

Prepared for:
Consolidated Edison
New York, New York


Alternatives Analysis Report
Consolidated Edison, Former MGP
East 115th Street, New York, New York
NYSDEC Site #V00540-2

AECOM, Inc. (formerly ENSR Corporation)
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Contents

| | |
|---|------------|
| 1.0 Introduction..... | 1-1 |
| 1.1 Project Background..... | 1-1 |
| 1.2 Site Description | 1-1 |
| 1.3 Site Topography and Drainage..... | 1-1 |
| 1.4 Site Geology and Hydrogeology..... | 1-2 |
| 1.4.1 Site Geology | 1-2 |
| 1.4.2 Harlem River Geology | 1-3 |
| 1.4.3 Site Hydrogeology | 1-3 |
| 1.5 Summary of Site Investigations | 1-4 |
| 1.6 RI Results | 1-4 |
| 2.0 Exposure Assessment | 2-1 |
| 2.1 Potentially Exposed Populations | 2-1 |
| 2.2 Potential Exposure Pathways | 2-1 |
| 2.3 Contaminant Fate and Transport..... | 2-2 |
| 3.0 Remedial Goals, Remedial Action Objectives, and SCGs..... | 3-1 |
| 3.1 Remedial Goals..... | 3-1 |
| 3.2 Remedial Action Objectives | 3-1 |
| 3.3 Applicable Standards, Criteria and Guidance Values..... | 3-2 |
| 3.3.1 Soil..... | 3-2 |
| 3.3.2 Groundwater | 3-3 |
| 3.3.3 Sediments | 3-3 |
| 4.0 Development of Remedial Action Alternatives | 4-1 |
| 4.1 Introduction | 4-1 |
| 4.2 Impacted Soil and Groundwater | 4-4 |
| 4.2.1 Alternative 1 - No Action..... | 4-6 |
| 4.2.2 Alternative 2 - In-Situ Thermal Treatment (ITT)/NAPL Recovery | 4-7 |
| 4.2.3 Alternative 3 - In-Situ Chemical Oxidation, Surfactant Flushing, and Biodegradation (Chemical Treatment)..... | 4-11 |
| 4.2.4 Alternative 4a - Excavation and Off-Site Disposal of Source Material Under School Building..... | 4-14 |
| 4.2.5 Alternative 4b - Excavation and Off-site Disposal Outside of School Building..... | 4-17 |
| 4.2.6 Alternative 5 – In-Situ Stabilization (ISS) for Area Outside the Building..... | 4-20 |
| 4.2.7 Alternative 6 – Barrier Wall and NAPL Recovery System Downgradient Property Boundary (outside building, along FDR Drive) | 4-24 |
| 4.2.8 Alternative 7 - Recovery Wells/Trenches..... | 4-27 |

| | | |
|------------|---|------------|
| 4.2.9 | Alternative 8 - Physical Barriers with Pumping for Hydraulic Control (360 Degree Complete Containment Wall) | 4-29 |
| 4.2.10 | Alternative 9 – Permeable Reactive Barrier..... | 4-33 |
| 4.3 | Impacted Subsurface Vapors | 4-37 |
| 4.3.1 | Alternative 1 - No Action..... | 4-38 |
| 4.3.2 | Alternative 2 - Monitoring..... | 4-39 |
| 4.3.3 | Alternative 3 - Passive Venting | 4-40 |
| 4.3.4 | Alternative 4 - Active Venting | 4-42 |
| 4.3.5 | Alternative 5 - Vapor Barriers..... | 4-44 |
| 4.4 | Impacted Sediments in the Harlem River..... | 4-45 |
| 4.4.1 | No Action..... | 4-47 |
| 4.4.2 | Institutional Controls | 4-48 |
| 4.4.3 | Institutional Controls and Monitored Natural Recovery (MNR)..... | 4-50 |
| 4.4.4 | Dredging..... | 4-53 |
| 5.0 | Comparative Analysis of Remedial Alternatives and Proposed Site Remedy | 5-1 |
| 5.1 | Comparative Analysis of Remedial Alternatives | 5-1 |
| 5.1.1 | Comparison of Remedial Alternatives for Soil and Groundwater | 5-1 |
| 5.1.2 | Comparison of Alternatives for Impacted Vapors Beneath the School Building | 5-2 |
| 5.1.3 | Comparison of Alternatives for Sediments | 5-3 |
| 5.1.4 | Preferred Remedy | 5-3 |
| 6.0 | References | 6-1 |

List of Appendices

| | |
|------------|---|
| Appendix A | Pilot Study Work Plan Former East 115th Street Station Manufactured Gas Plant (MGP) NYSDEC VCA Site No. V00540-2 |
|------------|---|

