that all persons operating any crane greater then 15,000 pounds capacity and or equipped with a boom of 25 feet or more shall hold and possess at all times while operating any such crane a current operator's certification as recognized by the National Commission for the Certification of Crane Operators (NCCCO) or its equivalent as approved by the recognized safety authority or state agency having jurisdiction over the Project.

28. GC/CM shall ensure that a "Written Critical Lift Plan" is reviewed and approved prior to any "Critical Lift" including any lift exceeding 75% rated capacity, multiple lifts, lifts involving the hoisting of personnel, lifts within general proximity of power lines, lifts posing risks to property or people, lifts where the operator does not have direct visual contact with the load, static tower crane erection and dismantling, and lifts involving specialized or unique rigging configurations.

29. GC/CM shall ensure that routine crane inspections are documented on a daily and weekly basis.

30. GC/CM shall ensure that any person performing rigging, signaling or supervisor duties for crane operations to carry on his or her person documentation and/or licensing of rigging and signaling safety training prior to assuming such duties. In the absence of such documentation, such individual shall not rig, signal or direct the operation of any crane at any time.

31. GC/CM shall be responsible to ensure that all cranes on the jobsite are free of loads at the end of each day. The act of leaving a load on an unmanned crane shall be prohibited.

32. GC/CM shall implement and enforce a mandatory Ground Fault Circuit Interrupters (GFCI) program. The use of an assured grounding program alone shall be prohibited. Consider installation of GFCI within the main or sub panels on the Project.

33. GC/CM shall ensure that site inspections are conducted daily and weekly, and that written records are maintained of such inspections. GC/CM shall require similar site inspections and records be maintained by subcontractors.

34. GC/CM shall ensure that the use of mobile phones, radios or similar devices by any person when operating vehicles, heavy equipment and other mobile mechanized equipment while on the Project site is expressly prohibited. (Unless specifically utilized for spotting and/or two way communication with a hands-free kit in place per CM approval).

35. GC/CM shall ensure that a "No Smoking" policy is enforced on the Project site. Smoking should only be allowed in exterior designated areas.

36. GC/CM shall permanently remove from the Project any person who, in the opinion of the general contractor, engages in any unsafe work activity, or who in any manner jeopardizes the safety of other workers or any member of the public.

37. All visitors, defined as non-Owner representatives, contractors, subcontractors and service providers, shall sign release forms before entering the Project site. GC/CM shall ensure that all visitors are accompanied at all times.

38. GC/CM shall submit for review a subcontractor pre-qualification and review program that shall be implemented during the pre-qualification of all subcontractors allowed on the Project site. At a minimum, the GC/CM shall obtain and confirm the EMR of each subcontractor seeking pre-qualification. At the Owner's option, any subcontractor with an EMR greater than 1.0 will not be allowed to bid work.

39. GC/CM shall develop and submit for review a public protection program pursuant to the requirements of ANSI standards A10.34 "Public Protection In Construction Zones" and any other applicable regulations.

40. GC/CM shall ensure that lifting loads over persons, occupied or temporary structures is prohibited. GC/CM shall also ensure that for all lifts where loads may expose any employee or member of the public to the hazards of dropped loads, effective and adequate means shall be implemented prior to the lift to eliminate such exposures. The responsible person for taking such action shall be the competent person in charge of the lifting activity and shall be identified in writing by name in any pre-lift written plans and/or job hazard analysis.

TISHMAN SPEYER
SAFETY ATTACHMENT ADDENDA
(NEW YORK)

In addition to the requirements set forth in the Safety Attachment, the following requirements also apply for projects in the City of New York, New York, and the additional requirements are numbered below so as to relate back to the same numbered items in the Safety Attachment, for ease of reference.

1. A competent watchman shall be on duty at the Project site during all hours when operations are not in progress (at least one additional watchman required for each additional 40,000 square feet of construction, or fraction thereof over 5,000). Watchmen shall be familiar with fire alarm boxes and the location and use of fire fighting equipment required to be on the Project site.

11. Safety netting required when construction activity is on a structure more than 6 stories or 75 feet above the adjoining ground or roof level.

12. Safety netting required when construction activity is on a structure more than 6 stories or 75 feet above the adjoining ground or roof level.

13. For all buildings 100 feet or more in height, the deck and protective guards of the sidewalk shed shall be extended parallel with the curb at least 20 feet beyond the ends of all faces of the structure, regardless of whether such extensions are in front of the property being developed or in front of adjacent property. The GC/CM shall also comply with all codes applicable to the erection and maintenance of sidewalk sheds.

14. When exterior walls are not in place, material piles shall be kept at least ten feet back from the perimeter of the building; material may be stored within two feet of the edge of a building provided however that such material is stored not more than two stories below the stripping operation on concrete structures or the uppermost concrete floor on steel frame structures (such material shall be secured against accidental movement).

15. GC/CM shall strictly comply with applicable laws and regulations pertaining to scaffolding, including, but not limited to Title 27, Subchapter 19, Article 8 of the New York City building code as well as N.Y. Labor Law § 240.

23. GC/CM shall strictly comply with applicable laws and regulations pertaining to scaffolding, including, but not limited to Title 27, Subchapter 19, Article 8 of the New York City building code as well as N.Y. Labor Law § 240. GC/CM shall also comply with N.Y. Labor Law § 241 with regard to construction safety.

26. All power-operated cranes must have a certificate of approval, a certificate of operation, and a certificate of on-site inspection (as defined in New York City building code).

27. Riggers and hoisting machine operators shall be licensed as required under Chapter One of Title 26 of the New York City Administrative Code. The operator shall be responsible for making the machine inoperative before leaving the machine.

