2350 Fifth Avenue

NEW YORK, NEW YORK

Feasibility Study

AKRF Project Number: 08010

NYSDEC Site #2-31-004

Prepared for:

2350 Fifth Avenue Corporation
309 East 94th Street, Ground Floor
New York, NY 10128

Prepared by:

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P.E. CERTIFICATION

I, Michelle Lapin, certify that I am currently a New York State registered Professional Engineer as defined in 6 NYCRR Part 375 and that the March 2011 Feasibility Study was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

STATE OF NEW YORK
MICHELLE LAPIN
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LICENSED PROFESSIONAL ENGINEER

NYS Professional Engineer #073934-1	3-21-11 Date	Signature

1.0 INTRODUCTION

This Feasibility Study (FS), a study undertaken to develop and evaluate alternatives for remediation, has been prepared by AKRF Engineering, P.C. (AKRF) for 2350 Fifth Avenue, New York, New York. This site is in Upper Manhattan (East Harlem) and is bounded by Fifth Avenue on the east, West 141st Street on the south, a garage and paved parking area on the west, and West 142nd Street on the north. See Figure 1 for the site location. The western boundary is about 75 feet east of Chisum Place. The site extends about 200 feet north-south and about 335 feet east-west. The Harlem River is approximately 250 feet to the east, beyond the Harlem River Drive.

The site is categorized as a Class 2 site (#231004) by the New York State (NYS) Department of Environmental Conservation (DEC) under its Inactive Hazardous Waste Disposal Site Remedial Program and investigative and remedial activities are being performed under an Order on Consent entered into by the owner. Remedial investigation (RI) sampling performed from 1996 to 2009 included collection and laboratory analysis of soil, groundwater, sub-slab insulation, soil vapor, and indoor air samples at the site and at off-site locations. A summary of the RI is provided in Section 3.0 and the findings are detailed in the April 2010 *Revised Remedial Investigation Report* (RIR) prepared by AKRF Inc. The RIR also summarizes the remediation measures already accomplished by implementation of Interim Remedial Measures (IRMs).

The purpose of an FS is to select an appropriate remedy to address current site conditions, taking into account both current and likely future site use. The chosen remedy must be fully protective of human health and the environment. In the FS, the RI data are used:

- to define the objectives of the remedy;
- to develop remedial alternatives; and
- to undertake an initial screening and detailed analysis of the alternatives.

These tasks are performed in accordance with the requirements of the NYS Inactive Hazardous Waste Disposal Site Remedial Program as defined by Environmental Conservation Law, Article 27, Title 13, associated regulations (including 6 NYCRR Part 375) and guidance documents (including NYS DEC's *DER-10: Technical Guidance for Site Investigation and Remediation* - December 2002 and Draft November 2009), and other applicable local, state and federal regulatory requirements.

2.0 SITE DESCRIPTION

2.1 Site and Vicinity Characteristics

The site is approximately 68,942 square feet and nearly entirely occupied by a building comprising three connected sections from east to west: a two-story section along Fifth Avenue; a three-story section in the center; and a one-story section to the west. See Figure 2 for a site plan. There are high-rise residential buildings on the blocks to the west, south, and southeast of the site. The Harlem River Drive is to the east/northeast, and a National Guard Armory occupies the block immediately to the north.

According to a survey performed by Montrose Surveying Co. LLP, the outdoor portions of the site are generally at an elevation of 6.5 to 9 feet. The building floor slab elevation ranges from approximately 9 to 13 feet. The elevations for the project are referenced to Manhattan Borough Datum (2.75 feet above mean sea level).

The site is currently used as a self storage facility and art studio space. It is zoned for light manufacturing (M1-1). Certificates of occupancy have been issued for use as a school with gymnasium, cafeteria and office, a storage facility, and accessory offices. The site is in a mixed-use residential, commercial and industrial area. The nearest residential areas are located directly south and west of the site, across 141st Street and Chisum Place, respectively. The nearest public open space is an 1,800 square foot memorial park, approximately 30 feet east of the eastern property boundary, at the intersection of 142nd Street and Madison and Fifth Avenues. One New York State Department of Health (NYSDOH) well, 20 day care facilities, one school, one hospital, one adult nursing home, three churches and three playgrounds were identified within a ¼-mile radius of the site.

The nearest environmental receptor is the Harlem River, which is located 200 to 300 feet east of the site. Groundwater in and surface water surrounding Manhattan are not used for potable supply.

2.2 Site History

The following site history was based on historical Sanborn fire insurance maps from 1893, 1909, 1939, 1951, 1976, and 1996, an 1865 shoreline and watercourses map of the site vicinity, and information provided by the current property owner.

The 1865 map shows that the site (and most of the surrounding area) was in the process of being filled in; the western third of the site was shown as land and the eastern two-thirds of the site was shown as wetlands. The site was completely filled in, but vacant on the 1893 Sanborn map. The site was still mostly vacant in 1909, with only a stone yard on West 142nd Street. Much of the surrounding area was occupied by contractor's yards and stables.

The existing building was originally constructed as a Borden Company ice cream factory: the three-story section in 1923; the two-story section in 1932; and the one-story section in 1950. The floor slab in the one-story (western) section included layers of insulation materials for refrigeration. At the westernmost section, there was typically tar paper directly under the slab, with a thin (two inches or less) layer of cork beneath. Under the cork was a layer of styrofoam eight to ten inches thick. Under the styrofoam was a layer of fill, more tar paper, and another concrete slab about four inches thick. There was fill beneath this slab, and at some locations brick and/or other concrete slabs were encountered within the fill. These were probably remains of earlier structures. An area just east of the section with the cork/styrofoam insulation had a thicker layer of cork (four to ten inches) under the slab, but no styrofoam.

The building was then occupied by a commercial laundry from 1970 to 1994 operating under a variety of names including Budge-Wood Service, Bluebird Laundry, and Swiss-American Laundry. The facility included dry cleaning utilizing tetrachloroethene (PCE or "perc") as a cleaning solvent. The dry cleaning operation and PCE storage were located near the northern side of the one-story portion of the building, just west of the West 142nd Street loading dock. The operation initially used "first-generation" machines, i.e., separate washers and dryers. Around 1984, these were replaced by "second-generation" machines, i.e., single units that performed washing, extraction, and drying. It is likely that the majority of PCE released was associated with the first generation machine use, which involved more handling of PCE than the later machines. The facility had a U.S. Environmental Protection Agency (EPA) ID number as a generator of hazardous waste (NYD071026173).

There is one closed-in-place underground fuel oil tank on the site, located under the West 142nd Street loading dock, immediately east of the former dry cleaning area. This was a 20,000-gallon tank that held #6 fuel oil. An underground diesel tank was reportedly formerly located under the north side of the building, east of the old loading dock.

The only below-grade space in the building is the former boiler room for the laundry operation, located on the north side of the three-story section of the building, just west of the fire exit opening onto West 142nd Street. This area was originally a loading dock that was excavated to create a boiler room when the building became a laundry. In the remainder of the building, the lowest (ground) floor is about four feet above street grade.

In 1995-1996, most of the ground floor, with the exception of the far western portion, was renovated for use as a New York City public school. It was occupied as a school in Fall 1997 and was later used by a church for services, offices, and classes. The church left the building in December 2004. The far western portion of the building was renovated in 2001 for use as a self storage facility. An office was constructed next to the West 141st Street loading docks and storage units were constructed in the western portion of the ground floor and on the second and third floors. In February 2006, the self storage facility expanded into the former school/church portion of the building. See Figure 2 for the current site plan showing the presumed locations of the foundation walls of the three original structures. No foundation plans could be obtained. The current site building was constructed in multiple phases over time, with multiple floor slabs encasing sub-slab insulation materials beneath one or more of these slabs in a portion of the building.

The surrounding area was mostly occupied by garages, auto repair shops, and light manufacturing in the 1930s through the 1950s, with the exception of the block directly north of the site, where the Fifth Avenue Armory was constructed between 1921 and 1933. The Delano Village (now Savoy Park) residential development, which occupies the area south and west of the site, was constructed in 1957-1959. At that time, a portion of West 141st Street was demapped, and a new street, Chisum Place, was constructed just west of the site.

2.3 Site Remedial History

The NYSDEC and 2350 Fifth Avenue Corporation entered into Consent Orders on July 3, 1997 and March 30, 2001 to investigate the site, implement interim remedial measures and prepare this FS. Based on the results of the preliminary site assessment, the site was listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites in July 1998 as a Class 2 site.

A multi-phase remedial investigation was performed on the subject site from 1996 to 2009, which included soil, sub-slab insulation material, soil vapor, indoor air and groundwater sampling, as detailed in the RIR and summarized in Section 3.0. Initial interim remedial measures (IRMs) were implemented in 1997 to prevent impacts to the air within the building. Interim remedial and mitigation measures implemented to date include removal of accessible contaminated sub-slab insulation material (cork and styrofoam) between floor slabs, installing an intra-slab venting system with horizontal piping between two floor slabs near the source area and one vertical well in the source area, and sealing penetrations in the existing building floor. The previous IRMs were detailed in an *Interim Remedial Measures Report* prepared by AKRF Inc, dated September 1997.

2.4 Planned Development and Contemplated Future Use

No significant demolition and/or development are currently planned for the site. For purposes of this FS, reasonably foreseeable future land uses are limited to those that would be permitted (without variances or waivers) under the site's current zoning and approvals, which may include industrial, commercial and certain institutional uses, including a self-storage facility, art studio space, church and/or school. A proposal to allow a use requiring a change in zoning or variances/waivers may require review under NYC's City Environmental Quality Review requirements, a process in which NYSDEC would be able to address the appropriateness of such a use given any contamination and associated exposure pathways remaining following implementation of remediation.

2.5 Geology, Hydrogeology and Subsurface Characteristics

Based on the U.S. Geological Survey Central Park Quadrangle map, the site lies at an elevation of approximately 10 feet or less above the National Geodetic Vertical Datum of 1929, an approximation of mean sea level. The Viele Map (Sanitary & Topographical Map of the City and Island of New York, 1865), which shows the original shoreline and watercourses in Manhattan, depicts most of the area of the site as part of the Harlem River, except for the western end, which is depicted as wetlands.

Borings performed during site investigations indicated a fill layer beneath the site and the surrounding area that varies from approximately 8 to 14 feet thick. The fill comprised silty sand intermixed with demolition debris (brick, concrete, and wood fragments), ash, and coal fragments. Beneath the fill was a layer of organic clay, which varied from approximately 1 to 12 feet thick. In general, the clay was thicker near Fifth Avenue and thinner towards the western end of the site. Native brown silty sand was identified beneath the clay and bedrock was not encountered in any investigation. U.S. Geological Survey studies indicate that bedrock would be encountered at about 50 feet below grade at the eastern end of the site and at approximately 30 feet below grade at the western end of the site.

The Harlem River is located approximately 200 to 300 feet east of the site. Based on the sensitive receptor report prepared by Toxics Targeting, Inc. (provided in the RIR), neither the river nor groundwater are used as a source of potable water and no non-potable water supply wells or intakes are believed to be located in the area. Groundwater in the vicinity of the site is divided into two apparently semi-confined aquifers. The presence of a clay layer apparently acts as an aquitard/aquiclude, separating the aquifer into a shallow aquifer above the clay and deeper aquifer below the clay. Shallow/deep cluster wells were installed to assess horizontal flow in each aquifer, as well as vertical flow between the aquifers. The groundwater surface in the shallow aquifer was irregular and approximately six to ten feet below grade. Measurements of groundwater elevation indicated varying horizontal flow directions, generally towards West 142nd Street and eastward along 142nd Street towards the Harlem River. Thus the flow in the shallow aquifer was generally towards the northeast on the site, whereas the flow on the block to the north (the armory site) was towards the south-southeast.

In general, groundwater flow in the deeper aquifer exhibited a slight west to east gradient (towards the Harlem River). However, there was almost no gradient in the center of the site and to the north of the site, the gradient indicated a northeasterly flow.

The difference in elevations measured (potentiometric surface) between closely located shallow and deep wells allowed for the determination of vertical flow between the aquifers. Throughout the site, groundwater was found to be flowing upward (from the deep to the shallow aquifer). However, the cluster wells along West 143rd Street, north of the site, indicate downward vertical flow.

In summary, it appeared that local groundwater flow is likely influenced by the presence of building foundations and utilities, and variations in the fill material.

3.0 NATURE AND EXTENT OF CONTAMINATION

Multiple investigations have been performed on the site to identify and further evaluate contamination conditions, as discussed in detailed in the RIR. A summary of the findings of these investigations is presented below.

3.1 Subsurface Condition

Shallow soils at the site, though primarily fill, include fine to medium sand with a trace of silt. A clay or silt/clay layer (containing some organics and peat) underlies the site beginning at a depth of 10 to 16 feet below grade. This clay layer varies from 2 to 12 feet thick, with generally increasing thickness to the east, closer to the Harlem River.

The groundwater table is 8 to 10 feet below grade. The clay layer appears to act as an aquitard/aquiclude, with groundwater levels in well clusters screened above and below the clay layer differing by as much as 2.5 feet. In general, the gradient is upwards, from the deeper to the surface aquifer, though a downward gradient was found in the wells on West 143rd Street.

Groundwater flow in the surface aquifer is to the northeast on the site, to the south or southeast on the armory block to the north, and to the east along West 142nd Street. Flow in the deeper aquifer is more generally towards the northeast.

3.2 Soil

Twenty-three of the 148 soil samples collected since the Preliminary Site Assessment in 1998 had one or more VOCs at a concentration greater that the 6NYCRR Part 375 Soil Cleanup Objectives for Protection of Groundwater (SCOPG). Twenty samples contained tetrachloroethene (PCE) or associated decomposition products at concentrations above SCOPG, with the remaining three samples exceeding SCOPG for petroleum-related hydrocarbons. PCE and associated decomposition products [trichloroethene (TCE), cis-1,2-DCE, trans 1,2-DCE, and vinyl chloride] were detected only in soil samples from the northwestern portion of the site. VOCs exceeding SCOPG, although confined to the northwestern portion of the site, were encountered in discrete areas (both horizontally and vertically), separated by samples with VOC concentrations below SCOPG, as shown on Figure 3. Depths of the samples with VOCs above SCOPGs were also inconsistent, isolated areas, ranging from 1 to 19 feet below grade. Over 85 percent of soil samples collected from October 2007 to December 2009 had PCE levels less than 1 milligram per kilogram (mg/kg).

Petroleum-related hydrocarbons were detected at concentrations below SCOPG in samples from several locations on the northern side of the building and around the old boiler room. All of these samples were at least 10 feet below sidewalk grade. N-propylbenzene was detected at a concentration greater than the SCOPG in one sample collected from a boring in the center of the building, from a depth 17 feet below grade.

A possible source of the hydrocarbon contamination was a former diesel tank reportedly located under the northern side of the building. It was noted that that the building's former boilers for the laundry used #6 oil that does not contain significant levels of the compounds detected. Samples with concentrations exceeding SCOPG (which are the same as SCOs for Unrestricted Use) are presented in Figure 3.

3.3 Sub-Slab Insulation Material

The IRM activities in 1997 included the removal of a portion of the sub-slab insulation material in the northwestern corner of the building (the current storage locker area). Approximately 10,000 square feet of insulation material remains south and southeast of the area where insulation was previously removed. Insulation material was primarily brown cork, 3 to 12 inches thick (average 8.25 inches), at depths ranging from 6 inches to 3.5 feet below grade beneath one or more concrete slabs. PCE concentrations in the remaining insulation material ranged from 0.9 to 560 mg/kg [approximately 0.04 to 154 milligrams per liter (mg/l) adjusting for measured or estimated density]. The physical properties of the insulation are different from soil and other media and the insulation has relatively low absorptive capacity, permeability and density. Insulation contaminated with the highest PCE concentrations was observed in an isolated area of the site, as shown on Figure 4.