List of Tables

| | |
|------------|--|
| Table 3-1 | NYSDEC Recommended Soil Clean-Up Objectives for Detected Constituents |
| Table 3-2 | Water Quality Standards for Detected Constituents in Groundwater |
| Table 3-3a | NYSDEC Sediment Screening Criteria (SSC) for Non-Polar Organic Compounds |
| Table 3-3b | NYSDEC Sediment Screening Criteria (SSC) for Metals |
| Table 4-1 | Soil Data Summary near MGP Features |
| Table 5-1 | Comparison of Alternatives for Soil and Groundwater |
| Table 5-2 | Comparison of Alternatives for Impacted Vapors underneath the Building |
| Table 5-3 | Comparison of Alternatives for Impacted Sediments |

List of Figures

| | |
|------------|--|
| Figure 1-1 | Site Location Map |
| Figure 1-2 | Historic Site Features |
| Figure 1-3 | Sediment Core Cross Section A-A' |
| Figure 1-4 | Cross Section B-B' |
| Figure 1-5 | Sediment Core Cross Section C-C' |
| Figure 1-6 | Water Table Map |
| Figure 1-7 | RI Sampling Locations |
| Figure 1-8 | Extent of NAPL |
| Figure 4-1 | Impacted Areas Beneath School |
| Figure 4-2 | Conceptual Plan for Enhanced NAPL Removal |
| Figure 4-3 | Sample Locations and Former MGP Structures |
| Figure 4-4 | Locations for Remedial Options in Outside Area |
| Figure 4-5 | Conceptual View of In-Situ Stabilization |
| Figure 4-6 | Locations for and Conceptual View of Groundwater 360 Degree Containment Option |
| Figure 4-7 | Locations for and Conceptual View of Permeable Reactive Barrier (PRB) Option |
| Figure 4-8 | Conceptual Vent System Design |
| Figure 5-1 | Locations for Remedial Options |

Executive Summary

On behalf of Consolidated Edison Company of New York (Con Edison), ENSR has prepared this Alternatives Analysis Report (AAR) for the East 115th Street Former Manufactured Gas Plant (MGP) Site (the Site) in New York, New York. The purpose of this AAR is to evaluate applicable remedial alternatives and identify those that will effectively address the MGP-related contaminants present at the Site. This report incorporates comments contained in the New York State Department of Environmental Conservation (NYSDEC)'s letters dated July 19, 2007 and September 11, 2007. The Site consists of approximately 5.5 acres and is currently used as a school: the Manhattan Center for Science and Mathematics and the Isaac Newton Junior High School for Science and Math (hereinafter referred to as the School). The Site is bounded to the north and west by residential and commercial properties. Thomas Jefferson Park is located adjacent to and south of the Site. FDR Drive and the Harlem River abut the Site to the east.

MGP residuals are present in soil, groundwater, and in the sediments of the Harlem River. The primary remedial goal for the areas of the East 115th Street Former MGP Site affected by MGP-related impacts is to restore these areas to the conditions that existed before the MGP-related contamination occurred, to the extent feasible without unduly interfering with the manner in which the areas are presently used, or endangering the health or safety of the users of the properties or the surrounding community. If this goal cannot be met, the alternative remedial goal for the Site is to ensure that the MGP-related contamination does not present a threat to human health or the environment considering the manner in which the property is used and to develop and implement the necessary remedial actions to remediate the areas to a level that is protective of public health and the environment for such uses.

Remedial options were evaluated for each of the media of concern. These media include subsurface soil and groundwater, indoor air, and river sediments. A brief discussion of site conditions and results of each evaluation are presented below.

Subsurface soil and groundwater impacts cover an approximately 2-acre area. The primary dissolved phase constituents present in the groundwater and soil are organic compounds. Non-aqueous phase liquid (NAPL) is present primarily underneath the school building and, to a lesser extent, in the area between the school building and Harlem River. Installation of a NAPL containment wall along the downgradient edge of the Site (along the FDR Drive) is the recommended remedial action for impacted subsurface soils and groundwater. A containment wall can be installed without closing the school and would effectively isolate and prevent potential migration of NAPL towards the Harlem River. Institutional controls are also recommended to prevent activities that might result in exposure to impacted subsurface soil and groundwater or that might compromise the effectiveness of the containment wall. Remedial alternatives that focused on removal or treatment of NAPL present beneath the school were evaluated. Specifically, the feasibility of In-Situ Chemical Oxidation (ISCO) and In-Situ Thermal Treatment (ITT) were thoroughly evaluated as potential methods to remove NAPL from underneath the school. Both technologies were determined to be extremely difficult to safely implement at the site and to have uncertain effectiveness.