Attachment VII

OSHA's Form 301
Injury and Illness Incident Report

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

This *Injury and Illness Incident Report* is one of the first forms you must fill out when a recordable work-related injury or illness has occurred. Together with the *Log of Work-Related Injuries and Illnesses* and the accompanying *Summary*, these forms help the employer and OSHA develop a picture of the extent and severity of work-related incidents.

Within 7 calendar days after you receive information that a recordable work-related injury or illness has occurred, you must fill out this form or an equivalent. Some state workers' compensation, insurance, or other reports may be acceptable substitutes. To be considered an equivalent form, any substitute must contain all the information asked for on this form.

According to Public Law 91-596 and 29 CFR 1904, OSHA's recordkeeping rule, you must keep this form on file for 5 years following the year to which it pertains.

If you need additional copies of this form, you may photocopy and use as many as you need.

Completed by ______________________

Title ______________________

Phone (_____)_____--________ **Date** ____/ ____/ ____

Information about the employee

1) **Full name** ______________________

2) **Street** ______________________

City ______________ **State** ______ **ZIP** ______

3) **Date of birth** _____ / _____ / _____

4) **Date hired** _____ / _____ / _____

5) ☐ **Male**
☐ **Female**

Information about the physician or other health care professional

6) **Name of physician or other health care professional** ______________________

____

7) **If treatment was given away from the worksite, where was it given?**

Facility ______________________

Street ______________________

City ______________ **State** ______ **ZIP** ______

8) **Was employee treated in an emergency room?**
☐ **Yes**
☐ **No**

9) **Was employee hospitalized overnight as an in-patient?**
☐ **Yes**
☐ **No**

Information about the case

10) **Case number from the *Log*** ______________ *(Transfer the case number from the Log after you record the case.)*

11) **Date of injury or illness** _____ / _____ / _____

12) **Time employee began work** ______________ **AM / PM**

13) **Time of event** ______________ **AM / PM** ☐ **Check if time cannot be determined**

14) ***What was the employee doing just before the incident occurred?*** **Describe the activity, as well as the tools, equipment, or material the employee was using. Be specific. *Examples:* "climbing a ladder while carrying roofing materials"; "spraying chlorine from hand sprayer"; "daily computer key-entry."**

15) ***What happened?*** **Tell us how the injury occurred. *Examples:* "When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time."**

16) ***What was the injury or illness?*** **Tell us the part of the body that was affected and how it was affected; be more specific than "hurt," "pain," or sore." *Examples:* "strained back"; "chemical burn, hand"; "carpal tunnel syndrome."**

17) ***What object or substance directly harmed the employee?*** ***Examples:*** **"concrete floor"; "chlorine"; "radial arm saw."** ***If this question does not apply to the incident, leave it blank.***

18) ***If the employee died, when did death occur?*** Date of death _____ / _____ / _____

APPENDIX H

Community Air Monitoring Plan

Queens Plaza Off-Site – Tax Lot 14
Long Island City, New York
Site No. C241151A

COMMUNITY AIR MONITORING PLAN

LIC Development Owner, LP
c/o Tishman Speyer
45 Rockefeller Plaza
New York, New York 10111

Project Number: 10112-004

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, New York 12233-7016

October 2015

Arnold F. Fleming, P.E.

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Community Air Monitoring Plan (CAMP)

1.0 Purpose

The purpose of the CAMP is to protect downwind receptors (e.g., residences, businesses, schools, nearby workers, and the public) from potential airborne contaminants released as a direct result of the Interim Remedial Measure (IRM). The CAMP helps to confirm that the IRM does not spread airborne contamination off-site by providing real-time monitoring protocols for VOCs and particulates (i.e., dust) at the downwind Site perimeter while the RI is in progress. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown.

The CAMP does not establish action levels for worker respiratory protection, which are given in the Health and Safety Plan included in Appendix E and developed in accordance with 40 CFR 1910 and 1920.

2.0 Contaminant Source

The main contaminants of concern in Site soils are creosote-based and petroleum-based VOCs, benzene, toluene, ethylbenzene, and xylenes, (collectively BTEX); the semi-volatile compound naphthalene; and the poly aromatic hydrocarbons (PAHs). Metals and polychlorinated biphenyls (PCBs) represent a secondary and minor concern.

3.0 Remedial Activities

The off-site Lot 14 Interim Remedial Measure Work Plan (IRMWP), to which this CAMP is an attachment, details the remediation activities that will be performed at the Site.

4.0 Receptor Population

Potentially exposed receptors during remediation are passersby, and, to a lesser degree, individuals living, working, and shopping in the vicinity of the project.

5.0 Monitoring Plan

If excavating, stockpiling, or otherwise handling on-site soils, the proposed CAMP, entailing upwind and downwind perimeter monitoring, will be implemented as described in the following sections. Due care will be taken to monitor and control fugitive odors and dust emissions from the Site, minimizing the risk of exposure to the surrounding receptor population during remediation.

5.1 Continuous Monitoring

Continuous monitoring will be conducted for all ground-intrusive activities and any handling of soils on the Site.

5.2 Periodic Monitoring

Periodic VOC monitoring will occur during non-intrusive activities such as collection of groundwater samples from monitoring wells and soil samples for disposal characterization.

5.2.1 VOC Monitoring, Response Levels, and Actions

VOCs will be continually monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) using a PID. Upwind concentrations will be measured at the start of each workday and periodically thereafter to establish background conditions. The PID will be calibrated at least daily, or more often if needed. The PID will be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work may resume with continued monitoring.

- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work may resume, provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less (but in no case less than 20 feet) is below 5 ppm over background for the 15-minute average.

- If the organic vapor level is above 25 ppm at the perimeter of the work area, work must cease. All 15-minute readings must be recorded and be available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

5.2.2 Particulate Monitoring, Response Levels, and Actions

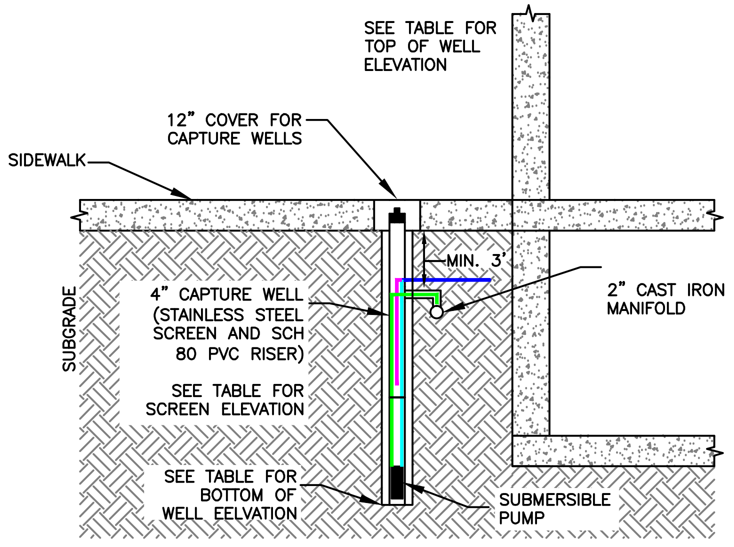
Particulate concentrations will be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring will be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment will be equipped with an audible alarm to indicate when particulates exceed the action level. In addition, fugitive dust migration will be visually assessed during all work.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques will be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 $\mu g/m^3$ above the upwind background level and provided that no visible dust is migrating from the work area.

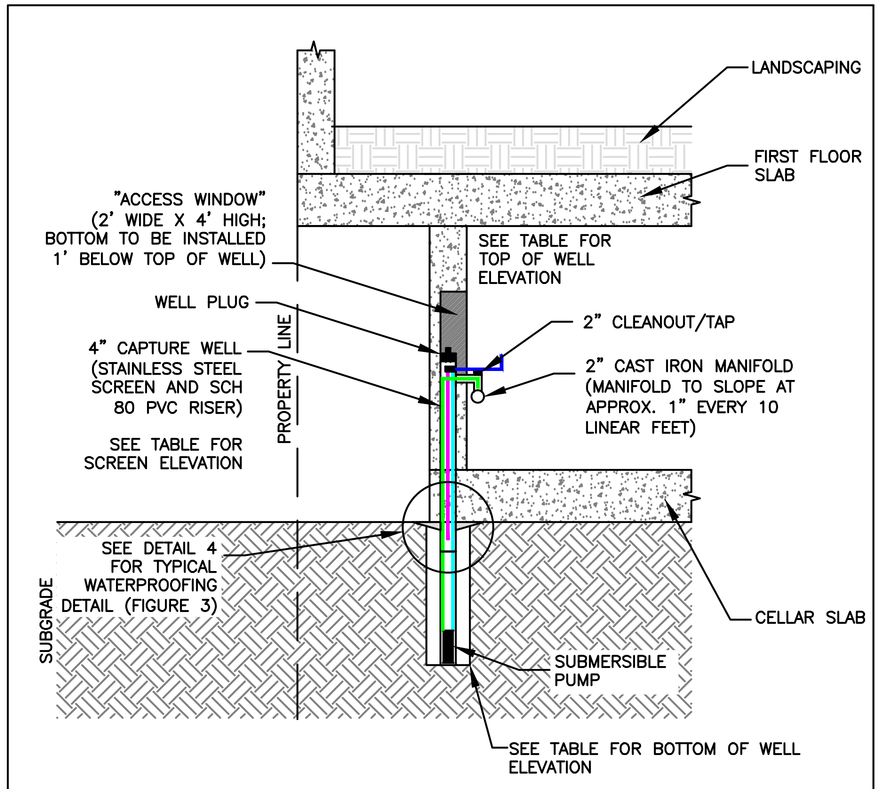
If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 $\mu g/m^3$ above the upwind level, work will cease and a re-evaluation of activities initiated. Work may resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration. All readings must be recorded and be available for State (DEC and DOH) personnel to review.

APPENDIX I

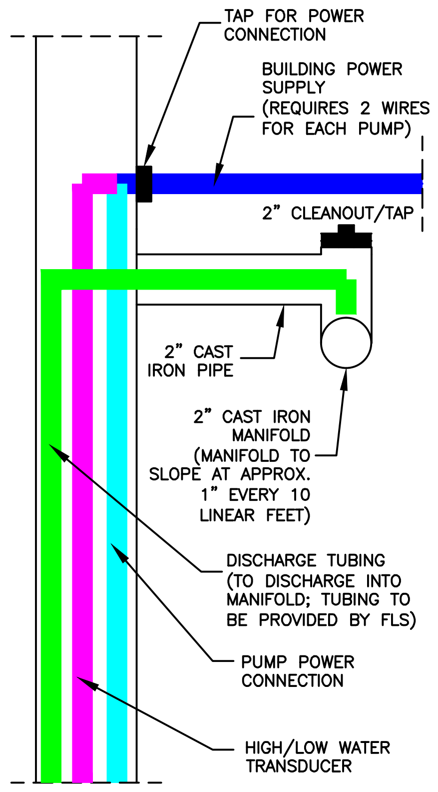
QPRD Capture Well Design Details



DETAIL 5
TYPICAL CAPTURE WELL DETAIL FOR
WELLS ALONG ORCHARD ST.
N.T.S.