There are no SCGs for sub-slab insulation material, but the SCOPGs applied to soil, as discussed in Section 3.2, are used for comparison purposes. VOCs were detected above SCOPG in six of the 13 core samples collected in 2009. Of the six samples exceeding the SCOPG of 1.3 mg/kg, PCE was detected above SCOPG in five samples. Levels of PCE greater than 5 mg/kg were found in an approximately 1,200-square foot area beneath Room 119 and in the adjacent corridor. Insulation sample locations and corresponding PCE concentrations are provided on Figure 4.

3.4 Soil Vapor

PCE was detected in all the soil vapor samples collected from 2007 to 2009, except sub-slab vapor point SG-34. The highest level of PCE, 332,000 micrograms per cubic meter ($\mu g/m^3$), was detected in a sample at SG-7, located on the West 142nd Street sidewalk near the old loading dock. This is also the area where the highest soil and groundwater contaminant levels were found. Levels of PCE in other soil vapor samples were much lower, and decreased with distance from the source area.

Unlike contamination in groundwater and soils near or in the clay layer (which is primarily PCE breakdown products), contamination in soil vapor is primarily PCE, suggesting that the source of the soil vapor contamination is most likely soils in the vadose zone above the water table, close to the source area.

3.5 Indoor Air

Prior to the 1997 IRM activities, PCE levels in indoor air generally exceeded 115 $\mu g/m^3$ and were as high as 1,420 $\mu g/m^3$, with the highest levels near the source area and in areas underlain by insulation materials. PCE has been since detected at much lower levels in occupied spaces with only one round of air samples indicating any exceedance of the 100 $\mu g/m^3$ PCE NYSDOH Air Guideline Value. Notably, no exceedances of the Air Guideline were found in occupied spaces when the sub-slab vapor extraction system was turned off from April 2005 to December 2006; however, during this same time frame, the concentration of TCE was slightly elevated in one sample, with a concentration of 9.3 $\mu g/m^3$ in the sample collected from Room 112 in August 2005.

After IRM implementation, the highest PCE levels in indoor air have been detected in the northern part of the building, in and around Room 112, with lower levels in the areas with insulation under the floors. Further investigation has indicated that elevated PCE levels are sometimes present in the old boiler room and in Locker 1454, both of which are presently unoccupied spaces. The old boiler room, the only sub-grade space in the building, is suspected of being the principal route through which subsurface PCE enters the building.

TCE has also been detected sporadically in indoor air sampling (concentrations from 0.75 μg/m^3 to 250 μg/m^3), with the highest concentrations in the boiler room; however, no TCE was detected during the more recent (November 2009 and April 2010) sampling events, except for the basement boiler room sample. As shown on Figure 5 and discussed in Section 5.2, indoor air and soil vapor sampling results for November to December 2009 have been compared to Matrix 1 and Matrix 2 of the *NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York*.

3.6 Groundwater

As shown on Figure 6, PCE and its decomposition products were detected at levels that exceeded Class GA (Drinking Water) Ambient Water Quality Standards and Guidelines in 6 NYCRR Section 703.5 in samples from 7 of the 24 groundwater monitoring wells sampled from 1998 to 2009, with the highest levels from M-11s, located on the West 142nd Street sidewalk, just north of the source area. The primary contaminants at this location were cis-1,2-DCE and vinyl chloride. No PCE or decomposition products were detected in M-11d, the deep well at this location. In addition to the seven monitoring wells with elevated concentrations of PCE and decomposition products, other VOCs exceeding the Class GA groundwater standards were present in one monitoring well, for the 1998 sample only.

In the 2009 sampling event, chlorinated VOCs were detected at levels exceeding the Class GA groundwater standards in samples from 5 of the 24 monitoring wells (M-1, 3d, 7, 11s, and 14d), and other VOCs were detected above Class GA Standards in monitoring well M-5. No chlorinated VOCs were detected in the remaining 18 wells sampled in 2009. The concentrations of chlorinated VOCs have decreased significantly from 2002 to 2009.

The subsurface capacity for natural biodegradation of chlorinated solvents was evaluated near the source area and found to be generally reducing (conditions that encourage biodegradation of chlorinated solvents). Natural attenuation of chlorinated solvents can also be accelerated by the presence of dehalogenating bacteria in addition to a reducing environment. These bacteria were not sampled for directly, but indicator parameters (byproducts of bacterial dehalogenation of chlorinated solvents) were detected in the majority of samples, including indicators for methanogenic bacteria, which are the most efficient at breakdown of chlorinated solvents.

About 1 inch of light non-aqueous phase liquid (LNAPL) was measured in monitoring well M-12s from 2007 to 2009. The LNAPL was sampled in December 2009 for petroleum fingerprint analysis and was reported to be consistent with motor oil.

4.0 EXPOSURE ASSESSMENT

Potentially exposed populations and potential exposure pathways for both on-site and off-site contamination are evaluated in this section. Exposure can only occur if there is a complete pathway from a specific chemical of concern contained in one of the media to a receptor. The mere presence of a chemical is not in itself evidence that a complete exposure pathway will exist. Based on results from the RIR (summarized in the previous section), the contaminated media consist of soil and groundwater, soil vapor and insulation material. Exposure could involve accidental ingestion of VOC-contaminated media, inhalation of VOC-containing air, ingestion of soil particulates that contain or have VOCs on their surface or dermal contact with soil, groundwater, vapors, or insulation material. Although contamination is present in indoor air, since it did not originate there, but rather migrated from the various subsurface media, for the purposes of the exposure assessment indoor air is not considered a separate medium. Potential receptors include:

- On-site and off-site building users including maintenance/construction workers following remediation;
- On-site specialized workers and building users during remediation;
- Off-site residents and other nearby sensitive receptors; and
- Off-site surface water users (including both human users and aquatic organisms).

4.1 Incomplete Pathways

The following potential exposure pathway is considered incomplete:

- *Groundwater ingestion by current or future building users or off-site populations:* New York City prohibits the use of Manhattan groundwater for potable purposes; therefore, this exposure pathway is not complete for any current or future on-site or off-site receptors.

4.2 Potentially Complete but Insignificant Pathways

The following pathway, although potentially theoretically complete, is considered to result in, at most, an insignificant exposure:

- *Off-site fish ingestion, surface water ingestion and dermal contact*: The Harlem River is classified by New York State as a Class I saline waterbody, suitable for secondary contact recreation, fishing, fish propagation and survival, but not suitable for swimming. The New York State Department of Health (NYSDOH) *2009-2010 Health Advisories: Chemicals in Sportfish and Game* advisory applicable to the Harlem River is that women of childbearing age and children under 15 not eat any fish and that others eat no more than one meal (8 ounces) per week of fish (but no American eel, Gizzard shad, Crab hepatopancreas or crab cooking liquid and not more than one meal per month of Atlantic needlefish, Bluefish, Rainbow smelt, Striped bass or White perch). These advisories are not based on VOC contamination. In addition to the lack of finding detectable levels of VOCs in any wells downgradient of the site's source area (i.e., towards the Harlem River), to the extent that contaminated groundwater might eventually discharge to the Harlem River, it would be quickly diluted by the hugely greater volume and flow of the "river", which is actually a tidal strait connecting the Hudson River, East River and Long Island Sound. Therefore, the potential for any significant VOC contamination to be migrating from the site to the Harlem River (and resulting human or ecological exposure) is negligible. As such, a Fish and Wildlife Resources Impact Analysis (FWRIA) was not required by NYSDEC and was not performed for this project.
- *Inhalation of vapors by off-site populations*: In November-December 2009, a vapor intrusion assessment, consisting of collection and laboratory analysis of sub-slab soil vapor and corresponding indoor air samples at three locations, was conducted at the north-adjacent armory property, across 142nd Street. One additional indoor air sample was collected to ascertain background indoor air concentrations within the property. It was noted that other potential sources of VOCs were present in the armory as evidenced by oil stains, storage cabinets marked "flammable," wet paint, various cleaning solutions, etc. Laboratory results indicated that PCE breakdown products were not detected in any samples, though PCE was detected in all four indoor air samples between 0.97 and 1.5 µg/m^3 (well below the 100 µg/m^3 NYSDOH air guidance value) and in two of the three sub-slab vapor samples at 1.5 and 31

µg/m^3. The indoor air concentrations of PCE detected off-site were also below the 2.5 µg/m^3 NYSDOH upper fence value for background concentrations of VOCs in air of fuel oil- heated homes. The NYSDOH guidance associated with these levels is “no further action”.

4.3 Complete Pathways

The following pathways are potentially complete and will be accounted for in the development of remedial alternatives:

- *Inhalation of vapors by building users:* VOCs detected in the subsurface media, as well as directly measured in the building’s indoor air, indicate that this exposure pathway may be complete.
- *Soil, groundwater and insulation material dermal contact, ingestion and inhalation by on-site environmental workers during remediation:* To the extent that proposed remediation would involve excavation in areas of known contamination, this could result in exposure. However, this would be mitigated by implementation of a site-specific Health and Safety Plan (HASP) including both work zone and perimeter air monitoring addressing both potential worker and other building user exposure.
- *Soil, groundwater and insulation material dermal contact and ingestion by building users (following remediation) and off-site populations:* There is the possibility that residual contamination may remain after remediation. Direct contact with these materials does not currently occur and would not be expected to occur on-site in the future, through the implementation of institutional controls (specified in a Site Management Plan or SMP) that would be required if any of these contaminated media would remain following implementation of the chosen remedial alternative. These institutional controls would establish mandatory procedures governing any subgrade work (e.g., utility repairs) to ensure the safety of workers and others. The population with the greatest likelihood for exposure would be utility workers; such workers have specialized training and internal corporate procedures for handling contaminated materials encountered.

5.0 ALTERNATIVES ANALYSIS

5.1 Introduction

The purpose of remedy selection is to identify, evaluate and select a remedy or alternative remedies to address the contamination identified by the remedial investigation, especially the complete exposure pathways identified by the exposure assessment. This is accomplished by developing *Remedial Action Objectives* (RAOs). RAOs are objectives for the protection of public health and the environment and are themselves developed based on contaminant-specific and medium-specific *Standards*, *Criteria and Guidance* (SCGs). SCGs broadly mean standards and criteria that are generally applicable, consistently applied, officially promulgated, and either directly applicable or not directly applicable but relevant and appropriate. Whether they are directly applicable, relevant and/or appropriate is a function of both legal/regulatory judgments and technical/scientific reasoning. For example, groundwater standards (which are based on use as a potable supply) are legally applicable throughout New York State but are likely of lesser importance in determining the optimal remedial alternative where potable use (or other exposure pathways) are absent.

Alternatives are developed by assembling various combinations of technologies or alternative components (which may address one or more media) that, taken cumulatively, address contamination on a site-wide basis. A variety of technologies (and overall alternatives) that could potentially be technically suitable are developed. Following an initial screening of these, the remaining alternatives are evaluated in more detail against the following seven criteria (community acceptance will also be considered but not until after public review of the remedy selection process):

- Overall protection of public health and the environment;
- Reduction in toxicity, mobility and volume of hazardous waste (e.g., by thermal destruction, biological or chemical treatments or containment wall construction);
- Long-term effectiveness and permanence;
- Short-term effectiveness and potential impacts during remediation;
- Implementation and technical reliability;
- Compliance with statutory requirements; and
- Cost.

5.2 Remedial Action Objectives

RAOs are to be protective of public health and the environment, given the intended use of the site, and to remove or eliminate identifiable sources of contamination, to the extent feasible, regardless of presumed risk or intended use of the site. Note, therefore, that these RAOs may in some cases go beyond performing remediation sufficient to eliminate exposure pathways. The goal of the RAOs is to restore the site to pre-disposal conditions; however, the recommended remedial alternative (See Section 5.6) includes institutional and engineering controls to address residual contamination and practicably and feasibly ensure proper long-term protection of public health and the environment.

The four "media" for which contamination were identified in the RI and a discussion of appropriate RAOs is presented below:

- Soil – The *6 NYCRR Subpart 375-6: Remedial Program Soil Cleanup Objectives* (SCOs) are the applicable objectives. There are objectives for Unrestricted Use and a variety of restricted use scenarios based on use of the property (residential, restricted-residential, commercial or industrial) or protection of either ecological or groundwater resources. For the purposes of selecting the appropriate RAOs, it is noted that for PCE and its breakdown products, the Unrestricted Use SCOs (which are identical to the Protection of Groundwater SCOs) are lower than all of the other restricted use SCOs. As such, the Unrestricted Use SCO is the appropriate RAO, though the extent to which it is consistently applied and relevant in comparable locations is questionable, since the SCO was calculated assuming groundwater use as a source of drinking water, which does not and cannot legally occur in Manhattan. The Unrestricted Use SCOs (and RAOs) for PCE and its breakdown products are, however, as follows:
    - PCE: 1.3 mg/kg;
    - TCE: 0.47 mg/kg;
    - trans-1,2-DCE: 0.19 mg/kg;

- cis-1,2-DCE: 0.25 mg/kg; and
- Vinyl Chloride: 0.02 mg/kg.

The location of borings with exceedances of the Unrestricted Use SCOs (and estimated interpolated area of exceedance) are shown on Figure 3.

It should be noted that, although groundwater likely eventually discharges to the Harlem River (a Class I saline waterbody), the fact that this is a tidal strait with fast currents means that no violations of NYSDEC *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (*June 1998), e.g., PCE limit of 1 µg/l in Class I waters, would be anticipated even if contaminated groundwater were to be discharging to the River. No detectable levels of VOCs were found in any wells on the downgradient perimeter of the site's source area (i.e., towards the Harlem River). Therefore, the potential for any significant VOC contamination to be migrating from the site to the Harlem River is negligible, and as such, the potential for significant exposure due to secondary contact (incidental ingestion or dermal contact) and ecological effects in the river is negligible. As such, the Class I Standards are not relevant for establishing RAOs.

- Insulation Material – As the sub-slab insulation material is different from a traditional soil matrix, based upon different physical properties and being isolated with a concrete slab both above and beneath the material, the NYSDEC Soil Cleanup Objectives are not applicable, but are provided for reference. As with soil contamination, direct contact is not considered likely to occur under any future use of the building and appropriate remedial alternatives are best evaluated by considering the material's potential to contribute to contamination in other media (groundwater and indoor air). As such, the RAO for this medium is selected as 5 mg/kg PCE. Figure 4 shows the approximately 10,000-square foot area where cork remains beneath one or more concrete slabs, the estimated 7,400-square foot area of insulation with greater than the SCOPG of 1.3 mg/kg PCE, and a 1,200-square foot area of insulation with the highest levels of PCE (greater than 5 mg/kg).
- Soil Vapor – The NYSDOH publication entitled *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (October 2006) presents guidance matrices for recommended actions (i.e., no further action, take reasonable and practical actions to identify source(s) and reduce exposures, monitor or mitigate) dependent on both soil vapor (sub-slab) and indoor air concentrations. The guidance matrices applicable to PCE and TCE included in the NYSDOH publication entitled, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (October 2006), are presented below and represent the RAOs. NYSDOH also has air guideline values for both PCE (100 µg/m^3) and TCE (5 µg/m^3). Note that mcg and µg are both abbreviations for micrograms.

NYSDOH Matrix for PCE

	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m^3)			
SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m^3)	< 3	3 to < 30	30 to < 100	100 and above
< 100	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
100 to < 1,000	5. MONITOR	6. MONITOR / MITIGATE	7. MITIGATE	8. MITIGATE
1,000 and above	9. MITIGATE	10. MITIGATE	11. MITIGATE	12. MITIGATE

NYSDOH Matrix for TCE

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m³)			
	< 0.25	0.25 to < 1	1 to < 5.0	5.0 and above
< 5	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
5 to < 50	5. No further action	6. MONITOR	7. MONITOR	8. MITIGATE
50 to < 250	9. MONITOR	10. MONITOR / MITIGATE	11. MITIGATE	12. MITIGATE
250 and above	13. MITIGATE	14. MITIGATE	15. MITIGATE	16. MITIGATE

Results of more recent soil vapor sampling were presented in Section 5.3, Table 11 and Figure 15 of the RIR. Results of indoor air sampling were presented in Section 5.4 of the RIR.