Indoor air testing has confirmed that under current conditions there appears to be no impact of MGP residuals on the indoor air quality inside the School building. However, an evaluation of potential remedial options was conducted that would assure continued protection of the building's indoor air quality in the future. Active venting is the recommended remedial action for indoor air. Active venting would provide an added level of assurance that sub-slab vapors will not enter the building. An active venting system can be installed and operated with minimal impact to school activities. Institutional controls and monitoring are also recommended to assure that the existing floor is not compromised and the venting system is operating properly.

MGP impacts are present in deep sediments over an approximately 2.8-acre area of the Harlem River. A key factor in the evaluation of remediation options for sediments is that MGP impacted sediments are overlain by several feet of non-impacted sediments. Thus, the impacted sediments are essentially isolated and not accessible to human and ecological receptors. For sediment of the Harlem River, monitored natural recovery is

recommended in addition to institutional controls, which would prevent or control activities that might expose buried impacted sediments.

In summary, recommended alternatives are as follows:

- NAPL containment via installation of a downgradient barrier wall;
- Limited excavation of NAPL-impacted soils;
- Active venting of impacted sub-slab vapors;
- Monitored natural recovery of river sediments; and
- Institutional controls.

1.0 Introduction

On behalf of Consolidated Edison Company of New York (Con Edison), ENSR has prepared Alternatives Analysis Report (AAR) for the East 115th Street Former Manufactured Gas Plant (MGP) Site (the Site) in New York, New York. This AAR has been prepared in accordance with the requirements of the New York State Department of Environmental Conservation (NYSDEC) *Draft Technical Guidance for Site Investigation and Remediation (Draft DER-10)* (NYSDEC, 2002)]. The purpose of this AAR is to evaluate appropriate remedial alternatives and identify effective alternatives that address the MGP-related contaminants present at the Site.

1.1 Project Background

The Site consists of approximately 5.5 acres of land extending north to south from 116th Street to 114th Street, and generally west to east from Pleasant Avenue to the Harlem River (Figure 1-1). According to available historical information, the Site was operated as a water gas MGP from 1895 to 1936. The MGP covered two city blocks (115th Street was present between Pleasant Avenue and the Harlem River during MGP operation). The MGP ceased operations in 1936, after which the Site was dismantled within two years. No information is available regarding the construction or demolition of MGP structures. In 1941, a school with a basement was erected on the property (over 115th Street) (Benjamin Franklin High School) and is still present today as the Manhattan Center for Science and Mathematics and the Isaac Newton Junior High School for Science and Math. During the approximate 40-year period of MGP operations, the plant used approximately 46,000 tons of coal, 9.4 million pounds of coke (for generating steam), 10.5 million pounds of gasoline, and 11,000 bushels (bu) of oxide per year. Figure 1-2 shows the locations of the former MGP operations and structures.

1.2 Site Description

The Site is located at 116th Street and Pleasant Avenue, New York, NY and is identified by the New York City Tax Map as Block 1713, Lot 1. Part of the previous MGP property included what are now the FDR Drive and the Harlem River. Research indicates that the subject property was situated adjacent to a ferry station which is now occupied in part by the Harlem River. It is possible that the property once included a pier that is no longer present. The location of the former MGP property and its extent were determined through review of Sanborn Insurance Maps. Figure 1-2 provides a plan of the Site, which depicts current site features and boundaries.

The Site is currently used as a school: the Manhattan Center for Science and Mathematics and the Isaac Newton Junior High School for Science and Math (hereinafter referred to as the School). Over 1500 students and the associated teachers and administrative staff routinely occupy the school. The Site is bounded to the north and west by residential and commercial properties. Thomas Jefferson Park is located adjacent to and south of the Site. FDR Drive and the Harlem River abut the Site to the east.

1.3 Site Topography and Drainage

Topography on the Site is relatively flat, with a slight pitch to the east towards the Harlem River. The Site consists of both vegetated land (grass) and covered areas (school building, roadways, parking areas and sidewalks). Runoff is inferred to flow off site through ground penetration and via overland flow into storm drains located on the streets and in some of the grassy areas, which convey runoff into the Harlem River.

1.4 Site Geology and Hydrogeology

This section describes the Site geology and hydrogeology. The information presented in this section includes published information, but relies mostly on site-specific information developed during the Remedial Investigation (RI) and Supplemental RI.

According to a bedrock geologic map of the New York Metropolitan Area, bedrock in the area of the Site consists of Early Paleozoic rock (mostly metamorphic). According to the Environmental Data Resources (EDR) report (EDR, 2002) for the Site, the bedrock unit lies within the Paleozoic Era and part of the Ordovician system (Middle Ordovician Series). Due to Manhattan's tight metamorphic bedrock, aquifers are not abundant and the bedrock in this area is not used for potable water supplies. RI activities at the Site were performed to bedrock.