DETAIL 6
TYPICAL CAPTURE WELL DETAIL FOR
WELLS ALONG LIRR
N.T.S.



DETAIL 7
TYPICAL CAPTURE WELL
MANIFOLD AND POWER DETAIL
N.T.S.

Well Id	Top of Well Elevation	Bottom of Well Elevation	Top of Screen Elevation	Bottom of Screen Elevation	Total Well Depth	Screen Length	Electrical Tap Elevation	Manifold Tap Elevation	Manifold Elevation	Typical Detail
CW-1	16/S	-24	10.5	-24/TOR	40	34.5	12.75	12.5	12	Detail 5
CW-2	14.5/S	-19	10.5	-19/TOR	33.5	29.5	12	11.75	11.5	Detail 5
CW-3	14/S	-12	10.5	-12/TOR	26	22.5	11.5	11.25	11	Detail 5
CW-4	13.5/S	3	10.5	3/TOR	10.5	7.5	11	10.75	10.5	Detail 5
CW-5	12.9/S	4	10	4/TOR	8.9	6	10.75	10.5	10.2	Detail 5
CW-6	12.8/S	1	9.5	1/TOR	11.8	8.5	10.5	10.25	9.8	Detail 5
CW-7	12.4/S	-6	9	-6/TOR	18.4	15	10	9.75	9.5	Detail 5
CW-8	14.5	-19	8.5	-19/BR	33.5	27.5	10.75	10.5	10	Detail 6
CW-9	14.5	-10	8.5	-10/TOR	24.5	18.5	11.25	11	10.5	Detail 6
CW-10	14.5	-13	8.5	-13/TOR	27.5	21.5	11.75	11.5	11	Detail 6
CW-11	14.5	-12	8.5	-12/TOR	26.5	20.5	12.25	12	11.5	Detail 6
CW-12	14.5	-7	8.5	-7/TOR	21.5	15.5	12.75	12.5	12	Detail 6
CW-13	14.5	-5	8.5	-5/TOR	19.5	13.5	13.25	13	12.5	Detail 6
CW-14	14.5	-15	8.5	-15/TOR	29.5	23.5	13.75	13.5	13	Detail 6
CW-15	14.5	-15	8.5	-15/TOR	29.5	23.5	14.25	14	13.5	Detail 6

TABLE
CAPTURE WELL INSTALLATION

S = top of well to be installed flush to surface

TOR = bottom of well to be installed to top of competent bedrock

BR = bottom of well to be installed 5' into competent bedrock

Fleming Lee Shue

Environmental Management & Consulting

158 West 29th Street, 9th Fl.
New York, NY 10001

Queens Plaza Residential Development

FIGURE 4

CAPTURE WELL DETAILS

Date
November 2015

Project Number
10112-005

LEGEND

▒	CONCRETE SLAB/WALL/SIDEWALK
▨	SUBGRADE
▬	BUILDING POWER SUPPLY
▬	PUMP POWER CONNECTION
▬	DISCHARGE TUBING (TO DISCHARGE INTO MANIFOLD)
▬	HIGH/LOW WATER LEVEL PRESSURE SWITCHES

FILE: P:\99999 – Tishman\Figures\Capture Well Design\FIG 4 – Capture Well Details.dwg DATE: 11/13/2015

APPENDIX J

Proposed Oxidant Brochure: Klozur® persulfate

Environmental
Solutions

KLOZUR® PERSULFATE
In Situ Chemical Oxidation

Product Sheet

The Field Proven and Versatile ISCO Solution to Address Soil & Groundwater Contamination

Klozur® persulfate is the oxidant of choice for *in situ* chemical oxidation (ISCO), because of its ability to treat a wide range of contaminants including chlorinated solvents, petroleum and PAHs. Klozur persulfate is ideal for contaminated source zones and hot spots that require rapid treatment. When properly activated, Klozur persulfate provides an unmatched combination of oxidative power, versatility, and control that can be delivered both safely and cost effectively.

Successful field applications of Klozur activated persulfate have been performed globally. These applications demonstrate the ability of Klozur activated persulfate to treat diverse organic contaminants of concern including: chlorinated ethenes (TCE, PCE, DCE and vinyl chloride), chlorinated ethanes (TCA and DCA), chlorinated methanes (carbon tetrachloride and methylene chloride), BTEX, MTBE, polyaromatic hydrocarbons (PAHs), petroleum hydrocarbons (TPHs, GRO, DRO), 1,4-dioxane and pesticides.

The benefits of Klozur Persulfate

When used with PeroxyChem's proprietary activation methods, Klozur persulfate provides a powerful multi-radical attack for the rapid destruction of recalcitrant compounds.

$$S_2O_8^{-2} + \text{Activator} \rightarrow SO_4\bullet^{-},\ OH\bullet^{-}$$

Multiple activation options and methods of delivery provide for a flexible and custom solution based on site conditions. With a solubility limit of up to 40 wt%, Klozur can be applied as a fully soluble solution. Klozur persulfate is a remarkable stable oxidant given its high oxidation potential, with a typical active lifetime in the subsurface of 3-6 months, providing an extended radius of influence. Klozur persulfate is safe to handle with PeroxyChem's recommended use guidelines; does not generate heat or gas.