Soil vapor and indoor air concentrations of both PCE and TCE below the “No Further Action” guidance concentrations in Matrices 1 and 2 (shown above) were present in 5 of 11 sampling locations evaluated, as shown on Figure 5. Additional indoor air samples were collected, but cannot be applied to NYSDOH Matrices 1 and 2 due to the lack of a nearby corresponding soil vapor sample. The indoor air data that is not shown on Figure 5 because there is no co-located soil vapor sample is in the same range of the data that is included.

The indoor air concentration of PCE in Locker 1454 was within the NYSDOH guidance value for the “Monitor” action, and the TCE concentration was within the NYSDOH guidance value for “No Further Action”; however, the “Mitigate” action was reached because of the elevated soil vapor concentrations of PCE and TCE in this area. Of the 7 indoor air samples with PCE and TCE concentrations below the NYSDOH “No Further Action” criteria, corresponding soil vapor concentrations at these locations reached the “Mitigate” action in two locations (SG-8/Room 131 for PCE only and SG-6/Locker 1454 for both PCE and TCE). The “Monitor” action was reached for PCE in four sampling locations (SG-9/Room 112, SG-9/Basement, SG-10/Room 131, and SG-13/Kitchen). Based on these results, certain areas (in the vicinity of SG-6 and SG-8) result in a recommendation to mitigate when applied to the NYSDOH Matrices for TCE and PCE. Interpolating from these results, mitigation is recommended over about 15% of the building, as shown on Figure 5. Similarly, monitoring is recommended in the vicinities of soil vapor samples SG-9, 10, and 13, while no further action is recommended over the remaining areas of the building. Based on isoconcentration lines of soil vapor concentrations as shown on Figure 15 of the RIR, about 55% of the site building would be within the NYSDOH “Mitigate” action, 25% would be within the “Monitor” action, and the remaining 20% would be “No Further Action”.

- Groundwater – The NYSDEC Class GA (Drinking Water) Standards are still considered applicable in Manhattan where groundwater is not and cannot legally be used as a source of drinking water. However, for purposes of identifying RAOs, the Class GA Standards are used, which are 5 µg/l for PCE and each of its breakdown products, with the exception of vinyl chloride, which is 2 µg/l. The five locations where samples exceeding any of these Class GA Standards in the most recent sampling event are shown in Figure 6.

5.3 Development of Remedial Alternatives

Based on the exposure assessment and remedial action objectives presented above, a range of remedial component alternatives (or technologies) for each of the four media are discussed in the subsections below. These components (or technologies) are then assembled into overall alternatives that address site-wide contamination. Note that a No Further Action alternative (i.e., no action beyond the already implemented IRMs) is always included per DER-10 as is an alternative that either fully removes the contamination or at the least allows unrestricted use of the site. It should be observed that NYSDEC's hierarchy of preference for remedial approaches (from most to least preferred) is; 1) removal and/or treatment; 2) containment; 3) elimination of exposure, and; 4) treatment of the source at the point of exposure.

5.3.1 Soil Remedial Alternative Components

Action alternatives for addressing on-site soil contamination include excavation, in-situ treatment and extraction. Removal of soil from beneath an existing building is generally problematic as it requires disturbance or removal of existing building uses and, frequently more importantly, can cause structural and other safety concerns. The site's interconnected buildings and unknown foundation design raise heightened concerns. That said, some amount of excavation beneath certain limited areas could be likely accomplished safely. Soils beneath the site could be more readily addressed either by injection of materials that encourage chemical oxidation (treatment) of the contaminants and/or by installation of one or more soil vapor extraction (SVE) systems targeting areas where elevated levels of VOCs are present. As such, the following components are considered for further analysis:

- S1 – No Further Action
- S2 – Soil Vapor Extraction
- S3 – In-Situ Chemical Oxidation
- S4 – Excavation and Off-Site Disposal

5.3.2 Groundwater Remedial Alternative Components

Action alternatives for addressing on-site groundwater contamination include chemical oxidation or reductive dechlorination, which would entail in-situ treatment via injection of liquids beneath the water table. Passive and/or active LNAPL recovery was also considered. Air sparging combined with SVE, which would involve injection of air beneath the water table, was not considered a viable alternative due to the shallow water table and low permeability of the organic clay layer across which the contaminated groundwater is present. Groundwater "pump and treat", whereby the groundwater would be pumped via one or more recovery wells, is a technology primarily used for containment of a plume. The extracted groundwater would be treated aboveground using physical treatment methods such as air stripping and/or granular activated carbon. Vapor treatment may also be required if air stripping was used to treat the groundwater. The treated groundwater would then be discharged to the combined sewer system. The extent of the plume is relatively confined and "pump and treat" would have little or no effect in reducing contaminant concentrations at the site. Furthermore, long term (i.e., several years) operation and maintenance of the system would be required. The use of pump and treat is often used when there is a threat to drinking water supplies, used in conjunction with a NAPL recovery system, and/or there are no other viable alternatives for treatment and/or containment. Other in-situ alternatives have been developed, including those outlined in this feasibility study, which are much more effective to treat and contain the contaminants at the site. Based upon the high capital and operation and maintenance costs, lack of effectiveness in reducing the relatively low contaminant concentrations in groundwater at the site, and a plume that is limited in extent, pump and treat has been excluded from further consideration. As such, the following components are considered for further analysis:

- G1 – No Further Action
- G2 – In-Situ Treatment (Chemical Oxidation and/or Reductive Dechlorination)
- G3 – LNAPL Recovery

5.3.3 Soil Vapor Remedial Alternative Components

Action alternatives for addressing on-site soil vapor contamination (and potential migration into indoor air) include installing a sub-slab (or inter-slab where multiple slabs are present) depressurization system (SSDS) to prevent sub-slab vapors from migrating into the building. Note that based on the off-site vapor intrusion assessment (see Section 5.5 of the RIR), no further action is required at off-site buildings.

As such, the following components are considered for further analysis:

- V1 – No Further Action
- V2 – HVAC Operation Under Positive Pressure
- V3 – Sub-Slab Depressurization System

5.3.4 Sub-Slab Insulation Remedial Alternative Components

Action alternatives for addressing insulation material are removal (requiring excavation) or, as with soil vapor, installing a sub-slab (or inter-slab where multiple slabs are present) depressurization system (SSDS).

As such, the following four components are considered for further analysis:

- I1 – No Further Action
- I2A – Removal and Off-Site Disposal (Full Removal)
- I2B – Removal and Off-Site Disposal (Partial Removal)
- I3 – Sub-Slab Depressurization System

5.3.5 Environmental Easement and Site Management

As part of remedial Alternatives 2, 3 and 4, institutional and engineering controls would be implemented for long-term management of the site and to prevent future exposure to any residual contamination. An environmental easement would be recorded for the site to implement the controls. A Site Management Plan (SMP) would be prepared to specify maintenance of the site cover, future soil and insulation handling requirements, operation and maintenance procedures, and land use restrictions. Periodic inspection and reporting would be required to verify that the restrictions and requirements included in the easement remain in-place and effective.

5.4 Selection of Overall Remedial Alternatives

As noted above, NYSDEC guidance requires a No Further Action Alternative and an alternative that allows unrestricted use of the site. It is anticipated that all action alternatives except for Alternative 5 (the unrestricted use alternative) would include institutional and engineering controls and an SMP. Estimated remediation costs are provided in Appendix A.

5.4.1 Alternative 1: No Further Action

Alternative 1 involves conducting no further remedial activities at the site (remedial components S1, G1, V1 and I1). Consideration of this alternative fulfills NYSDEC guidance requiring analysis of the "No Further Action" alternative.

5.4.2 Alternative 2: Exposure Reduction

Alternative 2 consists of the following components: S1, G1, V2 and I1. In summary, the HVAC system would be operated under positive pressure to address potential vapor intrusion, but this alternative would not address the contaminated media directly. Rather than attempt to remove all of the subsurface contamination, this alternative would prevent building users from being exposed by severing the pathways from the subsurface contamination to the inside of the building. Institutional controls to prevent groundwater use, uncontrolled excavation of residual contamination, and to ensure operation maintenance of the SSDS and floor slab (site cover) would be specified in an SMP for long-term management of the site, as discussed in Section 5.3.5.

S1/G1/I1 – No Further Action

Under Alternative 2, no remediation would be performed relative to soil, groundwater and sub-slab insulation contamination.

V2 – HVAC Operation Under Positive Pressure

Maintaining positive pressure inside the building would be achieved by adjusting the building's HVAC system to intake more outside air than it exhausts. The air handling units capable of providing positive pressure encompass the majority of the building where the school space was constructed. Additions to the HVAC system would be made in the portion of the building not previously renovated. As part of the initial interim action, the air handling units were adjusted in this manner to provide positive pressure; however, the adjustments were not a formalized IRM and were not subsequently inspected. In order to certify the operation of the HVAC under positive pressure under this Alternative, the existing air handling system would be inspected and adjusted as necessary, remaining open penetrations would be sealed, and monitoring procedures for open windows and doors would be established.

5.4.3 Alternative 3: Soil and Insulation Material Removal

Alternative 3 consists of the following components S4, G1, V2 and I2A. In summary, this alternative would excavate contaminated soil and remove contaminated insulation material to the extent practicable and feasible given the limitations excavating close to foundation elements and utilities. Accordingly, the removal alternative will not achieve complete removal to allow for unrestricted use without some form of engineering and institutional controls. Alternative 3 would include operation of the HVAC system under positive pressure to address potential vapor intrusion and an SMP for long-term management of the site, as discussed in Section 5.3.5.

S4 – Soil Excavation and Off-Site Disposal

The target area for soil excavation would be an approximately 8,000-square foot area located in the northwestern portion of the site to an average depth of 14 feet below grade, where soil concentrations were greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 3. The majority of this area is beneath an existing occupied building with a network of internal walls that contain plumbing, electrical and fire suppression utilities for the building. While underpinning would be implemented in certain areas, some of the internal load bearing walls cannot be demolished or otherwise supported for soil excavation. The remainder of this target area for soil excavation is beneath a sidewalk which includes transformer vaults and may contain utilities.

Soil excavation would entail demolition of the sidewalk, floor slabs and non-structural walls where appropriate, practicable and feasible. Excavation would proceed in the sidewalk and inside the existing building to the extent practicable and feasible to the depth of known contamination below the water table and around structures and sidewalk utilities. Because of structural walls, foundations and ceilings which must remain in-place, not all soil will be accessible for removal. A structural engineer would be consulted for evaluation of the existing building and design of shoring and foundation support (e.g., underpinning) where necessary to maintain the existing building. Plumbing and electrical trades would also be consulted for evaluating and disconnecting existing utilities in the removal area. Preliminary work may need to include an asbestos survey and abatement. Department of Buildings permits would be related to partial demolition, utility disconnection/relocation, and restoration. Site restoration would include backfilling with clean fill, repair of concrete at surface grade and repair of site finishes, as necessary.

The excavation would include working within containment with negative pressure with exhaust fans to control dust and vapors generated from demolition and removal activities. For the purposes of this FS, it is assumed that concrete could be disposed of as non-hazardous demolition debris and all excavated soil and fill material would be handled and disposed of as hazardous waste.

G1 – No Further Action

Under Alternative 3A, no remediation would be performed relative to groundwater or soil vapor contamination.

V2 – HVAC Operation Under Positive Pressure

Maintaining positive pressure inside the building would be achieved by adjusting the building's HVAC system to intake less air than it exhausts. In order to certify the operation of the HVAC under positive pressure, the existing air handling system would be inspected and adjusted as necessary, remaining open penetrations would be sealed, and monitoring procedures for open windows and doors would be established.

I2A –Removal and Off-Site Disposal of Contaminated Insulation (Full Removal)

The target area for full removal of contaminated sub-slab insulation would be an approximately 7,400-square foot area located in the northwestern portion of the site to an average depth of 2.5 feet below grade, where insulation concentrations were greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 4. Due to measured bulk densities of sub-slab insulation samples, the reported PCE concentrations are much higher per unit volume when compared to a soil sample, which have much higher bulk densities.

Removal of the sub-slab insulation material would entail demolition of the floor slabs and non-structural walls where appropriate and practicable. Although the insulation removal area overlaps with a portion of the soil removal area, the majority of the insulation is outside of the area where soil concentrations were identified to be greater than the SCOs for Unrestricted Use. Because of structural walls, foundations and ceilings that must remain in-place, not all sub-slab insulation material will be accessible for removal. A structural engineer would be consulted for evaluation of the existing building and design of shoring and foundation support (e.g., underpinning) where necessary to maintain the existing building. Plumbing and electrical trades would be consulted for evaluating and disconnecting existing utilities in the removal area. Preliminary work may need to include an asbestos survey and abatement. Department of Buildings permits would be related to demolition, utility disconnection/relocation, and restoration. Site restoration would include backfilling with clean fill, repair of concrete at surface grade and repair of site finishes, as necessary.

The sub-slab insulation removal would include working within containment with negative pressure with exhaust fans to control dust and vapors generated from demolition and removal activities. For the purposes of this FS, it is assumed that concrete could be disposed of as non-hazardous demolition debris and all other excavated material (fill/soil, cork, and styrofoam) would be handled and disposed of as hazardous waste.

5.4.4 Alternative 4: Treatment and Partial Removal

Alternative 4 consists of the following components for soil, groundwater, soil vapor and sub-slab insulation material: S2, S3, G2, G3, V3, I2B and I3. This alternative would treat soil and groundwater in-situ. By treating contamination in place, the need for extensive excavation to remove contaminated soil would be avoided. An SVE system is included to address treatment of soil and create negative pressure below the slab, and an SSDS to address soil vapor. Partial insulation material removal would be completed in the northwestern portion of the site. An SMP would be employed to ensure implementation of the institutional and engineering controls required for this alternative, as discussed in Section 5.3.5.

S2 - SVE

Vapor extraction wells would be installed down to the water table. The target area for the SVE system is the soil above the water table in an approximately 8,000-square foot area located in the northwestern portion of the site where soil concentrations were greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 3. For the purposes of this FS, 10 extraction wells (spacing of 25 to 30 feet) are assumed; however, the number and spacing of wells would be evaluated further as part of remedial design and during installation. An SVE pilot test was performed in 2009, and additional confirmatory data would be collected during system installation to confirm the observed zone of influence for each extraction well. Through a network of piping connected to a blower, a vacuum would be applied to the wells to draw off the contaminant vapors. The removed vapor would likely require further treatment, such as carbon adsorption prior to release to the atmosphere.

S3 – In-Situ Chemical Oxidation

In-situ soil treatment would be achieved through injecting a chemical oxidation product in an approximately 2,500-square foot area located in the northwestern portion of the site where soil concentrations were highest, within the area with concentrations greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 3. Because the injected material could react with naturally occurring organic carbon, the deeper organic clay layer would be considered when developing the injection plan during remedial design. The buried naturally occurring organics in the organic clay layer would also be considered when selecting a product and injection volume during the remedial design; however, it is assumed that the shallow portion of the vadose zone would be saturated with the chemical oxidation solution during each injection event. For the purposes of this FS, 25 shallow on-site injection wells are assumed at approximate 10-foot spacing with 2 injection events using a product such as Fenton's reagent; however, the number and spacing of wells would be evaluated further as part of remedial design.

G2 – In-Situ Groundwater Treatment

Groundwater treatment would be achieved through injecting a product to enhance reductive dechlorination over an approximately 6,000-square foot area located in the northwestern portion of the site where groundwater concentrations were greater than the Class GA Standards, as shown on Figure 6. For the purposes of this FS, 15 on-site injection wells are assumed at approximate 20-foot spacing with 2 injection events using a product such as Hydrogen Release Compound® (HRC), molasses, vegetable oil or other organic carbon source. The product used and number and spacing of wells would be evaluated further as part of remedial design. The organic clay layer near the water table would be considered when selecting a product and injection volume during the remedial design. If vinyl chloride is persistent following the injection program, additional treatment using Oxygen Release Compound® (ORC) or other oxygen source will be considered to promote aerobic degradation.