Also according to the EDR report (EDR, 2002), the overburden deposits are generally of low permeability. As a result, overburden groundwater is not used as a potable water source in Manhattan. Instead, New York City obtains its water from the Catskill Mountains of New York.

Soil borings and sediment cores advanced during the RI and the Supplemental RI provide information on the Site hydrogeology. Three cross sections have been prepared using the soil boring and sediment core information. One of these cross sections, A-A', included as Figure 1-3, is oriented generally perpendicular to the long axis of the Site and extends into the Harlem River. The second and third cross sections, B-B' and C-C', Figure 1-4 (on the Site) and Figure 1-5 (in the River) are oriented generally perpendicular to the first cross section and parallel to the Harlem River.

1.4.1 Site Geology

Based on the soil borings advanced at the Site, the overburden ranges in thickness from 25.5 feet to 48 feet, with bedrock encountered at twelve borings. The overburden above bedrock consisted of a fill unit underlain by a sand unit. Over most of the Site this sand unit was underlain by a clay unit. In the central portion of the Site, the clay unit was absent and, therefore, no confining unit exists above bedrock. In the eastern portion of the Site, the clay was absent, but a peat and silt, and/or silty sand, layer was present. This silt/silty sand layer may not act as a confining unit, but where non-aqueous phase liquid (NAPL) is present in this area; it is only present within or above this layer.

Each of the geologic units is described in more detail below.

- The fill unit contains building debris including brick, concrete, gravel, metal, clinker and coal. This unit was present across the Site to depths of approximately 8 to 16 feet below grade surface (bgs).
- The sand unit beneath the fill unit ranged in thickness between 10 and 15 feet, with the bottom of the unit ranging between 25 and 30 feet bgs. The water table was generally, but not exclusively, found at the top of this sand unit, (i.e., at the contact between the fill and sand). A silt and/or peat layer was observed within the sand unit beneath the school building in the area of the former gas holders. The silt/peat layer was generally encountered at a depth of about 10 feet below the basement floor and ranged in thickness between 3 and 7 feet. In the eastern portion of the Site a peat, silt, and/or silty sand, layer was observed. This layer was found around 14 to 15 feet bgs and ranged in thickness from 1 to 7 feet.
- A clay layer was encountered beneath the sand unit over the southern and western portions of the Site. Where present, the top of the clay layer was encountered at depths ranging between 25 and 30 feet bgs. Two soil borings were advanced through the clay layer to bedrock. At the soil boring for MW-5 the clay was 16.5 feet thick and extended to one foot above bedrock where it was underlain by sand. At SB-26 the clay layer was encountered at 25 feet bgs and was 10 feet thick. It was underlain by 6 feet of sand above bedrock. NAPL was not found beneath the clay layer at either of these two

borings. The lithology at SB-26 shows that, where present, this clay layer is a competent confining unit.

- The clay layer was not observed in the central portion of the eastern side of the Site in four borings. In two of these borings NAPL was observed to or near bedrock.
- Although a confining clay layer was not observed in the eastern portion of the Site, a peat and silt and/or silty clay layer is present. This layer was encountered between 14 and 15 feet bgs and was between 3 and 9 feet thick. NAPL was not observed below this peat/silty clay layer.

1.4.2 Harlem River Geology

Based on the sediment cores advanced in the Harlem River, the sediment overburden thickness in the river ranges from 11 feet to 24 feet below the sediment surface. Solid sediment core refusals were encountered with bedrock fragments (mica schist) observed at the base of cores at five locations. The refusal depths at these locations are similar to the depth of bedrock encountered on site beneath the adjacent eastern portion of the Site. Soft sediment core refusal was encountered at the other 18 sediment sampling locations at depths ranging from 21 feet to 24 feet below the sediment surface. Overall the depth to bedrock in the river parallel to the Site appears to be similar to that on site; however, the depth to bedrock appears to be deeper away from the Site and further into the center of the River.

The sediment overburden consists of a generally thick layer of fluffy black marine sediment which is underlain by an overburden consisting of a silt layer with varying amounts of sand and clay, which is generally followed by a sand layer, and then by a clay layer.

Each of these geologic units is described below.