Examples of Contaminants of Concern

CHLORINATED SOLVENTS
PCE, TCE, DCE, VC, TCA, DCA, Methylene Chloride, Carbon Tetrachloride, Chlorobenzene

PETROLEUM
TPH, BTEX, DRO, GRO

PAHs
Creosote, MGP residuals
1,4-dioxane, MTBE, TBA, energetics,
Chlorinated pesticides

The sound science of Klozur Activated Persuflate

Klozur activated persulfate has a long history of documented success. Site and laborortory data prove successful treatment of some of the most recalcitrant compounds, such as chlorinated ethanes, and emerging contaminants, such as 1,4-dioxane and PFOS/PFOA.

Application methods

- Direct push injection
- Fixed well injection
- Soil blending

PeroxyChem

Document 02-01-ESD-14

APPENDIX K

RemMetrik® Statistical Analysis

By S. Panter, Fleming-Lee Shue, Inc. 10/23/15

[1] Calculate Mean from Log-Normal Disribution for soils >= 9 feet. In saturated zone for injection (Borings SB-5 and SB-6). Calculate mean Total Petroleum Hydrocarbon concentration (GR0 + DRO) in main source zone area by SB-5 and SB-6 on Lot 14. Calculations by Stata program.

1. replace tph_total = 3 if tph_total <0 & area2 == 15 & matrix == 0 /*insert the MDL for DRO in tph_total for Non-detects*/ (replace non-detects with detection limit)

2. summ tph_total if area2 == 15 & matrix == 0 & samplbot >=9 & inlist(boring, "SB5", "SB6"), detail

3. ameans tph_total if area2 == 15 & matrix == 0 & samplbot >=9 & inlist(boring, "SB5", "SB6")

4. gen lntph = ln(tph_total) (convert values to logs)

5. summ lntph if area2 == 15 & matrix == 0 & samplbot >=9 & inlist(boring, "SB5", "SB6"), detail /*use SB-5 & SB-6 to obtain conservative estimate*/ (obtain summary statistics for calculation)

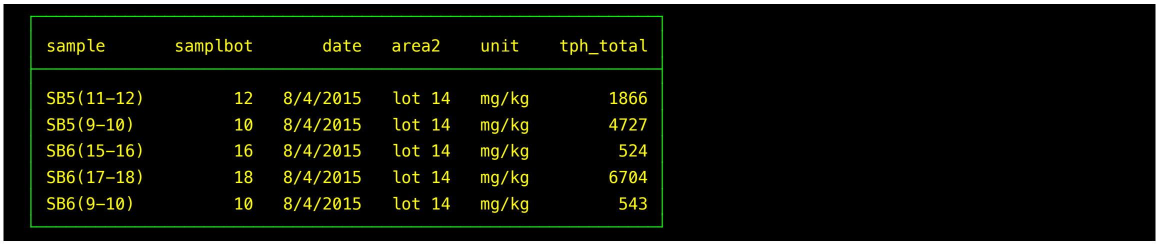
6. Calculate mean concentration from logs

7. The variance correction value from Table A9 in Gilbert is 1.675 (*Statistics for Environmental Pollution Monitoring*, Gilbert 1987.)

8. display exp(r(mean))*1.675 /*1.675 value from Table A9 in Gilbert, where n = 5 and var/2 = 0.70*/

9. display "The log-derived mean TPH concentration is " exp(r(mean))*1.675

Data Used in calculation, TPH, (SB-5 and SB-6, >= 9 ft.) mg/kg:



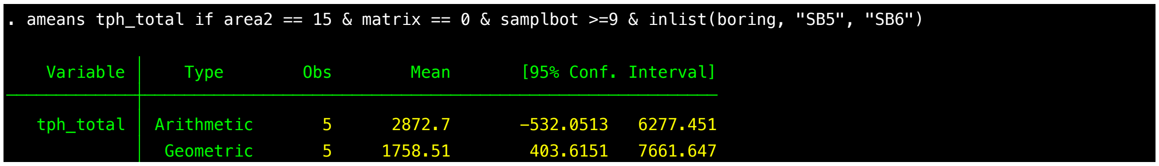
```
sample        samplbot       date   area2    unit    tph_total

SB5(11-12)          12   8/4/2015   lot 14   mg/kg        1866
SB5(9-10)           10   8/4/2015   lot 14   mg/kg        4727
SB6(15-16)          16   8/4/2015   lot 14   mg/kg         524
SB6(17-18)          18   8/4/2015   lot 14   mg/kg        6704
SB6(9-10)           10   8/4/2015   lot 14   mg/kg         543
```

By S. Panter, Fleming-Lee Shue, Inc. 10/23/15

Statistical Results:

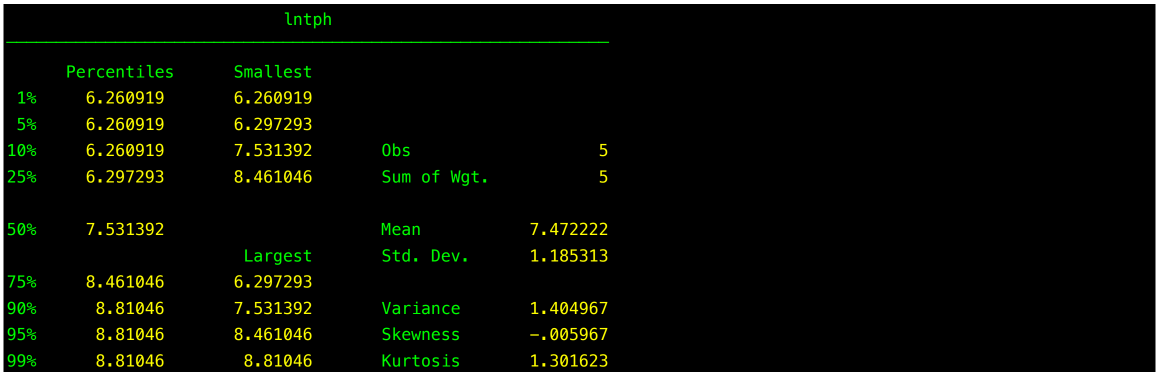
Non-transformed values (mg/kg)



```
. ameans tph_total if area2 == 15 & matrix == 0 & samplbot >=9 & inlist(boring, "SB5", "SB6")

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+----------------------------------------------------------
   tph_total | Arithmetic            5      2872.7      -532.0513   6277.451
             |  Geometric            5     1758.51       403.6151   7661.647
```