G3 – LNAPL Recovery

The extent of the LNAPL observed in well M-12s would be evaluated and recovery wells installed, as appropriate. Oil-absorbent socks or similar materials will be used to remove the LNAPL from the water table surface. If the thickness of the LNAPL is adequate for pumping, skimmer pumps may be used. The LNAPL and spent oil absorbent materials will be containerized and disposed of off-site.

For the purposes of this FS, five recovery wells are assumed with passive recovery over the course of five years; however, the number and spacing of wells and LNAPL recovery methodology would be evaluated further as part of remedial design.

V3/I3 – SSDS

The SSDS at this site would consist of sub-slab extraction points throughout the existing three-section building. For the purposes of this FS, 14 extraction zones are assumed; however, the number and spacing of extraction points would be evaluated further as part of remedial design. The exact number and location of extraction pits would be based upon the radius of influence of negative pressure observed during testing performed during installation. The existing intra-slab system would be evaluated to confirm negative pressure and system efficiency, and to determine whether additional sub-slab extraction points in the area of the existing system are warranted. The anticipated design would consist of extraction pits below the surface floor slab connected to in-line fans to extract vapors and create negative pressure beneath the slab. The removed vapor may require further treatment, such as carbon adsorption prior to release to the atmosphere. For the purposes of this FS, it is assumed that four of the SSDS zones will require treatment.

I2B – Removal and Off-Site Disposal of Contaminated Insulation (Partial Removal)

Remedial option I2B includes partial removal of sub-slab insulation to the extent practicable and feasible, in a maximum 1,200-square foot area in the northwestern portion of the site, as shown on the attached Figure 4.

The maximum removal area encompasses the area with the highest PCE concentrations detected in the insulation material. The removal of contaminated insulation from this area would result in contaminant mass reduction for this media in excess of 90%. A table summarizing the mass calculations is provided in Appendix B.

During remedial design, additional insulation sampling would be completed to confirm the presence of insulation within the targeted area shown on Figure 4 and confirmatory samples would be collected for laboratory analysis. The targeted removal area could be reduced in consultation with DEC based on this additional sampling.

Removal of the sub-slab insulation material would entail demolition of the floor slabs and non-structural components where appropriate, practicable and feasible. Because of structural walls, foundations, ceilings and utilities that must remain in-place, not all sub-slab insulation material will be accessible for removal within the defined area. A structural engineer would be consulted to confirm potential demolition areas and protection of the existing building. Plumbing and electrical trades would be consulted for evaluating and disconnecting existing utilities in the removal area. If the sampling identifies significantly lower concentrations than those identified as part of the FS or significant limitations are identified due to structural concerns, utility conflicts, or other considerations, the targeted area for insulation removal may be reduced.

Preliminary work would include an asbestos survey and any abatement, as necessary. Department of Buildings permits would be required for demolition, utility disconnection/relocation, and restoration. Site restoration would include backfilling with clean fill, repair of concrete at surface grade and repair of site finishes, as necessary.

The sub-slab insulation removal would include working within containment with negative pressure via exhaust fans to control dust and vapors generated from demolition and removal activities. It is assumed that concrete could be disposed of as non-hazardous demolition debris and all other excavated material (fill/soil, cork, and styrofoam) would be handled and disposed of as hazardous waste.

5.4.5 Alternative 5: Removal Plus Treatment for Unrestricted Use

Alternative 5 consists of the following components S2, S3, S4, G2, G3 and I2A. In summary, this alternative would excavate contaminated soil and remove contaminated insulation material to the extent practicable and feasible given the limitations that excavation close to foundation elements and utilities may not be possible. Because the removal alternative (Alternative 3) will not achieve complete removal of contaminated soil, Alternative 5 would include in-situ treatment of soil and groundwater to address residual contamination in an effort to allow for unrestricted use of the site.

S2 – SVE

Vapor extraction wells would be installed down to the water table. The target area for the SVE system is the soil above the water table in an approximately 8,000 square foot area located in the northwestern portion of the site where soil concentrations were greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 3. For the purposes of this FS, 10 extraction wells (spacing of 25 to 30 feet) are assumed; however, the number and spacing of wells would be evaluated further as part of remedial design and during installation. An SVE pilot test was performed in 2009, and additional confirmatory data would be collected during system installation to confirm the observed zone of influence for each extraction well. Through a network of piping connected to a blower, a vacuum would be applied to the wells to draw off the contaminant vapors. The removed vapor would likely require further treatment, such as carbon adsorption prior to release to the atmosphere.

S3 – In-Situ Chemical Oxidation

In-situ soil treatment would be achieved through injecting a chemical oxidation product in an approximately 2,500-square foot area located in the northwestern portion of the site where soil concentrations were highest, within the area with concentrations greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 3. Because the injected material could react with naturally occurring organic carbon, the deeper organic clay layer would be considered when developing the injection plan during remedial design. The buried naturally occurring organics in the organic clay layer would also be considered when selecting a product and injection volume during the remedial design; however, it is assumed that the shallow portion of the vadose zone would be saturated with the chemical oxidation solution during each injection event. For the purposes of this FS, 25 shallow on-site injection wells are assumed at approximate 10-foot spacing with 2 injection events using a product such as Fenton's reagent; however, the number and spacing of wells would be evaluated further as part of remedial design.

S4 – Soil Excavation and Off-Site Disposal

The target area for soil excavation would be an approximately 8,000-square foot area located in the northwestern portion of the site to an average depth of 14 feet below grade, where soil concentrations were greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 3. The majority of this area is beneath an existing occupied building with a network of internal walls that contain plumbing, electrical and fire suppression utilities for the building. While underpinning would be implemented in certain areas, some of the internal load bearing walls cannot be demolished or otherwise supported for soil excavation. The remainder of this target area for soil excavation is beneath a sidewalk that includes transformer vaults and may contain utilities.

Soil excavation would entail demolition of the sidewalk, floor slabs and non-structural walls where appropriate, practicable and feasible. Excavation would proceed in the sidewalk and inside the existing building to the extent practicable and feasible to the depth of known contamination below the water table and around structures and sidewalk utilities. Because of structural walls, foundations and ceilings which must remain in-place, not all soil will be accessible for removal. A structural engineer would be consulted for evaluation of the existing building and design of shoring and foundation support (e.g., underpinning) where necessary to maintain the existing building. Plumbing and electrical trades would be consulted for evaluating and disconnecting existing utilities in the removal area. Preliminary work may need to include an asbestos survey and abatement. Department of Buildings permits would be related to partial demolition, utility disconnection/relocation, and restoration. Site restoration would include backfilling with clean fill, repair of concrete at surface grade and repair of site finishes, as necessary.

The excavation would include working within containment with negative pressure with exhaust fans to control dust and vapors generated from demolition and removal activities. For the purposes of this FS, it is assumed that concrete could be disposed of as non-hazardous demolition debris and all excavated soil and fill material would be handled and disposed of as hazardous waste.

G2 – In-Situ Groundwater Treatment

Groundwater treatment would be achieved through injecting a product to enhance reductive dechlorination over an approximately 6,000-square foot area located in the northwestern portion of the site, where groundwater concentrations were greater than the Class GA Standards, as shown on Figure 6. For the purposes of this FS, 15 on-site injection wells are assumed at approximately 20-foot spacing with 2 injection events using a product such as Hydrogen Release Compound® (HRC), molasses, vegetable oil or other organic carbon source. The product used and number and spacing of wells would be evaluated further as part of remedial design. The organic clay layer near the water table would be considered when selecting a product and injection volume during the remedial design. If vinyl chloride is persistent following the injection program, additional treatment using Oxygen Release Compound® (ORC) or other oxygen source will be considered to promote aerobic degradation.

G3 – LNAPL Recovery

The extent of the LNAPL observed in well M-12s would be evaluated and recovery wells installed, as appropriate. Oil-absorbent socks or similar materials will be used to remove the LNAPL from the water table surface. If the thickness of the LNAPL is adequate for pumping, skimmer pumps may be used. The LNAPL and spent oil absorbent materials will be containerized and disposed of off-site.

For the purposes of this FS, five recovery wells are assumed with passive recovery over the course of five years; however, the number and spacing of wells and LNAPL recovery methodology would be evaluated further as part of remedial design.

I2A –Removal and Off-Site Disposal of Contaminated Insulation (Full Removal)

The target area for full removal of contaminated sub-slab insulation would be an approximately 7,400-square foot area located in the northwestern portion of the site to an average depth of 2.5 feet below grade, where insulation concentrations were greater than the SCOs for Unrestricted Use (which are the same as SCOs for Protection of Groundwater), as shown on Figure 4. Due to measured bulk densities of sub-slab insulation samples, the reported PCE concentrations are much higher per unit volume when compared to a soil sample, which have much higher bulk densities.

Removal of the sub-slab insulation material would entail demolition of the floor slabs and non-structural walls where appropriate and practicable. Although the insulation removal area overlaps with a portion of the soil removal area, the majority of the insulation is outside of the area where soil concentrations were identified to be greater than the SCOs for Unrestricted Use. Because of structural walls, foundations and ceilings that must remain in-place, not all sub-slab insulation material will be accessible for removal. A structural engineer would be consulted for evaluation of the existing building and design of shoring and foundation support (e.g., underpinning), where necessary, to maintain the existing building. Plumbing and electrical trades would be consulted for evaluating and disconnecting existing utilities in the removal area. Preliminary work may need to include an asbestos survey and abatement. Department of Buildings permits would be related to demolition, utility disconnection/relocation, and restoration. Site restoration would include backfilling with clean fill, repair of concrete at surface grade and repair of site finishes, as necessary.

The sub-slab insulation removal would include working within containment with negative pressure with exhaust fans to control dust and vapors generated from demolition and removal activities. For the purposes of this FS, it is assumed that concrete could be disposed of as non-hazardous demolition debris and all other excavated material (fill/soil, cork, and styrofoam) would be handled and disposed of as hazardous waste.

5.5 Analysis of Remedial Alternatives

In this section, the remedial alternatives are evaluated against the following seven criteria:

1. Overall protection of public health and the environment, i.e., how each alternative would eliminate, reduce or control through removal, treatment, containment, engineering controls or institutional controls any existing or potential pathways of exposure to public health or environmental impacts identified by the RI.
2. Reduction in toxicity, mobility and volume of hazardous waste (e.g., by thermal destruction, biological or chemical treatments or containment wall construction), i.e., the ability of each alternative to achieve each of the RAOs, whether it conforms to the SCGs and if it does not why conformity should be dispensed with, e.g., if it would result in greater risk to public health than alternatives or be technically impracticable or equivalent to that required by the SCG through another approach. Preference is given to remedies that permanently or significantly reduce the toxicity, mobility or volume of contamination.
3. Long-term effectiveness and permanence, i.e., if contamination would remain after the remedy has been implemented, whether it could result in exposure.
4. Short-term effectiveness and potential impacts during remediation; e.g., potential adverse impacts including loss of use of the property, traffic, odors, vapors, dust, and noise.

5. Implementation and technical reliability, i.e., the technical and non-technical feasibility of an alternative such as the difficulties associated with construction and monitoring the effectiveness, potential difficulties in obtaining approvals, and the reliability of implementation of institutional or engineering controls.
6. Compliance with statutory requirements.
7. Cost effectiveness, i.e., whether the remedy's costs are proportional to its effectiveness.

Community acceptance will be evaluated after the public meeting to be held prior to approval of this FS.

5.5.1 Alternative 1: No Action

Overall Protection of Public Health and the Environment

Alternative 1 would not provide overall protection of public health and the environment because it would not address potential for vapor intrusion of PCE and related compounds inside the building.

Compliance with Standards, Criteria, and Guidance (SCGs)

Alternative 1 would not comply with the SCGs because contaminants would be left in place at concentrations that exceed SCOs (soil and insulation material), groundwater would remain above Class GA Standards, and soil vapor and indoor air levels could potentially exceed NYSDOH guidelines.

Short-Term Effectiveness

Alternative 1 would not provide short-term effectiveness because there would be no controls in place to prevent potential exposure via vapor intrusion.

Long-Term Effectiveness and Permanence

Alternative 1 would not provide long-term effectiveness and permanence because contamination would be left in the subsurface, allowing potential vapor intrusion to continue indefinitely.

Reduction of Toxicity, Mobility or Volume with Treatment

Contaminant toxicity, mobility, and volume would not be reduced if Alternative 1 is selected, as none of the contaminated material would be removed, stabilized, or treated.

Implementability

Alternative 1 requires no action and, therefore, could be easily implemented.

Cost

There would be no costs associated with Alternative 1.

5.5.2 Alternative 2: Exposure Reduction

Overall Protection of Public Health and the Environment

Alternative 2 would provide HVAC system operation under positive pressure to prevent unacceptable exposure of building users. Therefore, Alternative 2 would provide overall protection of public health in consideration of current and reasonably foreseeable future land use, but not the environment. Restrictions requiring appropriate engineering controls during future excavation activities and prohibiting potable and non-potable supply wells would protect future maintenance workers and building users from subsurface residual contaminants. The SMP and environmental easement would include protocols for inspections and annual certification to ensure proper long-term functioning of the remedy, as outlined in Section 5.3.5.

Compliance with Standards, Criteria, and Guidance (SCGs)

Alternative 2 would not comply with the SCGs, as soil and insulation materials exceeding SCOs would remain in place. Groundwater would likely remain above Class GA Standards for a long period of time. With the HVAC operation under positive pressure and continued operation of the intra-slab system installed as the IRM, indoor air in occupied spaces would likely meet the NYSDOH guidelines.

Short-Term Effectiveness

Alternative 2 would provide short-term effectiveness with air monitoring to confirm indoor air exposure is being mitigated. It would take approximately one month and no soil disturbance to implement this alternative.

Long-Term Effectiveness and Permanence

Alternative 2 would provide long-term effectiveness and permanence, because although contamination would remain in the subsurface for a long period of time, exposure to this contamination would be prevented by severing the pathways from the subsurface contamination to the inside of the building Though HVAC adjustments to maintain positive pressure inside the building can be implemented, there can be limitations in an old inter-connected building, as it would entail maintaining an extensive monitoring network and may be ineffective if a window or door were inadvertently left open. An SMP would govern excavation beneath the existing building or other activities that could affect performance of the systems.

Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 2 would not significantly alter the toxicity, mobility or volume of contamination.

Implementability

Effective operation of the HVAC system under positive pressure requires appropriate adjustments to the existing system and evaluation of building airflow. This alternative requires eliminating short-circuiting (e.g., due to cracks or penetrations in the slab, or open windows and doors). Given the uncertainty of window and door positions throughout the day in an occupied building and maintaining positive pressure may not be continuous. Notwithstanding, with a conservative design and inspection/certification program, the design objectives to prevent vapor intrusion could be achieved.

Cost

The estimated cost associated with Alternative 2 is approximately $156,000 for implementation with subsequent operation and maintenance costs of approximately $291,000 over 30 years. Estimated remediation costs are provided in Appendix A.

5.5.3 Alternative 3: Soil and Insulation Material Removal

Overall Protection of Public Health and the Environment

Alternative 3 would provide overall protection of public health and the environment in consideration of current and potential future land use. This alternative would result in removal of the majority, but likely not all, soil and insulation material exceeding the RAOs. Soil and insulation material removal would not directly address groundwater or soil vapor, but would be expected to lead to attenuation in groundwater over time. HVAC operation under positive pressure would prevent unacceptable exposure of building users.

Site controls (e.g., HASP) would prevent unacceptable exposure during remediation activities, though it is assumed that use of the building during excavation would be restricted in the active work area and immediate vicinity. Engineering controls, including the HVAC adjustments, would prevent unacceptable exposure to future building users. Restrictions requiring appropriate engineering controls during future excavation activities and prohibiting potable and non-potable supply wells would protect future maintenance workers and building users from subsurface residual contaminants. The SMP would include protocols for inspections and annual certification to ensure proper long-term functioning of the remedy, as discussed in Section 5.3.5.