- The first unit encountered at each sediment sample location was a fluffy dark gray to black marine sediment. All but four of the sediment cores were advanced in the shoal of the river. The black marine sediment was generally thicker on the shoal of the river, ranging from 9 to 19 feet thick, and thinner toward the channel, where it is only 2.5 to 8 feet thick.
- Beneath this sediment layer a silt layer was observed. The composition of this silt layer varied and was either silt, clayey silt, or sandy silt. At some locations peat was also observed with this silt layer. The silt layer ranged in thickness from 1 to 7 feet. In some areas a thin sandy layer containing debris (gravel, twigs, clinker, glass, wood, and shells) was observed at the interface between the black marine sediment and the silt layer. Also, at some locations, mostly where shallow refusal occurred, this layer was not observed.
- Beneath the silt layer a sand layer was observed. This layer ranged in thickness from 1 to 9 feet thick. Similar to the silt layer, this sand layer was not observed at some locations, mostly where shallow refusal occurred.
- Beneath the sand layer, a clay layer was observed. This clay layer was observed at 11 of the sediment sample locations. All of these locations had soft refusal in the clay layer. Based on the depths of the clay where encountered and the depths of the core samples, it appears that at the 13 locations where the clay was absent, it was absent either because of refusal on bedrock above the elevation of the clay layer or because the boring did not reach the depth of the clay layer.

1.4.3 Site Hydrogeology

In general, groundwater was encountered on site at the contact between the fill and sand units. The nearest surface water body to the Site is the Harlem River, which abuts the Site to the east across FDR Drive. Five rounds of fluid level measurements were obtained from the five monitoring wells installed at the Site during the

two phases of the RI. The results of all of the rounds of fluid level measurements were similar; Figure 1-6 is a water table elevation map prepared from the most recent water level measurement round (August 27, 2004). As this water table map shows, groundwater flow beneath the Site is to the southeast toward the Harlem River.

During fluid level gauging no measurable NAPL was observed in any of the monitoring wells. However, NAPL sheen was observed during well development and a small bead of NAPL was observed on the measuring tape while gauging well MW-2 during fluid level monitoring events.

Field parameters and analytical results from groundwater sampling show relatively elevated conductivity and elevated sodium concentrations. These elevated concentrations indicate that the groundwater at the Site is brackish and would not be considered potable.

1.5 Summary of Site Investigations

On June 28, 2002, Con Edison conducted an indoor air and soil gas assessment at the Site to determine whether there was any evidence of MGP-related subsurface vapor intrusion into the school building. The assessment was conducted in accordance with the NYSDEC and New York State Department of Health (NYSDOH)-approved, *Work Plan for Evaluation of Subsurface Vapor Intrusion* (RETEC, 2002).

In addition to collecting indoor air and soil gas samples during this investigation, soil samples were collected from two shallow borings, one completed inside and one completed outside the building. A groundwater sample was also collected from the boring outside the building through a temporary screen. The results indicated the presence of MGP-impacted soil and groundwater at the sampled locations.

A second indoor air assessment was conducted in the school building on December 30, 2002. The sampling and analytical protocols for this program were consistent with the above-referenced work plan. The results of this and the June 2002 assessment indicated no discernable MGP-related impacts in the indoor air in the school building.

A first phase of RI activities was performed at the East 115th Street Former MGP Site between August 18, 2003 and September 5, 2003. This phase of field investigation included soil borings, monitoring well installations, excavation of test pits, and the collection of soil, groundwater, and NAPL samples.

The results of all of the above referenced investigations are included in the RI report submitted to NYSDEC (ENSR, 2004). This report was approved by the NYSDEC in a letter dated August 12, 2004.

A second phase of RI activities performed at the East 115th Street Former MGP Site was conducted between August 23, 2004 and January 19, 2005. This phase of field work included the advancement of soil borings on site and sediment cores adjacent to the Site within the Harlem River, and the collection of subsurface soil, sediment, indoor and ambient air, and soil gas samples for laboratory analysis. The results of these activities were summarized in the Supplemental Remedial Investigation Report submitted to the NYSDEC (ENSR, 2005). This report was approved by the NYSDEC in a letter dated September 15, 2005. This letter also requested that Con Edison initiate preparation of the AAR.

1.6 RI Results

The results and conclusions of the RI are briefly summarized below. More complete discussions of the RI results are included in the *RI Report* (ENSR, 2004) and the *Supplemental RI Report* (ENSR, 2005). Figure 1-7 shows the RI sampling locations and Figure 1-8 shows the extent of NAPL at the Site.

Potential for MGP Impacts on Indoor Air in the School Building

- Three rounds of indoor air sampling were conducted in the school building, including one round collected following the removal of potential non-MGP related contaminant sources from the basement of the school. Samples were collected in the school's basement and on the school's first floor.
- The results of the indoor air sampling indicate that low levels of volatile organic compounds (VOCs) were present in the indoor air and that the compounds detected appeared to have sources related to the routine cleaning and maintenance activities occurring within the building.
- Most of the VOCs that are possibly attributable to former MGP operations were detected in the indoor air samples at concentrations within the typical range of these compounds in indoor air (i.e., within the 90th percentile of NYSDOH background values).
- The concentration of one non-MGP-related VOC was present in two first floor indoor air samples at concentrations notably above the typical indoor air range. This compound, 1, 4-dichlorobenzene, was also present in one soil gas sample at a very low concentration. 1, 4-Dichlorobenzene is a compound commonly found in mothballs and deodorizers.
- The results of the indoor air sampling events indicated no discernable MGP-related impacts in the indoor air in the school building.