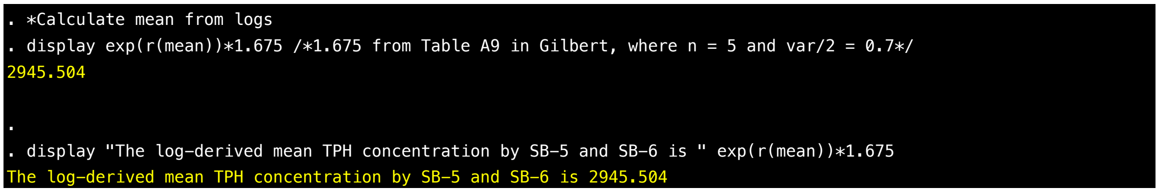
Total TPH transformed to logs (mg/kg) and statistical values:



```
                            lntph
-------------------------------------------------------------
      Percentiles      Smallest
 1%     6.260919       6.260919
 5%     6.260919       6.297293
10%     6.260919       7.531392       Obs                   5
25%     6.297293       8.461046       Sum of Wgt.           5

50%     7.531392                      Mean           7.472222
                        Largest       Std. Dev.      1.185313
75%     8.461046       6.297293
90%      8.81046       7.531392       Variance       1.404967
95%      8.81046       8.461046       Skewness       -.005967
99%      8.81046        8.81046       Kurtosis       1.301623
```

Final estimated mean concentration of TPH concentration (transformed back to an arithmetic value) is 2,946 mg/kg. The value lies between the 95% geometric confidence limits for the mean (above):



```
. *Calculate mean from logs
. display exp(r(mean))*1.675 /*1.675 from Table A9 in Gilbert, where n = 5 and var/2 = 0.7*/
2945.504

.
. display "The log-derived mean TPH concentration by SB-5 and SB-6 is " exp(r(mean))*1.675
The log-derived mean TPH concentration by SB-5 and SB-6 is 2945.504
```

For the interval in SB-4, there was only one measured value, 1,429 mg/kg. This is the value to be used for mass estimation in the SB-4 area.

5.5 Contaminant Mass

An important factor for characterizing site impacts and putting a site into context is to estimate the overall contaminant mass and its location in three-dimensional space. Contaminant mass is the sum total of all organic contaminant as measured by TPH (gasoline and diesel range organics). Contaminant mass defines the magnitude of impacts, irrespective of individual compound concentrations, measures the residual contaminant stored within the soil matrix, and is a reliable indicator of where one should focus remedial measures in order to optimize contaminant removal/treatment and achieve the most protective cleanup. Contaminant concentrations may be high in some instances but may correspond to a small mass of actual contaminant. Conversely, lower contaminant concentrations over a larger area may correspond to a much greater quantity of actual contaminant mass that can result in more detrimental effects. Removing the maximum quantity of contaminant mass will reduce overall toxicity and optimize protectiveness.

The contaminant mass estimate focuses on the source zone area, the area impacted by NAPL staining and analytical impacts from creosote above the RRSCOs. The source zone area is the volume of soil containing creosote and/or petroleum hydrocarbons that are the principal source of contaminants affecting soil, groundwater, and soil vapor (Lundegard and Johnson 2006, p. 93, No. II.

The source zone area on Lot 14 based on both physical and analytical observations encompasses the width of Lot 14 from SB-4 to the southern edge of Lot 14 by SB-5 and SB-6. It includes the interval from 23 ft-bgs to 28 feet ft-bgs at SB-4, the interval from 8 ft-bgs to bedrock (13 ft-bgs) at SB-5, and from 8 ft-bgs to bedrock (18 ft-bgs) at SB-6 where soil impacts are greatest. One signature creosote compound used to identify the source zone area is naphthalene. The naphthalene concentration in the samples north of SB-4 and the impacted interval in SB-4 ranged from non-detect to 8,860 µg/kg and had a median value of non-detect (No. of observations, 14). The naphthalene concentration in the samples in the impacted interval in SB-4 and south of SB-4 ranged from 55,000 µg/kg to 796,000 µg/kg and had a median value of 215,000 µg/kg (No. of observations, 7).

The source zone dimensions are 25 feet (width of Lot 14) by 35 feet. Based on the analytical data and soil boring logs, the estimated impacted area from SB-5 and SB-6 is an area of 25 feet (width of Lot 14) by 18 feet to the north. For SB-4, the estimated impacted area dimensions are

25 feet by 17 feet. In SB-4, it is the bottom 5 feet that is most impacted. For the purpose of contaminant mass estimate, the targeted source area soil dimensions and volumes are as follows:

Boring	Length	Width	Thickness	Volume, ft^3	Volume, m^3
SB-6	18	12.5	10	2,250	63.7
SB-5	18	12.5	5	1.125	31.9
SB-4	17	25	5	2,125	60.2
Total	35	25	--	5,500	156

The average total contaminant concentration given by TPH for the combined SB-5 and SB-6 source volume measured 2,946 mg/kg (n = 5 samples). For the SB-4 source volume, there was only one sample (n = 1 sample) in the target area and the ensuing total contaminant concentration for the source volume measured 1,429 mg/kg.