Compliance with Standards, Criteria, and Guidance (SCGs)

Alternative 3 partially complies with the applicable SCGs to the extent that soil and insulation material above the RAOs would be targeted for removal. However, the presence of building foundation elements, the adjacent sidewalk and street, and utilities would likely mean that some of these materials could not be safely removed. Groundwater and, to a lesser extent, soil vapor contamination (due to remaining soil and insulation material that cannot be physically removed) may attenuate over time, but SCGs might not be attained for many years. Air SCGs would be met by operating the HVAC system under positive pressure.

Short-Term Effectiveness

Approximately 15,250 square feet of the building slab (combined square footage of soil and insulation removal areas) would need to be removed which would take approximately 8 to 12 months to implement this alternative. A HASP with an air monitoring plan to prevent unacceptable exposure would be implemented, though it is assumed that use of the work zone and immediate vicinity would be restricted during excavation. Off-site disposal of the approximately 6,300 tons of removed materials (concrete, insulation, and soil/fill) and their replacement with backfill would be associated with approximately 225 trucks making round-trips.

Long-Term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence, though institutional (e.g., prohibitions on use of groundwater and implementation of an SMP), engineering controls and long-term monitoring would be needed to ensure protection of building users from residual contamination. Though HVAC adjustments to maintain positive pressure inside the building can be implemented, there can be limitations in an old inter-connected building, as it would entail maintaining an extensive monitoring network and may be ineffective if a window or door were inadvertently left open.

Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 3 would reduce contaminant mobility and volume, as the accessible soil and insulation material with concentrations exceeding the SCOs would be removed and disposed of at a receiving facility with appropriate treatment and/or engineering controls to prevent contaminant migration. The contaminant toxicity would be reduced if materials containing VOCs were to be incinerated (however, this is unlikely).

Implementability

The targeted areas for contaminated soil and insulation removal contemplated for Alternative 3 are located within the sidewalk with numerous utilities and a building constructed in phases, which will significantly complicate the design and implementation of this alternative to ensure protection of the utilities and the structural integrity of the building. Implementation would require specialized construction procedures, as removal of large portions of an existing building slab and subsequent excavation can only be performed with the most careful procedures to avoid structural damage. Because of the ceiling height, specialized equipment would be required in an attempt to reach the necessary excavation depths. The variable and discrete locations and depths of soil contamination throughout the northwestern portion of the site complicates targeting and removal even further. The construction issues and permits associated with this work could result in an extended timeframe; difficult engineering and approvals will be needed. Furthermore, a significant volume of soil and insulation is expected to be inaccessible for removal due to structural and other considerations (e.g., utilities) that make the removal alternative impracticable. Portions of the soil and insulation exceeding the SCOs could not be practicably and feasibly removed as part of this alternative.

Effective operation of the HVAC system under positive pressure requires appropriate adjustments to the existing system and evaluation of building airflow. This alternative requires eliminating short-circuiting (e.g., due to cracks or penetrations in the slab, open windows and doors). Given the uncertainty of window and door positions throughout the day in an occupied building and maintaining positive pressure may not be continuous. Notwithstanding, with a conservative design and inspection/certification program, the design objectives to prevent vapor intrusion could be achieved.

Cost

The estimate cost for implementing Alternative 3 is approximately $4,465,000 for implementation of the soil and insulation material removal and implementing the HVAC adjustments. Ongoing operation and monitoring costs for 30 years would be on the order of $291,000 for this Alternative.

5.5.4 Alternative 4: Treatment and Partial Insulation Removal

Overall Protection of Public Health and the Environment

Alternative 4 would consist of treating contamination in soil and groundwater, removing LNAPL, and addressing residual contamination in insulation material and soil vapor via partial insulation removal and an SSDS to prevent unacceptable exposure of building users. Therefore, Alternative 4 would provide overall protection of public health and the environment in consideration of current and reasonably foreseeable future land use. Restrictions requiring appropriate engineering controls during future excavation activities and prohibiting potable and non-potable supply wells would protect future maintenance workers and building users from subsurface residual contaminants. The SMP would include protocols for inspections and annual certification to ensure proper long-term functioning of the remedy, as discussed in Section 5.3.5.

Compliance with Standards, Criteria, and Guidance (SCGs)

Alternative 4 would only partially comply with the SCGs, as potentially not all soils exceeding SCOs would likely be remediated to below the SCO levels by the treatment technologies. Insulation materials that could not be practicably and feasibly removed or that are outside the designated removal area would not likely be fully remediated. Groundwater would also likely remain above Class GA Standards for an extended period of time. With the operation of an SSDS, indoor air would meet the NYSDOH guidelines.

Short-Term Effectiveness

Alternative 4 would provide short-term effectiveness during installation of the remediation systems via implementation of a HASP with worker and building user air monitoring to prevent exposure. It would take approximately six to nine months to implement this alternative, plus an additional five years of SVE operation and maintenance. Only limited soil disturbance would be required to perform this remedial approach compared to Alternative 3.

Long-Term Effectiveness and Permanence

Alternative 4 would provide long-term effectiveness and permanence because, although some contamination would likely remain in the subsurface for a long period of time, exposure to this residual contamination would be prevented by the continued operation of the SSDS and SVE systems and implementation of a SMP governing excavation beneath the building or other activities that could affect performance of the systems.

Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 4 would alter the toxicity and volume of contamination, as it would, over time, both remove contaminants (LNAPL and partial insulation removal and off-site disposal, and SVE system) or destroy them (via soil and groundwater treatment) and ensure that potential residual vapors do not enter the building (SSDS). Contaminant toxicity in groundwater would be reduced through dechlorination. If vinyl chloride persists, an aerobic degradation product would be evaluated.

Implementability

The targeted area for partial removal of contaminated insulation contemplated for Alternative 4 is limited to a section south of the storage locker area and north of the cafeteria, in the western portion of the site building. Any removal within a building constructed in phases with unknown foundation construction would have a more complicated remedial design and implementation. As such, the limited extent of planned removal in this alternative is intended to maintain structural integrity of the building and associated utilities. Implementation would require specialized construction procedures and equipment to avoid structural damage, and to accommodate equipment use indoors with limited door widths and ceiling height. The construction issues and permits associated with this work could result in an extended timeframe.

The technology for the various treatment alternatives is readily available. The effectiveness of the treatment can be frequently determined in a short period of time (weeks or months), though careful monitoring would be required. Effective SVE and SSDS require appropriate spacing of the extraction points and flow rates sufficient to cover all areas between extraction points. They also require eliminating short-circuiting (e.g., due to cracks or penetrations in the slab). Given the unknown foundation design of the interconnected buildings, the likelihood that some desirable extraction point locations will not be acceptable because of utility or other conflicts, the presence of fill materials, and penetrations through the slab, implementing these systems will require careful design and installation. For example, it is possible that extraction point spacing may vary across the building and need to be evaluated and modified as the system is installed. Notwithstanding, with a conservative design and post-installation testing program, the design objectives to prevent vapor intrusion can be achieved.

Cost

The estimated cost associated with Alternative 4 is approximately $1,371,000 for implementation with subsequent operation and maintenance costs of approximately $1,335,000 over 30 years.

5.5.5 Alternative 5: Removal Plus Treatment for Unrestricted Use

Overall Protection of Public Health and the Environment

The goal would be to remove the majority, but likely not all, soil and insulation material exceeding the RAOs. Remaining soil and groundwater contamination would be addressed by in-situ treatment. However, residual contamination in soil and insulation above SCGs, which are not practicably and feasibly accessible during removal and treatment, would likely remain. In the absence of institutional controls and potentially engineering controls, Alternative 5 would not be effective to overall protection of public health (related to current and potential future land uses) and the environment.

Site controls (e.g., HASP) would prevent unacceptable exposure during remediation activities, though it is assumed that use of the building during excavation would be restricted in the active work area and immediate vicinity.

Compliance with Standards, Criteria, and Guidance (SCGs)

Alternative 5 would comply with the applicable SCGs, to the extent that soil and insulation material above the RAOs would be targeted for removal. Although the presence of building foundation elements, the adjacent sidewalk and street, and utilities would likely mean that some of these materials could not be safely removed, the in-situ treatment technologies would target residual contamination, and the groundwater contamination. However, residual contamination in soil and insulation above SCGs, which are inaccessible during removal and treatment, would likely remain.

Short-Term Effectiveness

Approximately 15,250 square feet of the building slab (combined square footage of soil and insulation removal areas) would need to be removed, followed by in-situ treatment, which would take approximately 12 to 18 months to implement this alternative, plus an additional 5 years of SVE operation and maintenance. A HASP with an air monitoring plan to prevent unacceptable exposure would be implemented, though it is assumed that use of the work zone and immediate vicinity would be restricted during excavation. Off-site disposal of the approximately 6,300 tons of removed materials (concrete, insulation, and soil/fill) and their replacement with backfill would be associated with approximately 225 trucks making round-trips.

Long-Term Effectiveness and Permanence

Alternative 5 would provide long-term effectiveness and permanence because the in-situ treatment is anticipated to remove contaminants remaining after the removal action. However, residual contamination in soil and insulation, which are not practically and feasibly accessible during removal and treatment, would likely remain.

Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 5 would significantly reduce contaminant mobility and volume, as a significant amount of the soil and insulation material with concentrations exceeding the SCOs would be removed and disposed of at a receiving facility with appropriate treatment and/or engineering controls to prevent contaminant migration. The contaminant toxicity would be reduced if materials containing VOCs were to be incinerated (however, this is unlikely). The toxicity and volume of contamination would be further reduced by both removing contaminants (LNAPL removal and SVE system) or destroying them (via soil or groundwater treatment). Contaminant toxicity in groundwater would be reduced through dechlorination and if vinyl chloride persists, an aerobic degradation product would be evaluated.

Implementability

The targeted areas for contaminated soil and insulation removal contemplated for Alternative 5 are located within the sidewalk with numerous utilities and a building constructed in phases with unknown foundation construction, which will significantly complicate the design and implementation of this alternative to ensure protection of the utilities and the structural integrity of the building. Implementation would require specialized construction procedures as removal of large portions of an existing building slab and subsequent excavation can be performed only with the most careful procedures to avoid structural damage. Because of the ceiling height, specialized equipment would be required in an attempt to reach the necessary excavation depths. The variable and discrete locations and depths of soil contamination throughout the northwestern portion of the site complicates targeting and removal even further. The construction issues and permits associated with this work could result in an extended timeframe; difficult engineering and approvals will be needed. Furthermore, a significant volume of soil and insulation is expected to be not practicably and feasibly accessible for removal due to structural and other considerations (e.g., utilities). Therefore, portions of the soil and insulation exceeding the SCOs would not be removed as part of this alternative.

The technology for the various treatment alternatives is readily available. The effectiveness of the treatment can be frequently determined in a short period of time (weeks or months), though careful monitoring would be required. Effective SVE requires appropriate spacing of the extraction points and flow rates sufficient to cover all areas between extraction points. They also require eliminating short-circuiting (e.g., due to cracks or penetrations in the slab). Given the unknown foundation design of the interconnected buildings, the likelihood that some desirable extraction point locations will not be acceptable because of utility or other conflicts, the presence of fill materials, and penetrations through the slab, implementing these systems will require careful design and installation. For example, it is possible that extraction point spacing may vary across the building and need to be evaluated and modified as the system is installed. Notwithstanding, with a conservative design and post-installation testing program, the design objectives for the SVE systems can be achieved.

Cost

The estimate cost for implementing Alternative 5 is approximately $5,103,000. Operation and maintenance costs on the order of $510,000 over 30 years would be associated with this Alternative.

5.6 Preferred Alternative

Alternative 1 is not considered a reasonable remedial option because it does not accomplish the remedial action goals of protection of public health and the environment. Alternative 5 provides greater reduction of contamination in soil, insulation, and groundwater, but includes significantly greater costs and does not protect of public health due to the lack of institutional and engineering controls. The off-site vapor intrusion assessment indicated that the site contamination does not appear to be affecting indoor air quality off-site. Groundwater sampling has indicated that the groundwater plume is limited in extent and has not traveled a significant distance (and not to the Harlem River).

Alternatives 2, 3 and 4 all accomplish the remedial action goals with implementation of an SMP. Because contamination would remain in the subsurface for a long period of time under Alternative 2, this option is not preferable. The $3,094,000 greater cost, less feasible implementability and greater time span of Alternative 3 (compared to Alternative 4) is not justified, particularly since it is likely that some portion of contaminated soil and/or insulation material would remain in place due to structural concerns with the existing site building, adjacent sidewalk and street and public utilities. Targeted removal of soil is also complicated, as the soil contamination was identified in variable, discrete areas and depths. Because of the relatively low contaminant levels in the additional targeted insulation removal area for Alternative 3 compared to Alternative 4, the incremental mass of PCE removed in the insulation for Alternative 3 would be negligible. Alternative 4 would address all areas with soil, insulation material, groundwater and soil vapor contamination, even with limitations, which would be overcome by conservative design and performance testing.

Alternative 4 was selected as the preferred remedial option because it is protective of the public health and environment, effective and permanent, easily implementable, and the toxicity and volume of contamination would be reduced over time. With implementation of an SMP and environmental easement, residual contamination would be addressed to ensure proper long-term protection of public health and the environment.

6.0 REFERENCES

1. NYSDEC, *DER-10 Technical Guidance for Site Investigation and Remediation*, Division of Environmental Remediation, May 2010.
2. AKRF, Inc., *Revised Draft Remedial Investigation Report*, April 2010.
3. AKRF, Inc., *Interim Remedial Measures Report*, September 1997.
4. NYSDEC, *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*, June 1998.
5. NYSDOH, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, October 2006.
6. NYSDOH, *2009-2010 Health Advisories: Chemicals in Sportfish and Game*, 2010.
7. 6 NYCRR Section 375-6: *Remedial Program Soil Cleanup Objectives (SCOs)*, December 14, 2006.
8. 6 NYCRR Section 703.5: *Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations*, July 16, 1999.
9. Viele, Egbert L., *Sanitary & Topographical Map of the City and Island of New York*, 1865.
10. U.S. Geological Survey *Central Park Quadrangle map*, 1995.

7.0 GLOSSARY OF TERMS

AKRF – AKRF Engineering, P.C. or AKRF, Inc.