Extent of MGP Soil Gas Impacts

- Five soil gas samples were collected during the RI in the western area of the Site in the area of the former MGP gas holders. Four soil gas samples were collected inside the building, at approximately 2.5 feet below the slab, and one soil gas sample was collected outside the building, at approximately 5 feet bgs.
- Several hydrocarbons typically associated with petroleum products were present in all five soil gas samples. One hydrocarbon (indan) typically associated with MGP tars was present in three of the five soil gas samples,
- Naphthalene, may be typically (though not uniquely) associated with MGP sources, was notably absent or present in low concentrations in all of the soil gas samples.
- The soil gas samples contained some VOCs that were clearly not MGP related and some VOCs that could be related to both non-MGP petroleum products and MGP-related materials. Some of the soil gas samples contained VOCs at concentrations that were an order of magnitude higher than typical values for indoor air.
- The results of the soil gas sampling in the area of the former gas holders, in conjunction with the soil and groundwater results discussed below, indicate that the soil gas beneath the school building is impacted by MGP-related constituents.

Potential for Off-Site Migration of MGP Vapors

- Soil gas samples were collected at four outdoor locations in order to evaluate the potential for MGP-impacted vapors to migrate off-site toward the residential buildings located along Pleasant Avenue to the northwest and East 116th Street to the northeast.

- The results of the soil gas sampling indicate that with the exception of naphthalene, soil gas samples did not contain any of the compounds included in the analysis that may be typically (though not uniquely) associated with MGP sources (naphthalene, indene, indan, or thiophene).
- Naphthalene was detected at low levels, below $6 \mu\text{g}/\text{m}^3$, in both of the samples collected north of the building, along East 116th Street, and in one of the samples collected west of the building, along Pleasant Avenue.
- Other compounds that could be associated with MGP operations, including benzene, were detected in soil gas samples at low concentrations, close to the range of typical indoor air background values.
- The soil gas samples were characterized by low or non-detectable concentrations of naphthalene and indan, in contrast to the high relative concentrations of these compounds in the vapor headspace sample for soil from SB-26, which was located in an area of known MGP impact. In the soil gas samples, the highest ratio of naphthalene to benzene was only 1.02. The ratio of indan to benzene could not be determined because indan was not detected in the soil gas samples. These results contrasted with the headspace sample, which was characterized by ratios of naphthalene and indan to benzene of 25 and 22.7, respectively. This indicates that the VOCs measured in the soil gas samples collected during the Supplemental RI are likely to have non-MGP sources.
- Based on the low levels of the above compounds, and the distance to the buildings located across East 116th Street and Pleasant Avenue, the potential for subsurface MGP vapor intrusion into these buildings is considered low.

Extent of On-Site NAPL/Soil Impacts

- Nine surface soil sample locations and thirty-seven soil borings were advanced during the RI and Supplemental RI to define the extent of MGP-impacted soils at the Site.
- Surface soil sample results show low levels of polycyclic aromatic hydrocarbons (PAHs) and inorganics at concentrations above NYSDEC Recommended Soil Cleanup Objectives (RSCOs) (NYSDEC, 1994). These constituents appear to be related to urban background conditions and not related to former MGP operations.
- Soils in the northeastern and northwestern portions of the property located between the school building and Pleasant Avenue and East 116th Street do not appear to have been significantly impacted by MGP residuals.
- Soils beneath the school building in and around the two gas holders have been impacted by NAPL. The observance of NAPL in this area included staining, sheens and residual tar. NAPL in the large gas holder appears to be the source of NAPL found outside and primarily downgradient of the former structure.
- In the southern and eastern portions of the Site, between the school building and the FDR Drive and downgradient of the large gas holder the analytical results indicate that there is a slight, primarily PAH impact present in the subsurface soils located above the water table. The absence of visual or olfactory impacts, i.e., sheen, odor, NAPL or elevated photo-ionization detector (PID) readings, in the soils above the water table, indicate that these impacts are likely associated with the historic fill that was found to be present across the Site.
- NAPL has been observed between the school building and FDR Drive starting at the water table and extending to the first confining unit or bedrock. In the southern portion of the Site where a clay layer is present and in the eastern portion of Site where a peat/silty layer is present, NAPL is confined above

these layers. In a limited area in the central portion of the Site where a confining layer is not present, NAPL has been observed directly above bedrock.