Area	Avg. Contaminant Mass Conc., mg/kg
SB-5/SB-6	2,946 (n = 5)[1]
SB-4	1,429 (n = 1)

The contaminant mass estimates for each source volume and the total contaminant mass volume in the source area are as follows:

Source Area	Avg. Contaminant Mass Conc., mg/kg	Bulk density, kg/m^3	Soil Volume, m^3	Contaminant Mass, kg	Contaminant Mass, lbs.	Percent Contaminant Mass
SB-5 & SB-6	2,946	1,600	95.6	450.5	991	76.6
SB-4	1,429	1,600	60.2	137.6	303	23.4
Total	--	--	155.8	588	1,294	100

The estimated total volume of spilled creosote in the source zone soil volume is as follows:

Contaminant Mass, kg	Creosote density, g/mL	kg/g	mL/Liter	Liters	Gallons	55-Gallon Drums
588	0.96	0.001	1,000	613	162	2.9

---

[1] The average value is the Minimum Variance Unbiased estimator calculated by converting the values to logarithms and adjusting for variance, from Gilbert, 1987, Section 13.1.1., p. 165.

APPENDIX L

Citizen Participation Plan

Appendix L – Identification of Citizen Participation Activities

Required Citizen Participation (CP) Activities	CP Activities) Occur at this Point
Application Process:	
• Prepare site contact list (SCL) • Establish document repositories	When Requestor prepares Application to participate in BCP
• Publish notice in Environmental Notice Bulletin (ENB) announcing receipt of application and 30-day comment period • Publish notice in local newspaper • Mail notice to site contact list (all mailings require certification of mailing sent to NYSDEC within 5 days) • Conduct 30-day public comment period on the complete application	When NYSDEC determines that BCP application is complete. The 30-day comment period begins on date of publication of notice in ENB. End date of comment period is as stated in ENB notice. Therefore, ENB notice, newspaper notice and notice to the BSCL should be provided to the public at the same time.
After Execution of Site Cleanup Agreement (BCA):	
• Prepare Citizen Participation (CP) Plan	Draft CP Plan must be submitted within 20 days of execution of BCA. CP Plan must be approved by NYSDEC before distribution.
Before NYSDEC Approves Proposed Remedial Investigation (RI) Work Plan:	
• Place proposed RI Work Plan in document repository • Mail fact sheet to BSCL about proposed RI Work Plan and 30-day public comment period • Conduct 30-day public comment period on the proposed RI Work Plan	Before NYSDEC approves RI Work Plan. If RI Work Plan is submitted with application, comment periods will be combined and public notice will include fact sheet. 30-day comment period begins/ends as per dates identified in fact sheet.
• Place approved RI Work Plan in document repository	When NYSDEC approves RI Work Plan
Before NYSDEC Approves Remedial Investigation Report:	
• Mail fact sheet to BSCL describing results of RI	Before NYSDEC approves RI Report.
• Place approved RI Report in the document repository	When NYSDEC approves RI Report
Before NYSDEC Approves Interim Remedial Measure Work Plan (IRMWP):	

Required Citizen Participation (CP) Activities	**CP Activities) Occur at this Point**
• Place draft IRMWP in document repository • Mail fact sheet to BSCL about proposed IRMWP and announcing 45-day comment period • Conduct 45-day public comment period about draft IRMWP • Hold public meeting about draft IRMWP (if requested by affected community or at discretion of NYSDEC project manager in consultation with other NYSDEC staff as appropriate)	Before NYSDEC approves IRMWP. 45-day comment period begins/ends as per dates identified in fact sheet. Public meeting would be held within the 45-day comment period.
• Place approved IRMWP and final Decision Document in document repository	When NYSDEC approves IRMWP and finalized Decision Document
Before Start of Interim Remedial Measure (IRM):	
• Mail fact sheet to BSCL summarizing upcoming Interim Remedial Measure	Before the start of Interim Remedial Measure
Before NYSDEC Approves Final Engineering Report:	
• Mail fact sheet to BSCL that describes report, and any proposed institutional engineering controls	Before NYSDEC approves Final Engineering Report
• Place final Engineering Report in document repository	When NYSDEC approves Final Engineering Report
When NYSDEC Issues Certificate of Completion (COC):	
• Place Notice of COC in document repository • Mail fact sheet to BSCL that announces issuance of COC	Within 10 days after NYSDEC issues COC