DCE – dichloroethene

DER – NYSDEC Division of Environmental Remediation

EPA – United States Environmental Protection Agency

FS – Feasibility Study

HASP – Health and Safety Plan

HVAC – Heating Ventilation and Air Conditioning

IRM – Interim Remedial Measure

LNAPL – Light Non-Aqueous Phase Liquid

mcg/m^3 – micrograms per cubic meter

mg/kg – milligrams per kilogram

mg/l – milligrams per liter

MW – monitoring well

NYCRR – New York Codes, Rules and Regulations

NYSDEC – New York State Department of Environmental Conservation

NYSDOH – New York State Department of Health

OSHA – Occupational Safety and Health Administration

PCE – Tetrachloroethene

PCB – Polychlorinated Biphenyl

PID – photoionization detector

PPE – personal protective equipment

ppm – parts per million

QA/QC – Quality Assurance/Quality Control

RAO – Remedial Action Objective

RI – Remedial Investigation

RIR – Remedial Investigation Report

SCG – Standards, Criteria and Guidance

SCO –Soil Cleanup Objective

SCOPG – Soil Cleanup Objective for the Protection of Groundwater

SMP – Site Management Plan

SSDS - Sub-Slab Depressurization System

SVE – Soil Vapor Extraction

TCE – Trichloroethene

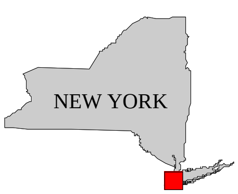
UST – underground storage tank

µg/m^3 – micrograms per cubic meter

µg/l – micrograms per liter

VOC – volatile organic compound

FIGURES



SCALE IN FEET

0’ 1000’ 2000’ 4000’

SCALE: 1”=2000’

N

SOURCE:
7.5 MINUTE SERIES USGS TOPOGRAPHIC MAP
QUADRANGLE: CENTRAL PARK, NY 1995

2350 FIFTH AVENUE
NEW YORK, NEW YORK

PROJECT SITE LOCATION

AKRF
Environmental Consultants
440 Park Avenue South, New York, N.Y. 10016

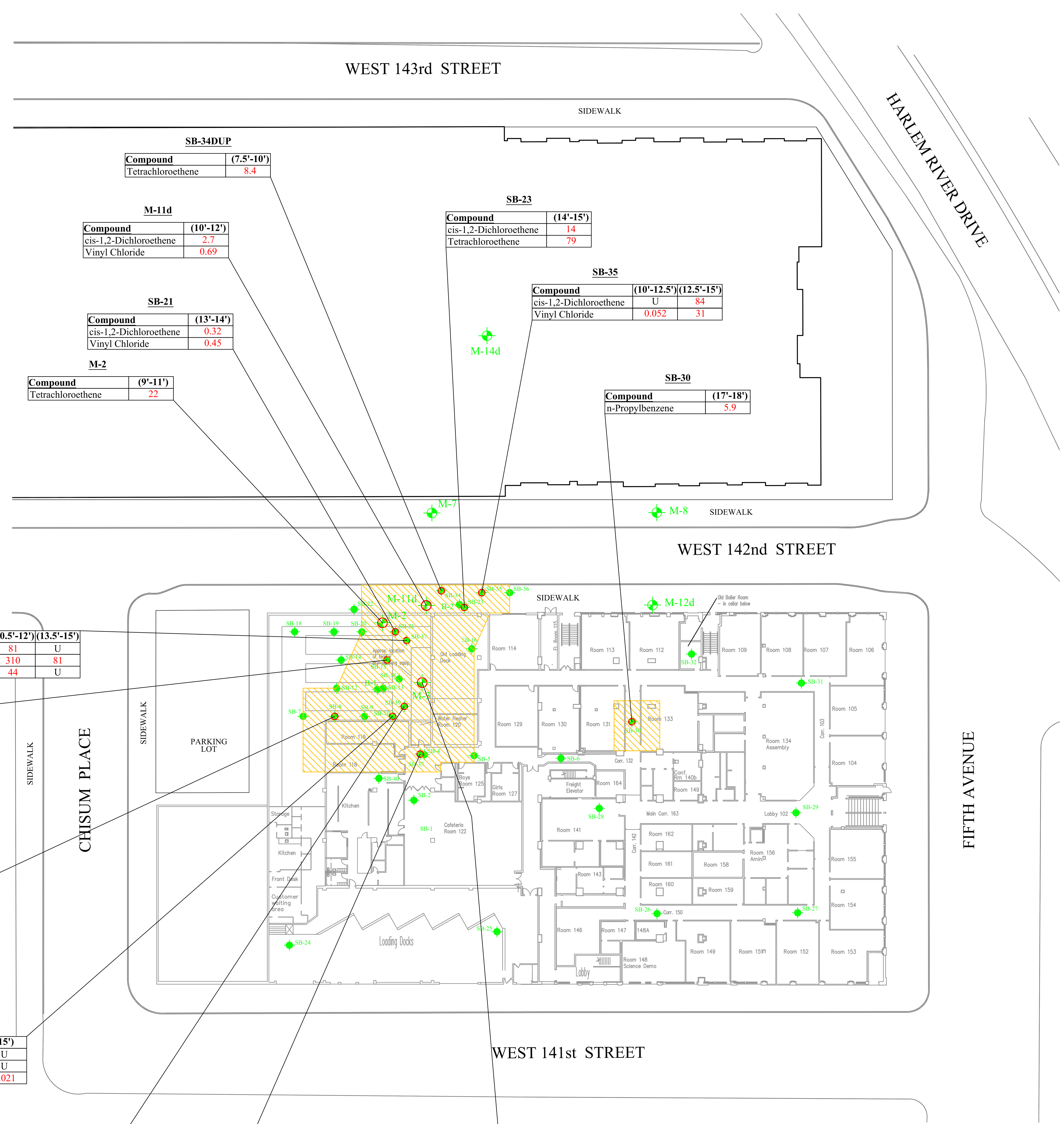
DATE	**4.16.10**
PROJECT No.	**08010**
SCALE	**as shown**
FIGURE	**1**

2350 FIFTH AVENUE
NEW YORK, NEW YORK

CURRENT SITE PLAN

AKRF
Environmental Consultants
440 Park Avenue South, New York, NY 10016

DATE 4.16.10
PROJECT NO. 08010
SCALE 1"30'
FIGURE 2



SB-34DUP

Compound	(7.5'-10')
Tetrachloroethene	8.4

M-11d

Compound	(10'-12')
cis-1,2-Dichloroethene	2.7
Vinyl Chloride	0.69

SB-21

Compound	(13'-14')
cis-1,2-Dichloroethene	0.32
Vinyl Chloride	0.45

M-2

Compound	(9'-11')
Tetrachloroethene	22

SB-23

Compound	(14'-15')
cis-1,2-Dichloroethene	14
Tetrachloroethene	79

SB-35

Compound	(10'-12.5')	(12.5'-15')
cis-1,2-Dichloroethene	U	84
Vinyl Chloride	0.052	31

SB-30

Compound	(17'-18')
n-Propylbenzene	5.9

SB-37

Compound	(4.5'-6')	(10.5'-12')	(13.5'-15')
cis-1,2-Dichloroethene	U	81	U
Tetrachloroethene	89	310	81
Trichloroethene	U	44	U

SB-15

Compound	(18')
cis-1,2-Dichloroethene	0.35
Vinyl Chloride	0.15

SB-8

Compound	(15'-16')
2-Butanone	0.13

SB-10

Compound	(8')	(15')
cis-1,2-Dichloroethene	0.3	U
Tetrachloroethene	27	U
Vinyl Chloride	U	0.021

SB-39

Compound	(10.5'-12')	(13.5'-15')
2-Butanone	U	0.12
Vinyl Chloride	0.021	U

SB-33

Compound	(6'-8')
Tetrachloroethene	920

M-3

Compound	(0.5'-2')	(3'-5')	(6'-8')	(8'-10')	(10'-12')
Tetrachloroethene	20	6.3	10	84	11
Vinyl Chloride	U	U	U	U	0.51

SYMBOL LEGEND:

M-8 MONITORING WELL LOCATION - COMPOUNDS NOT DETECTED ABOVE SCO

M-3 MONITORING WELL LOCATION - COMPOUNDS DETECTED ABOVE SCO

SB-16 SOIL BORING LOCATION - COMPOUNDS NOT DETECTED ABOVE SCO

SB-35 SOIL BORING LOCATION - COMPOUNDS DETECTED ABOVE SCO

SOIL WITH CONCENTRATIONS GREATER THAN SCOs FOR PROTECTION OF GROUNDWATER

10 COMPOUND DETECTED EXCEEDS SCO FOR PROTECTION OF GROUNDWATER

GENERAL NOTES:

1. BASE MAPS PROVIDED BY MONTROSE WITH LOCATIONS SURVEYED IN DEC 2006, JAN 2008 AND DEC 2009 OR MEASURED IN FIELD WITH TAPE MEASURE.

2. SOIL SAMPLES COLLECTED AS PART OF REMEDIAL INVESTIGATION ACTIVITIES PERFORMED IN JANUARY/FEBRUARY 1998, APRIL 2002, AUGUST/OCTOBER 2006, AND OCTOBER 2007 THROUGH DECEMBER 2009.

3. DATA ONLY SHOWN FOR SAMPLES AND DEPTHS WITH COMPOUNDS IN EXCEEDANCE OF NYSDEC PART 375 SOIL CLEANUP OBJECTIVES FOR PROTECTION OF GROUNDWATER.

4. CONCENTRATIONS SHOWN IN MILLIGRAMS PER KILOGRAM (mg/Kg).

5. EXCEEDANCES FOR ACETONE AND METHYLENE CHLORIDE ARE NOT SHOWN. DETECTIONS WITHIN METHOD BLANKS INDICATED THAT THESE COMPOUNDS ARE ATTRIBUTED TO SAMPLE PREPARATION IN THE LABORATORY, AND ARE NOT REPRESENTATIVE OF THE SITE SOIL.

0' 15' 30' 60'
SCALE IN FEET

AKRF
Environmental Consultants
440 Park Avenue South, New York, N.Y. 10016

2350 FIFTH AVENUE
NEW YORK, NEW YORK

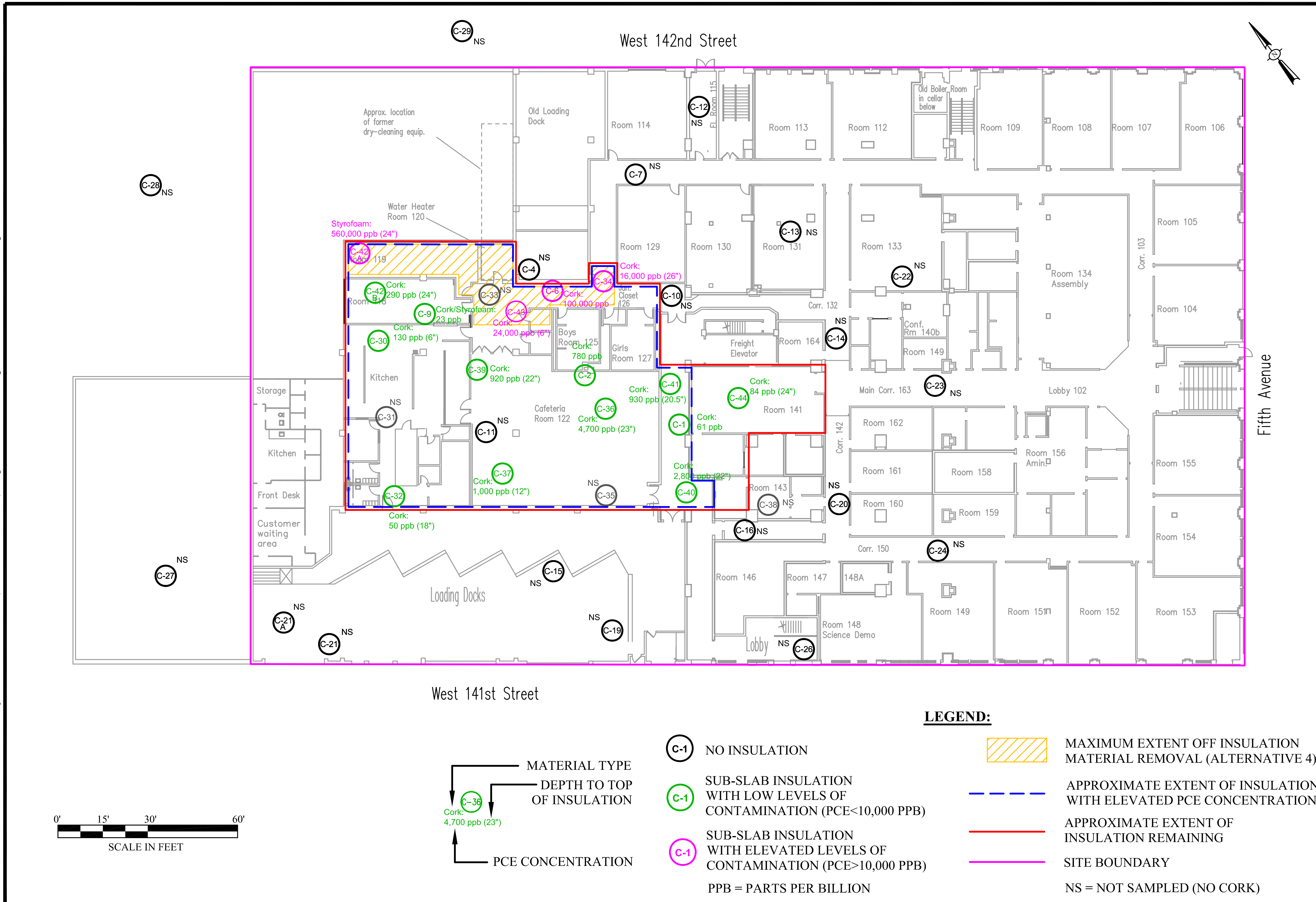
SOIL SAMPLES WITH COMPOUNDS EXCEEDING SOIL CLEANUP OBJECTIVES

DATE 5.21.10

SCALE as shown

PROJECT No. 08010

FIGURE 3



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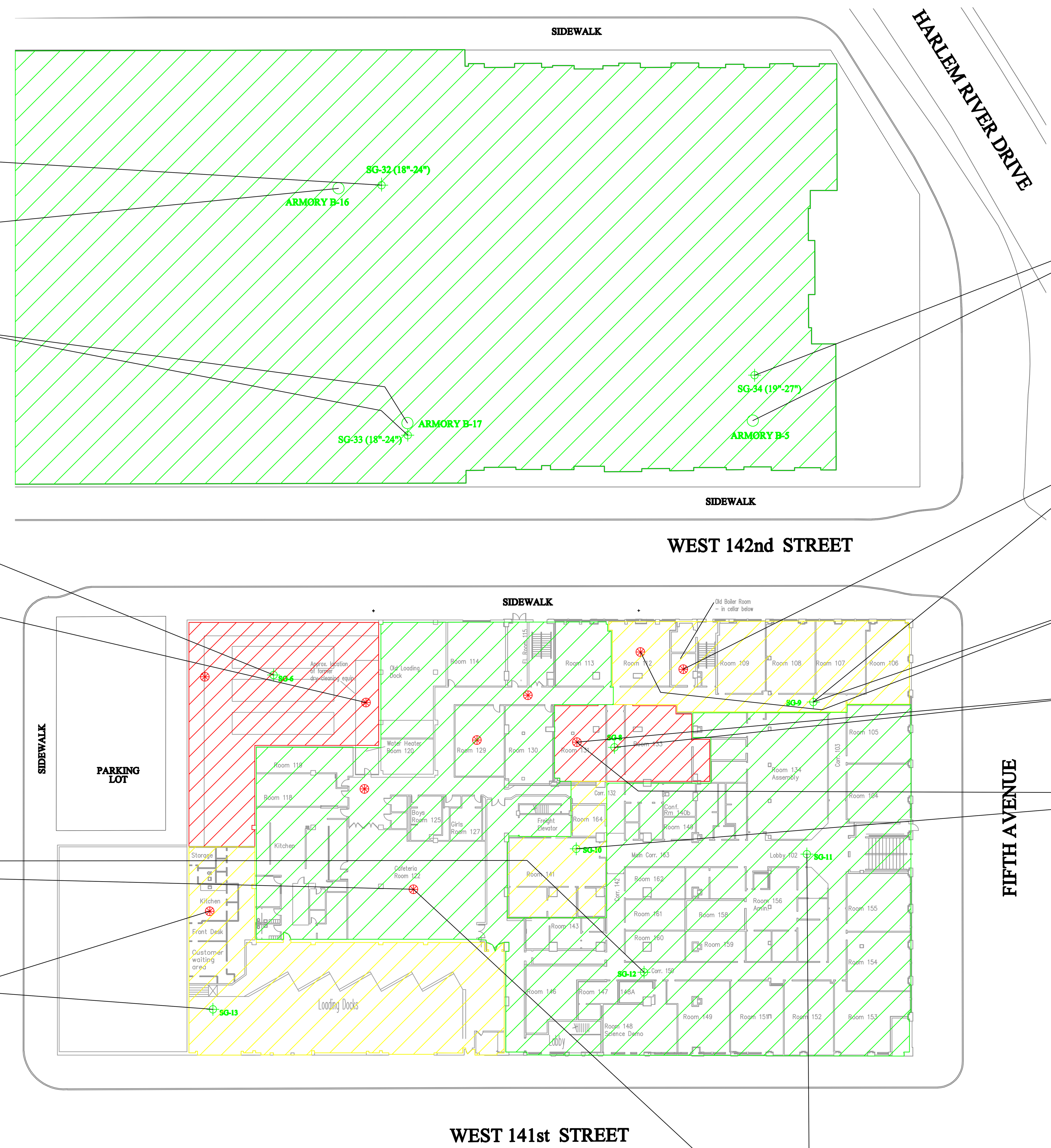
2350 FIFTH AVENUE, NEW YORK, NY
SUB-SLAB INSULATION MATERIAL SAMPLES AND PCE CONCENTRATIONS