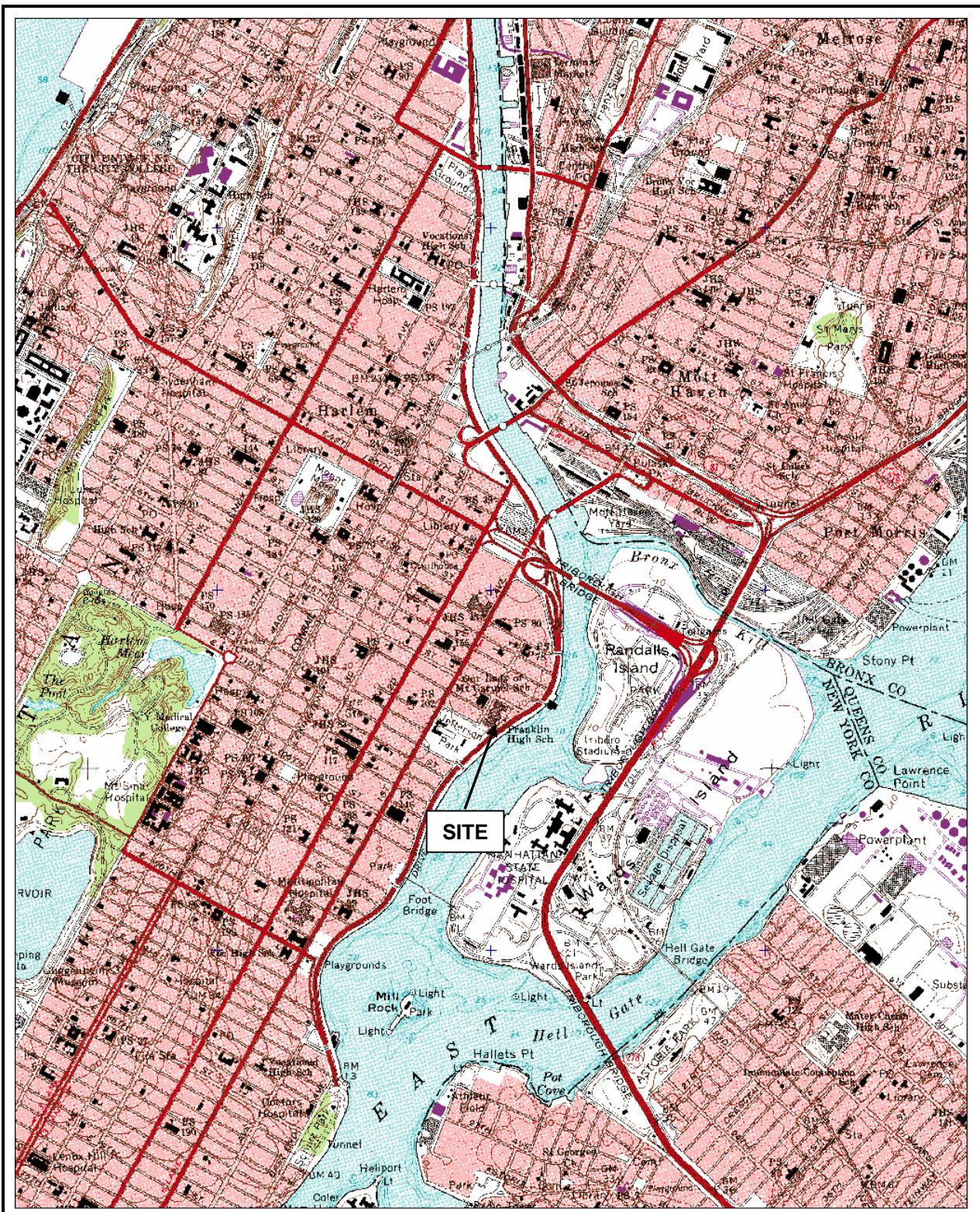
- Soil borings were also advanced to delineate the extent of NAPL and MGP constituents in the eastern and western corners of the Site. No NAPL was observed and concentrations of total VOCs and total PAHs were below the NYSDEC RSCOs in borings SB-22 and SB-31 located at the southwestern corner of the Site. In the eastern-most boring, SB-30, a NAPL stain was observed at 11 feet bgs to 13 feet bgs and sheen was observed at 15.5 feet bgs to 16 feet bgs. The limited observance of NAPL at this location indicates the close proximity to the northern limit of the NAPL plume in the eastern most portion of the Site. This is further supported by the benzene, toluene, ethylbenzene, and xylenes (BTEX) and PAH concentrations detected in the soils samples collected at SB-30, where soil samples were collected of the stained soils and the total BTEX and total PAH concentrations were below the NYSDEC RSCOs for total VOCs and total semi-volatile organic compounds (SVOCs).
- NAPL was observed in seven borings (SB-10, SB-14, SB-18, SB-20, SB-21, MW-2, and MW-3) located near the property boundary with the FDR Drive, indicating the potential for NAPL to have migrated off site in the southeastern direction. Sediment sampling in the Harlem River was performed to complete the delineation of MGP impacts in this direction.