Appendix L –Site Contact List

State and Local Officials

NY City Mayor Mayor: Bill de Blasio Address: City Hall New York NY, 10007 Phone: 311 or (212) 788-9600 Fax: (212) 788-2460 Web Email Form: http://nyc.gov/html/mail/html/mayor.html	Queens Borough President Borough President: Melinda Katz Address: 120-55 Queens Boulevard Kew Gardens NY, 11424 Phone: (718) 286-3000 Fax: (718) 286-2885 Email Address: info@queensbp.org
NY City Comptroller Comptroller: Scott M. Stringer Address: Municipal Building 1 Centre Street New York NY, 10007 Phone: (212) 669-3916 Email Address: action@comptroller.nyc.gov	Honorable Andrew Cuomo The State Capitol Albany, NY 12224
NYC Council District - 26 Council Member: Jimmy Van Bramer Address: 47-01 Queens Boulevard (suite 205), Sunnyside, New York 11104 Phone: (718) 383-9566 Fax: (718) 383-9076 Email Address: gioia@council.nyc.ny.us Website:http://www.nyccouncil.info/constituent/member_details.cfm?con_id=54	Francis McLaughlin Assistant Deputy Director, New York State Parks State Office Building 163 W. 125th St., 17th Fl. New York, NY 10027
Honorable Serphin R. Maltese New York State Senate 71-04 Myrtle Ave. Glendale, NY 11385	NY Senate District - 12 Senator: Michael Gianaris 31-19 Newtown Avenue Suite 402 Astoria, NY 11102 Phone: 718-728-0960 Fax: 718-728-0963 Email Address: onorato@senate.state.ny.us
Thomas V. Panzone Regional Citizen Participation Specialist – Region 2 New York State Department of Environmental Conservation 47-20 21st St. Long Island City, NY 11101-5407	Commissioner Emily Lloyd New York City Department Of Environmental Protection 59-17 Junction Boulevard, 13th Floor Flushing, NY 11373
NY Assembly District - 37 Assembly Member: Catherine Nolan Address: 45-25 47th Street, Woodside, NY 11377 Phone: 718-456-9492	US House District - 14 Representative: Joseph Crowley Address: 1651 3rd Ave.,Ste 311 New York, NY, 10128

Email Address: nolanc@assembly.state.ny.us	Phone: (212) 860-0606 Fax: (212) 860-0704
US Senator: Charles E. Schumer Address: 757 3rd Avenue Suite 17-02 New York NY, 10017 Phone: (212) 486-4430 Fax: (212) 486-7693 Web Email Form: http://schumer.senate.gov/SchumerWebsite/contact/webform.cfm	US Senator: Kirsten Gillibrand Address: 780 3rd Avenue Suite 2601 New York NY, 10017 Phone: (212) 688-6262 Fax: (202) 228-0406 Web Email Form: http://clinton.senate.gov/email_form.html
John Zimmerman, Air Resources New York City Department Of Environmental Protection 59-17 Junction Blvd. Corona, NY 11368	John Wuthenow New York City Department Of Environmental Protection 59-17 Junction Blvd. Corona, NY 11368
Honorable Letitia James Public Advocate One Centre St., 15th Fl., North New York, NY 10007-1602	

Community Board

Joseph Conley, Chairman Queens Community Board 2 43-22 50th Street, 2nd Fl. Woodside, NY 11377 Phone: 718.533.8773 Fax: 718.533.8777 Email: qn02@cb.nyc.gov; commboard2@nyc.rr.com	

Media

The Daily News 450 W. 33rd St. New York, NY 10001 www.nydailynews.com	Newsday: Newsday - Queens Edition 235 Pinelawn Road Melville, NY 11747 Queens newsroom: 631-843-2700
Queens Chronicle PO Box 74-7769 Rego Park, NY 11374-7769 Tel: (718) 205-8000 Fax: (718) 205-0150 e-mail: Mailbox@qchron.com	Western Queens Gazette 42-16 34th Ave. Long Island City, NY 11101 Tel. (718) 361-6161 Fax (718)784-7552 Web site- www.qgazette.com E-mail- qgazette@aol.com
Queens Ledger 69-60 Grand Avenue Maspeth, New York	Daily News/Queens 118-35 Queens Blvd. Forest Hills, NY 11375 ; Queens County

Tel: 718-639-7000 news@queensledger.com www.queensledger.com	www.nydailynews.com Editorial Assistant -- Maxine Simpson Tel: 718-793-332 Fax: 718-793-2910

Local School Officials

Academy of Finance & Enterprise Principal Victoria Armano 30-20 Thomson Ave Long Island City, NY 11101 Phone: 718-389-3623 Fax: 718-389-3724	High School of Applied Communication Principal Daniel Korb 30-20 Thomson Ave Long Island City, NY 11101 Phone: 718-389-3163 Fax: 718-389-3427
Middle College High School Principal Linda Siegmund 31-10 Thomson Ave Long Island City, NY 11101 Phone:718-349-4000 Fax: 718-349-4003	International High School at LaGuardia Principal John Starkey 31-10 Thomson Ave -MB52 Long Island City, NY 11101 Phone: 718-482-5455 Fax: 718-392-6904
NYC Geographic District #30 - RIC # 4 Superintendent Reyes Irizarry 28-11 Queens Plaza N Long Island City, NY 11101	High School for Information Technology Principal Joseph Reed 21-16 44th Rd Long Island City, NY 11101 Phone:718-361-9920 Fax: 718-361-9995
High School for Information Technology Principal Noralee Montemarano 21-16 44th Rd Long Island City, NY 11101 Phone: 718-937-4270 Fax: 718-937-5236	Newcomers High School Principal Orlando Sarimento 28-01 41st Avenue Long Island City, NY 11101 Phone:718-937-6005 Fax: 718-937-6316
Academy of American Studies High School Principal William Bassell 28-01 41st Avenue Long Island City, NY 11101 Phone:718-361-8786 Fax: 718-361-8832	Robert F. Wagner Jr. Institute for Arts & Technology Principal Ann Seifullah 47-07 30th Pl Long Island City, NY 11101 Phone: 718-472-5671 Fax: 718-472-9117
LIC YMCA Early Child Care Program: Michael Keller Senior Executive Director Long Island City YMCA 32-23 Queens Blvd. Long Island City, NY 11101 718-392-7932	LaGuardia Community ECLC I/T 31-10 Thompson Ave Long Island City, NY 11101
LaGuardia Community College 31-10 Thompson Ave Long Island City, NY 11101	LaGuardia Community College ECLC Program Inc. 45-35 Van Dam St

	Long Island City, NY 11101

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