DATE 03.07.2011

PROJECT NO. 08010

SCALE 1"=30'

FIGURE revised 4



	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-32	Armory B-16	
Tetrachloroethene ($\mu g/m^3$)	1.5	1.0	No Further Action
Trichloroethene ($\mu g/m^3$)	U	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-33	Armory B-17	
Tetrachloroethene ($\mu g/m^3$)	31	0.97	No Further Action
Trichloroethene ($\mu g/m^3$)	U	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-34	Armory B-5	
Tetrachloroethene ($\mu g/m^3$)	U	1.5	No Further Action
Trichloroethene ($\mu g/m^3$)	U	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-9	Basement/Boiler Rm	
Tetrachloroethene ($\mu g/m^3$)	300	8.2	Reduce Exposure/Monitor
Trichloroethene ($\mu g/m^3$)	0.94	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-6	Locker 1454	
Tetrachloroethene ($\mu g/m^3$)	180,000	3.7	Mitigate
Trichloroethene ($\mu g/m^3$)	81,000	U	Mitigate

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-9	Room 112	
Tetrachloroethene ($\mu g/m^3$)	300	1.5	Monitor
Trichloroethene ($\mu g/m^3$)	0.94	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-8	Room 131	
Tetrachloroethene ($\mu g/m^3$)	1,000	U	Mitigate
Trichloroethene ($\mu g/m^3$)	12	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-12	Cafeteria	
Tetrachloroethene ($\mu g/m^3$)	0.66	U	No Further Action
Trichloroethene ($\mu g/m^3$)	U	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-10	Room 131	
Tetrachloroethene ($\mu g/m^3$)	280	U	Monitor
Trichloroethene ($\mu g/m^3$)	21	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-13	Kitchen Sales Office	
Tetrachloroethene ($\mu g/m^3$)	480	0.97	Monitor
Trichloroethene ($\mu g/m^3$)	2.8	U	No Further Action

	Soil Vapor Sample Location	Indoor Air Sample Location	NYSDOH Matrix Recommendation
	SG-11	Cafeteria	
Tetrachloroethene ($\mu g/m^3$)	34	U	No Further Action
Trichloroethene ($\mu g/m^3$)	U	U	No Further Action

SYMBOL LEGEND:

SG-11 SOIL VAPOR SAMPLE LOCATION

INDOOR AIR SAMPLE LOCATION

GENERAL NOTES:

1. BASE MAPS PROVIDED BY MONTROSE WITH LOCATIONS SURVEYED IN DEC 2006, JAN 2008 AND DEC 2009 OR MEASURED IN FIELD WITH TAPE MEASURE.

2. SOIL VAPOR AND INDOOR AIR SAMPLES COLLECTED AS PART OF REMEDIAL INVESTIGATION ACTIVITIES PERFORMED IN NOVEMBER AND DECEMBER 2009.

3. COLOR CODING INDICATES RESULT OF NYSDOH MATRIX 1 AND MATRIX 2: RED SHADING INDICATES MITIGATE, YELLOW SHADING INDICATES MONITOR, AND GREEN SHADING INDICATES NO FURTHER ACTION.

4. CONCENTRATIONS SHOWN IN MICROGRAMS PER CUBIC METER OF AIR ($\mu g/m^3$).

5. EXCEEDANCES FOR ACETONE AND METHYLENE CHLORIDE ARE NOT SHOWN. DETECTIONS WITHIN METHOD BLANKS INDICATED THAT THESE COMPOUNDS ARE ATTRIBUTED TO SAMPLE PREPARATION IN THE LABORATORY, AND ARE NOT REPRESENTATIVE OF THE SITE.

0' 15' 30' 60'
SCALE IN FEET

AKRF
Environmental Consultants
440 Park Avenue South, New York, N.Y. 10016

2350 FIFTH AVENUE
NEW YORK, NEW YORK

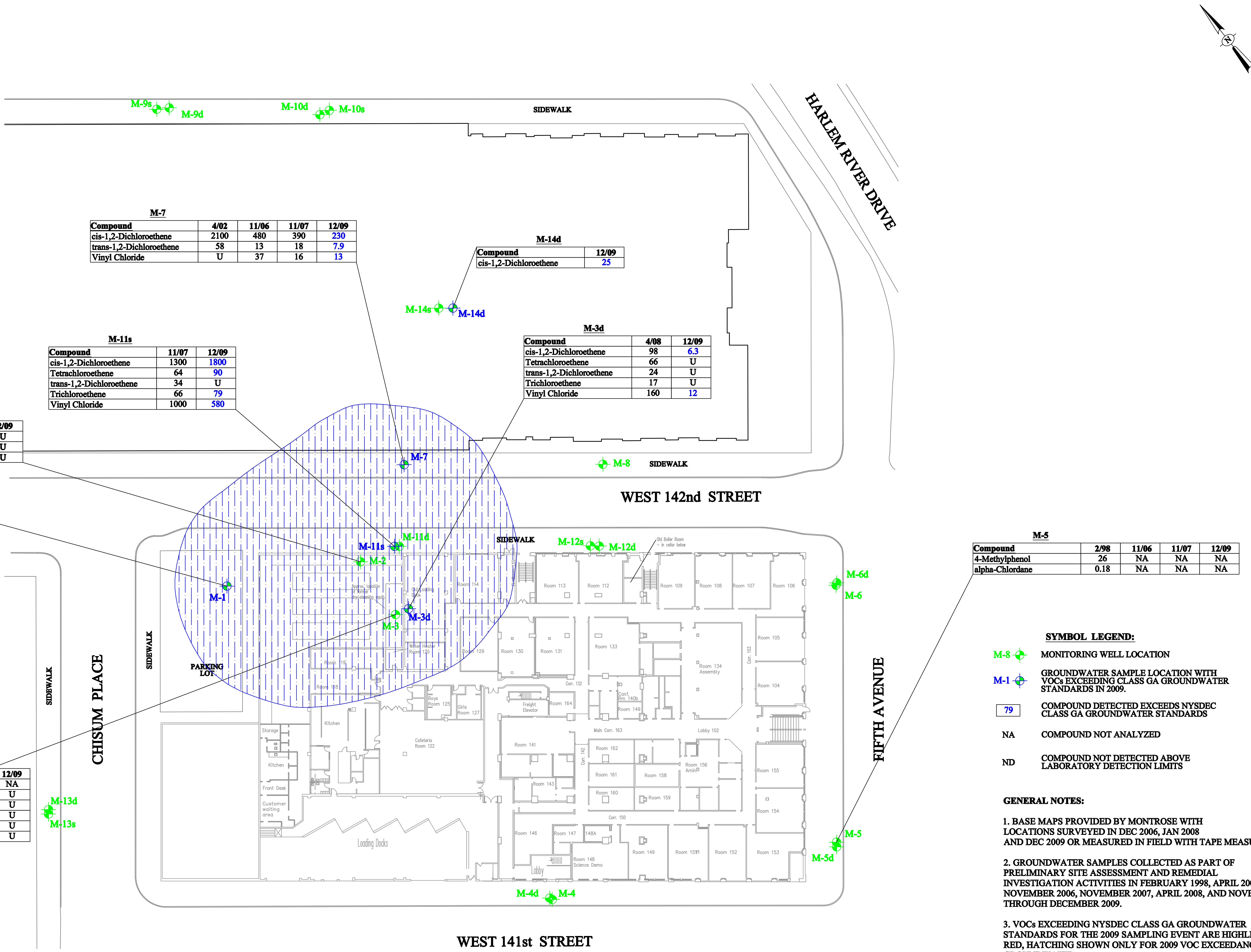
SOIL VAPOR AND INDOOR AIR SAMPLES APPLIED TO NYSDOH MATRICES

DATE
5.21.10

SCALE
as shown

PROJECT No.
08010

FIGURE
5



M-7

Compound	4/02	11/06	11/07	12/09
cis-1,2-Dichloroethene	2100	480	390	230
trans-1,2-Dichloroethene	58	13	18	7.9
Vinyl Chloride	U	37	16	13

M-14d

Compound	12/09
cis-1,2-Dichloroethene	25

M-11s

Compound	11/07	12/09
cis-1,2-Dichloroethene	1300	1800
Tetrachloroethene	64	90
trans-1,2-Dichloroethene	34	U
Trichloroethene	66	79
Vinyl Chloride	1000	580

M-3d

Compound	4/08	12/09
cis-1,2-Dichloroethene	98	6.3
Tetrachloroethene	66	U
trans-1,2-Dichloroethene	24	U
Trichloroethene	17	U
Vinyl Chloride	160	12

M-2

Compound	2/98	4/02	11/06	11/07	12/09
1,2-Dichloroethene(Total)	7	U	U	0.85	U
Tetrachloroethene	48	U	U	0.74	U
Vinyl Chloride	180	13	U	1.6	U

M-1

Compound	2/98	11/06	11/07	12/09
Benzene	18	U	U	U
Toluene	8	U	U	U
Xylenes (Total)	16	U	NA	U
Tetrachloroethene	U	U	U	7.9

M-5

Compound	2/98	11/06	11/07	12/09
4-Methylphenol	26	NA	NA	NA
alpha-Chlordane	0.18	NA	NA	NA

M-3

Compound	2/98	4/02	11/06	11/07	12/09
1,2-Dichloroethene (Total)	180	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	490	7.3	13	U
trans-1,2-Dichloroethene	NA	77	U	U	U
Tetrachloroethene	800	75	12	30	U
Trichloroethene	56	6	U	U	U
Vinyl Chloride	71	200	13	18	U

SYMBOL LEGEND:

M-8 — MONITORING WELL LOCATION

M-1 — GROUNDWATER SAMPLE LOCATION WITH VOCs EXCEEDING CLASS GA GROUNDWATER STANDARDS IN 2009.

79 — COMPOUND DETECTED EXCEEDS NYSDEC CLASS GA GROUNDWATER STANDARDS

NA — COMPOUND NOT ANALYZED

ND — COMPOUND NOT DETECTED ABOVE LABORATORY DETECTION LIMITS

GENERAL NOTES:

1. BASE MAPS PROVIDED BY MONTROSE WITH LOCATIONS SURVEYED IN DEC 2006, JAN 2008 AND DEC 2009 OR MEASURED IN FIELD WITH TAPE MEASURE.

2. GROUNDWATER SAMPLES COLLECTED AS PART OF PRELIMINARY SITE ASSESSMENT AND REMEDIAL INVESTIGATION ACTIVITIES IN FEBRUARY 1998, APRIL 2002, NOVEMBER 2006, NOVEMBER 2007, APRIL 2008, AND NOVEMBER THROUGH DECEMBER 2009.

3. VOCs EXCEEDING NYSDEC CLASS GA GROUNDWATER STANDARDS FOR THE 2009 SAMPLING EVENT ARE HIGHLITED IN RED, HATCHING SHOWN ONLY FOR 2009 VOC EXCEEDANCES IN GROUNDWATER.

4. CONCENTRATIONS SHOWN IN MICROGRAMS PER LITER (μg/L).

5. EXCEEDANCES FOR ACETONE AND METHYLENE CHLORIDE ARE NOT SHOWN. DETECTIONS WITHIN METHOD BLANKS INDICATED THAT THESE COMPOUNDS ARE ATTRIBUTED TO SAMPLE PREPARATION IN THE LABORATORY, AND ARE NOT REPRESENTATIVE OF THE SITE GROUNDWATER.

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2350 FIFTH AVENUE
NEW YORK, NEW YORK

GROUNDWATER SAMPLES WITH VOCs EXCEEDING CLASS GA STANDARDS

DATE 5.21.10

SCALE as shown

PROJECT No. 08010

FIGURE 6

Appendix A

Estimated Remediation Costs

Appendix A-1
Summary of Costs for Remedial Alternatives
2350 Fifth Avenue, New York, New York

Remedial Alternatives	Description	Capital Costs	Engineering & Expenses	Operation & Maintenance Costs	Total
Alternative 1 - No Further Action					
S1	No Further Action	$0	$0	$0	$0
G1	No Further Action	$0	$0	$0	$0
I1	No Further Action	$0	$0	$0	$0
V1	No Further Action	$0	$0	$0	$0
	Total	**$0**	**$0**	**$0**	**$0**
Alternative 2 - Exposure Reduction					
S1	No Further Action	$0	$0	$0	$0
G1	No Further Action	$0	$0	$0	$0
I1	No Further Action	$0	$0	$0	$0
V2	HVAC System - Positive Pressure	$144,000	$12,000	$290,640	$446,640
	Total	**$144,000**	**$12,000**	**$290,640**	**$446,640**
Alternative 3 - Soil and Insulation Material Removal					
S4	Soil Removal	$2,641,200	$364,800	$0	$3,006,000
G1	No Further Action	$0	$0	$0	$0
I2A (Full)	Insulation Removal (7,400 sf area)	$1,120,800	$182,400	$0	$1,303,200
V2	HVAC System - Positive Pressure	$144,000	$12,000	$290,640	$446,640
	Total	**$3,906,000**	**$559,200**	**$290,640**	**$4,755,840**
Alternative 4 - Treatment and Partial Insulation Removal					
S2	Soil Vapor Extraction	$174,000	$60,960	$221,040	$456,000
S3	Chemical Oxidation	$124,500	$39,600	$0	$164,100
G2	In-Situ Treatment	$219,000	$39,600	$133,560	$392,160
G3	NAPL Recovery	$27,000	$19,200	$154,920	$201,120
I3/V3	Subslab Depressurization System	$183,600	$55,440	$825,840	$1,064,880
I2B (Partial)	Insulation Removal (1,200 sf area)	$327,600	$100,800	$0	$428,400
	Total	**$1,055,700**	**$315,600**	**$1,335,360**	**$2,706,660**
Alternative 5 - Soil and Insulation Material Removal Plus Treatment					
S2	Soil Vapor Extraction	$174,000	$60,960	$221,040	$456,000
S3	Chemical Oxidation	$124,500	$39,600	$0	$164,100
S4	Soil Removal	$2,641,200	$364,800	$0	$3,006,000
G2	In-Situ Treatment	$219,000	$39,600	$133,560	$392,160
G3	NAPL Recovery	$27,000	$19,200	$154,920	$201,120
I2A (Full)	Insulation Removal (7,400 sf area)	$1,120,800	$182,400	$0	$1,303,200
	Total	**$4,306,500**	**$706,560**	**$509,520**	**$5,522,580**

Appendix A-2
Soil Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
S2 - Soil Vapor Extraction								
Capital Costs								
Mobilization	1	LS	10000	$10,000			$2,000	**$12,000**
Well installation	10	per well	2500	$25,000			$5,000	**$30,000**
Trenching, Piping & Restoration	1	LS	75000	$75,000			$15,000	**$90,000**
Blower Package & Carbon Units	1	LS	30000	$30,000			$6,000	**$36,000**
Electrical	1	LS	5000	$5,000			$1,000	**$6,000**
Subtotal				**$145,000**			**$29,000**	**$174,000**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	25000	$25,000			$5,000	**$30,000**
Field Oversight & Start-up	20	days	1200	$24,000			$4,800	**$28,800**
Laboratory (TO-15)	6	samples	300	$1,800			$360	**$2,160**
Subtotal				**$50,800**			**$10,160**	**$60,960**
Annual O&M Costs								
Carbon Replacement	1	LS	10000	$10,000	5	$44,500	$8,900	**$53,400**
Electricity (7.5HP blower)	49275	per KW-hr	0.15	$7,400	5	$32,900	$6,580	**$39,480**
Inspection, Maintenance & Monitoring	12	months	2000	$24,000	5	$106,800	$21,360	**$128,160**
Subtotal				**$41,400**		**$184,200**	**$36,840**	**$221,040**
				Total S2 - Soil Vapor Extraction				**$456,000**

Appendix A-2
Soil Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
S3 - Chemical Oxidation								
Capital Costs								
Mobilization	1	LS	10000	$10,000			$2,000	**$12,000**
Well Installation	25	per well	750	$18,750			$3,750	**$22,500**
Chemical injection	1	LS	60000	$75,000			$15,000	**$90,000**
Subtotal				**$103,750**			**$20,750**	**$124,500**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	15000	$15,000			$3,000	**$18,000**
Field Oversight & Start-up	15	days	1200	$18,000			$3,600	**$21,600**
Subtotal				**$33,000**			**$6,600**	**$39,600**
Annual O&M Costs								
Subtotal				**$0**	**0**	**$0**	**$0**	**$0**
				Subtotal S3 - Chemical Oxidation				**$164,100**

Appendix A-2
Soil Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
S4 - Soil Removal and Off-Site Disposal								
Capital Costs								
Mobilization & General Conditions	1	LS	150000	$150,000			$30,000	**$180,000**
Asbestos Abatement	1	LS	100000	$100,000			$20,000	**$120,000**
Utility Relocation/Repair/Protection	1	LS	50000	$50,000			$10,000	**$60,000**
Demolition	1	LS	125000	$125,000			$25,000	**$150,000**
Underpinning	1	LS	250000	$250,000			$50,000	**$300,000**
Shoring & Excavation	1100	CY	500	$550,000			$110,000	**$660,000**
Backfill & Compaction	1100	CY	60	$66,000			$13,200	**$79,200**
Containment/HVAC	1	LS	200000	$200,000			$40,000	**$240,000**
Soil Loading & Disposal	1700	tons	300	$510,000			$102,000	**$612,000**
Restoration	1	LS	200000	$200,000			$40,000	**$240,000**
Subtotal				**$2,201,000**			**$440,200**	**$2,641,200**
Engineering & Expenses								
Geotechnical/Structural Design	1	LS	10000	$10,000			$2,000	**$12,000**
Remedial Design, Coordination & Reporting	1	LS	100000	$100,000			$20,000	**$120,000**
Air Monitoring Equipment	6	months	10000	$60,000			$12,000	**$72,000**
Field Oversight	120	days	1200	$144,000			$28,800	**$172,800**
Laboratory	1	LS	10000	$10,000			$2,000	**$12,000**
Subtotal				**$324,000**			**$60,800**	**$364,800**
Annual O&M Costs								
Subtotal				**$0**	**0**	**$0**	**$0**	**$0**
				Subtotal S4 - Soil Removal				**$3,006,000**

Notes:
Total O&M Costs based upon specified years of O&M and discount rate of 4%
Electricity consumption based on $0.15 per kw-hr

Appendix A-3
Groundwater Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
G2 - Groundwater In-Situ Treatment (Reductive Dechlorination & Supplemental Aerobic Treatment)								
Capital Costs								
Mobilization	4	LS	5000	$20,000			$4,000	**$24,000**
Well Installation	15	wells	1500	$22,500			$4,500	**$27,000**
Chemical injection	2	events	50000	$100,000			$20,000	**$120,000**
ORC injection	2	events	20000	$40,000			$8,000	**$48,000**
Subtotal				**$182,500**			**$36,500**	**$219,000**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	15000	$15,000			$3,000	**$18,000**
Field Oversight & Start-up	15	days	1200	$18,000			$3,600	**$21,600**
Subtotal				**$33,000**			**$6,600**	**$39,600**
Annual O&M Costs								
Groundwater Monitoring	1	LS	20000	$20,000	5	$89,000	$17,800	**$106,800**
Reporting	1	LS	5000	$5,000	5	$22,300	$4,460	**$26,760**
Subtotal				**$25,000**		**$111,300**	**$22,260**	**$133,560**
				Subtotal G2 - Groundwater In-Situ Treatment				**$392,160**

Appendix A-3
Groundwater Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
G3 - NAPL Recovery								
Capital Costs								
Mobilization	1	LS	2500	$2,500			$500	**$3,000**
Well Installation	5	wells	4000	$20,000			$4,000	**$24,000**
Subtotal				**$22,500**			**$4,500**	**$27,000**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	10000	$10,000			$2,000	**$12,000**
Field Oversight & Start-up	5	days	1200	$6,000			$1,200	**$7,200**
Subtotal				**$16,000**			**$3,200**	**$19,200**
Annual O&M Costs								
Well Gauging & Product Recovery	12	months	2000	$24,000	5	$106,800	$21,360	**$128,160**
Reporting	1	LS	5000	$5,000	5	$22,300	$4,460	**$26,760**
Subtotal				**$29,000**		**$129,100**	**$25,820**	**$154,920**
					Subtotal G3 - NAPL Recovery			**$201,120**

Notes:
Total O&M Costs based upon specified years of O&M and discount rate of 4%

Appendix A-4
Insulation Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
I2A - Insulation Removal and Off-Site Disposal (Full Removal - 7,400 square foot area)								
Capital Costs								
Mobilization & General Conditions	1	LS	75000	$75,000			$15,000	**$90,000**
Asbestos Abatement	1	LS	50000	$50,000			$10,000	**$60,000**
Utility Relocation/Repair	1	LS	25000	$25,000			$5,000	**$30,000**
Demolition	1	LS	100000	$100,000			$20,000	**$120,000**
Floor & Cork Removal	690	CY	500	$345,000			$69,000	**$414,000**
Backfill & Compaction	550	CY	60	$33,000			$6,600	**$39,600**
Containment/HVAC	1	LS	50000	$50,000			$10,000	**$60,000**
Loading & Disposal	520	tons	300	$156,000			$31,200	**$187,200**
Restoration	1	LS	100000	$100,000			$20,000	**$120,000**
Subtotal				**$934,000**			**$186,800**	**$1,120,800**
Engineering & Expenses								
Geotechnical/Structural Design	1	LS	10000	$10,000			$2,000	**$12,000**
Remedial Design, Coordination & Reporting	1	LS	50000	$50,000			$10,000	**$60,000**
Air Monitoring Equipment	3	months	10000	$30,000			$6,000	**$36,000**
Field Oversight & Start-up	60	days	1200	$72,000			$14,400	**$86,400**
Laboratory	1	LS	7500	$7,500			$1,500	**$9,000**
Subtotal				**$169,500**			**$30,400**	**$182,400**
Annual O&M Costs								
Subtotal				**$0**	**0**	**$0**	**$0**	**$0**
		Subtotal I2A - Insulation Removal (Full Removal - 7,400 square foot area)						**$1,303,200**

Appendix A-4
Insulation Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
I2B - Insulation Removal and Off-Site Disposal (Partial Removal - max. 1,200 square foot area)								
Capital Costs								
Mobilization & General Conditions	1	LS	50000	$50,000			$10,000	**$60,000**
Asbestos Abatement	1	LS	30000	$30,000			$6,000	**$36,000**
Utility Relocation/Repair	1	LS	10000	$10,000			$2,000	**$12,000**
Demolition	1	LS	30000	$30,000			$6,000	**$36,000**
Floor & Cork Removal	120	CY	500	$60,000			$12,000	**$72,000**
Backfill & Compaction	100	CY	60	$6,000			$1,200	**$7,200**
Containment/HVAC	1	LS	30000	$30,000			$6,000	**$36,000**
Loading & Disposal	90	tons	300	$27,000			$5,400	**$32,400**
Restoration	1	LS	30000	$30,000			$6,000	**$36,000**
Subtotal				**$273,000**			**$54,600**	**$327,600**
Engineering & Expenses								
Geotechnical/Structural Design	1	LS	5000	$5,000			$1,000	**$6,000**
Remedial Design, Coordination & Reporting	1	LS	50000	$50,000			$10,000	**$60,000**
Air Monitoring Equipment	1	month	10000	$10,000			$2,000	**$12,000**
Field Oversight & Start-up	20	days	1200	$24,000			$4,800	**$28,800**
Laboratory	1	LS	5000	$5,000			$1,000	**$6,000**
Subtotal				**$94,000**			**$16,800**	**$100,800**
Annual O&M Costs								
Subtotal				**$0**	**0**	**$0**	**$0**	**$0**
	Subtotal I2B - Insulation Removal (Partial Removal - max. 1,200 square foot area)							**$428,400**

Appendix A-4
Insulation Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
I3 - Subslab Depressurization System								
Capital Costs								
Mobilization	1	LS	10000	$10,000			$2,000	**$12,000**
Suction Pit Installation	14	zones	2500	$35,000			$7,000	**$42,000**
Piping & Restoration	14	zones	2500	$35,000			$7,000	**$42,000**
Blower Package (1HP)	14	zones	3500	$49,000			$9,800	**$58,800**
Carbon Units	4	zones	2500	$10,000			$2,000	**$12,000**
Electrical	14	zones	1000	$14,000			$2,800	**$16,800**
Subtotal				**$153,000**			**$30,600**	**$183,600**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	15000	$15,000			$3,000	**$18,000**
Field Oversight & Start-up	20	days	1200	$24,000			$4,800	**$28,800**
Laboratory (TO-15)	24	samples	300	$7,200			$1,440	**$8,640**
Subtotal				**$46,200**			**$9,240**	**$55,440**
Annual O&M Costs								
Carbon Replacement	2	change-outs	4000	$8,000	30	$138,300	$27,660	**$165,960**
Electricity (14 x 1.0 HP blower)	91980	per KW-hr	0.15	$13,800	30	$238,600	$47,720	**$286,320**
Inspection, Maintenance & Monitoring	12	months	1500	$18,000	30	$311,300	$62,260	**$373,560**
Subtotal				**$39,800**		**$688,200**	**$137,640**	**$825,840**
				Total I3 - Subslab Depressurization System				**$1,064,880**

Notes:
Total O&M Costs based upon specified years of O&M and discount rate of 4%
Electricity consumption based on $0.15 per kw-hr

Appendix A-5
Soil Gas Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
V2 - HVAC Operation Under Positive Pressure								
Capital Costs								
HVAC System Additions/Modifications	1	LS	100000	$100,000			$20,000	**$120,000**
HVAC System Adjustments	1	LS	20000	$20,000			$4,000	**$24,000**
Subtotal				**$120,000**			**$24,000**	**$144,000**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	10000	$10,000			$2,000	**$12,000**
Subtotal				**$10,000**			**$2,000**	**$12,000**
Annual O&M Costs								
Inspection & Monitoring	4	quarters	1000	$4,000	30	$69,200	$13,840	**$83,040**
HVAC System Adjustments	1	LS	5000	$5,000	30	$86,500	$17,300	**$103,800**
Reporting	1	LS	5000	$5,000	30	$86,500	$17,300	**$103,800**
Subtotal				**$14,000**		**$242,200**	**$48,440**	**$290,640**
Subtotal V2 - HVAC System Operation Under Positive Pressure								**$446,640**

Appendix A-5
Soil Gas Remedial Alternatives
2350 Fifth Avenue, New York, New York

Description	Quantity	Units	Unit Price	Cost	# Years	Total O&M Cost (NPV)	Contingency (20%)	Total
V3 - Subslab Depressurization System								
Capital Costs								
Mobilization	1	LS	10000	$10,000			$2,000	**$12,000**
Suction Pit Installation	14	zones	2500	$35,000			$7,000	**$42,000**
Piping & Restoration	14	zones	2500	$35,000			$7,000	**$42,000**
Blower Package (1HP)	14	zones	3500	$49,000			$9,800	**$58,800**
Carbon Units	4	zones	2500	$10,000			$2,000	**$12,000**
Electrical	14	zones	1000	$14,000			$2,800	**$16,800**
Subtotal				**$153,000**			**$30,600**	**$183,600**
Engineering & Expenses								
Design, Coordination & Reporting	1	LS	15000	$15,000			$3,000	**$18,000**
Field Oversight & Start-up	20	days	1200	$24,000			$4,800	**$28,800**
Laboratory (TO-15)	24	samples	300	$7,200			$1,440	**$8,640**
Subtotal				**$46,200**			**$9,240**	**$55,440**
Annual O&M Costs								
Carbon Replacement	2	change-outs	4000	$8,000	30	$138,300	$27,660	**$165,960**
Electricity (14 x 1.0 HP blower)	91980	per KW-hr	0.15	$13,800	30	$238,600	$47,720	**$286,320**
Inspection, Maintenance & Monitoring	12	months	1500	$18,000	30	$311,300	$62,260	**$373,560**
Subtotal				**$39,800**		**$688,200**	**$137,640**	**$825,840**
				Total V3 - Subslab Depressurization System				**$1,064,880**

Notes:
Total O&M Costs based upon specified years of O&M and discount rate of 4%
Electricity consumption based on $0.15 per kw-hr

APPENDIX B

CONTAMINANT MASS CALCULATIONS, SUB-SLAB INSULATION MATERIAL

Appendix B
PCE Contaminant Mass Calculations, Sub-Slab Insulation Material
2350 Fifth Avenue, New York, New York

Sample ID	PCE (µg/Kg)	Bulk Density(ρ)		Dimensions (ft)			Area (sq ft)	Total PCE (grams)	% of PCE removed
		g/cm^3	Method	L	W	H			
C-42A(2'-2.5')	**560,000**	**0.275**	**Avg**	**11**	**36**	**0.50**	**396**	**862.92**	**80.23%**
C-43(1-2)	**24,000**	**0.275**	**Avg**	**26**	**22**	**1.04**	**572**	**111.29**	**10.35%**
C-6	**100,000**	**0.275**	**Avg**	**8**	**14**	**0.75**	**112**	**65.37**	**6.08%**
C-34(2-3)	**16,000**	**0.275**	**Avg**	**13**	**8**	**0.83**	**104**	**10.79**	**1.00%**
C-42B(2'-2.5')	290	0.275	Avg	12	35	0.79	420	0.75	0.07%
C-9	23	0.275	Avg	22	15	0.92	330	0.05	0.01%
C-30(0.5-1.5')	130	0.275	Avg	22	20	0.83	440	0.37	0.03%
C-31 - No insulation		0	NA	24	35	0.00	840	0.00	0.00%
C-32(1.5-2.5)	150	0.275	Avg	17	35	0.83	595	0.58	0.05%
C-4 - No insulation		0	NA	0	0	0.00	0	0.00	0.00%
C-33 - No insulation		0	NA	0	0	0.00	0	0.00	0.00%
C-39(1.5'-2.5')	920	0.275	Avg	23	35	0.50	805	2.88	0.27%
C-11 - No insulation		0	NA	15	30	0.00	450	0.00	0.00%
C-37(1'-2')	1,000	0.275	Avg	20	30	0.92	600	4.28	0.40%
C-2 - No insulation		0	NA	19	33	0.00	627	0.00	0.00%
C-36(1.5-2.5)	4,700	0.275	Avg	22	30	0.50	660	12.07	1.12%
C-35 - No insulation		0	NA	17	30	0.00	510	0.00	0.00%
C-10 - No insulation		0	NA	0	0	0.00	0	0.00	0.00%
C-41(1.5'-2.5')	930	0.275	Avg	15	22	0.50	330	1.19	0.11%
C-1	61	0.275	Avg	15	27	0.75	405	0.14	0.01%
C-40(1.5'-2.5')	2,800	0.09	Lab	15	35	0.58	525	2.18	0.20%
C-44(2-3)	84	0.46	Lab	23	35	0.79	805	0.70	0.06%

Notes:

The maximum sub-slab insulation removal area is represented by the first four samples: C-42A, C-43, C-6 and C-34.
Thickness of insulation layer (H) is based on observed recovery documented in the boring log.
Samples from 1997 (C-1 to C-29) and 2009 (C-30 to C-44) are given equivalent consideration.
Cores where no insulation material was found are generally given equivalent consideration (in sq. ft.) when surrounded by cores where insulation was present (C-31, C-11 and C-35).
Dimensions are averaged for irregularly shaped areas for a resulting total square footage representative of the polygon.
Contaminant mass and volume presented in RIR were based on averages, not individually characterized areas as presented above.