Extent of MGP Groundwater Impact

- Groundwater samples were collected from the five wells constructed at the Site. Two wells were located upgradient of the former MGP or upgradient of the former MGP activities at the Site. Three wells were located within the former MGP footprint and downgradient of the large gas holder, the suspected source of NAPL at the Site.
- Typical organic MGP constituents were not detected in the two upgradient wells at concentrations above the NYSDEC Water Quality Standards (WQS). However, non-MGP- related VOCs (1, 2-dichloroethene, acetone, carbon disulfide, chloroform, methylene chloride (MW-1 only), tetrachloroethene, and trichloroethene) were detected in both of these wells. Tetrachloroethene was detected in MW-1 at a concentration above the WQS. Cyanide was detected in only one of the upgradient wells at the WQS. Other inorganics (iron, manganese, and sodium) were also detected in these upgradient wells.
- Organic constituents typically associated with former MGP operations, BTEX and PAHs were detected in all of the downgradient wells at concentrations above the WQS. Cyanide was detected in two of the downgradient wells, but at concentrations below the WQS. Additional inorganics (iron, magnesium, manganese and sodium) were also detected in one or more of the wells located downgradient of the former MGP operations.
- Measurable NAPL was not observed in any of the monitoring wells at the time of groundwater sampling, two weeks after the wells were installed or one year later during the Supplemental RI. A sheen, however, was observed in the drums containing development and purge water from monitoring wells MW-2 and MW-3 and bead of NAPL was observed on the fluid level tape when it was removed from monitoring well MW-2.
- Groundwater beneath and in the area of the Site is not used for drinking water, and based on the conductivity of the water and elevated sodium concentrations, is brackish and would not be considered potable.

Potential for Historic and/or On-going Discharge of NAPL into Harlem River

- Visual observations in soil borings advanced along the Site boundary with the FDR Drive indicate the presence of NAPL below the water table in this area.
- The well gauging results to date indicate that NAPL has not accumulated in any of the on-site monitoring wells since they were installed in 2003. However, a NAPL sheen was observed during well development, and a small bead of NAPL was observed on the measuring tape during gauging of MW-2 on two occasions.
- Visual MGP impacts (tar, sheen, globules, and stain) were observed in the sediments within a portion of the Harlem River adjacent to the Site. These impacts are limited to an area approximately 180 feet by 680 feet beneath the western shoal of the river at depths ranging between 14 and 27 feet below the sediment surface. The thickness of NAPL-impacted sediments ranged from 0.25 feet at the downstream (southern) end of the area sampled to 4.3 feet at the upstream (northern) end of the area sampled.
- Gas chromatograph/flare ionization detector (GC/FID) fingerprint analyses of nine sediment samples indicate that the NAPL in the sediments most closely resembles a carbureted water gas tar.
- Additional sediment cores were advanced in various directions from the area where visually impacted sediments were observed in order to delineate the horizontal extent of MGP impacts. Although BTEX and PAHs were detected in some of these samples above the NYSDEC Sediment Screening Criteria (SSC), the concentrations of these constituents were significantly lower than in samples from the NAPL-impacted zone. The combined visual and analytical data for these delineation samples indicate that the horizontal extent of the MGP-impacted sediments has generally been established.
- Concentrations of BTEX and PAHs in sediment samples collected below the visually impacted intervals were either below the NYSDEC SSCs, or significantly lower than those detected in the visually impacted zone, thus indicating that the vertical extent of the MGP impacts has generally been established.
- In addition, total PAH concentrations were below the Effects Range-Medium (ERM) guidance value (NYSDEC, 1999a) in most of the perimeter and deepest sediment samples with the exception of three perimeter locations and the three deepest samples.
- The depth of the MGP impacts observed in the river sediments ranged from 14 feet to 27 feet below the sediment/water interface. The MGP impacts are, therefore, present below the biologically active zone and are not impacting potential ecological receptors.
- Given the thickness of non-impacted sediments overlying the NAPL-impacted zone (14 feet to 27 feet), NAPL release to surface water is not anticipated under ambient conditions.
- Based on the sediment sampling results, it appears that, historically, NAPL migrated off site and impacted sediments within a portion of the Harlem River adjacent to the Site.
- Given that NAPL has not accumulated in any of the downgradient wells located along the Site boundary since they were installed in 2003, the on-going discharge of NAPL into the Harlem River is unlikely.



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS 742 ft Scale: 1 : 25,000 Detail: 13-0 Datum: WGS84

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SITE LOCATION MAP

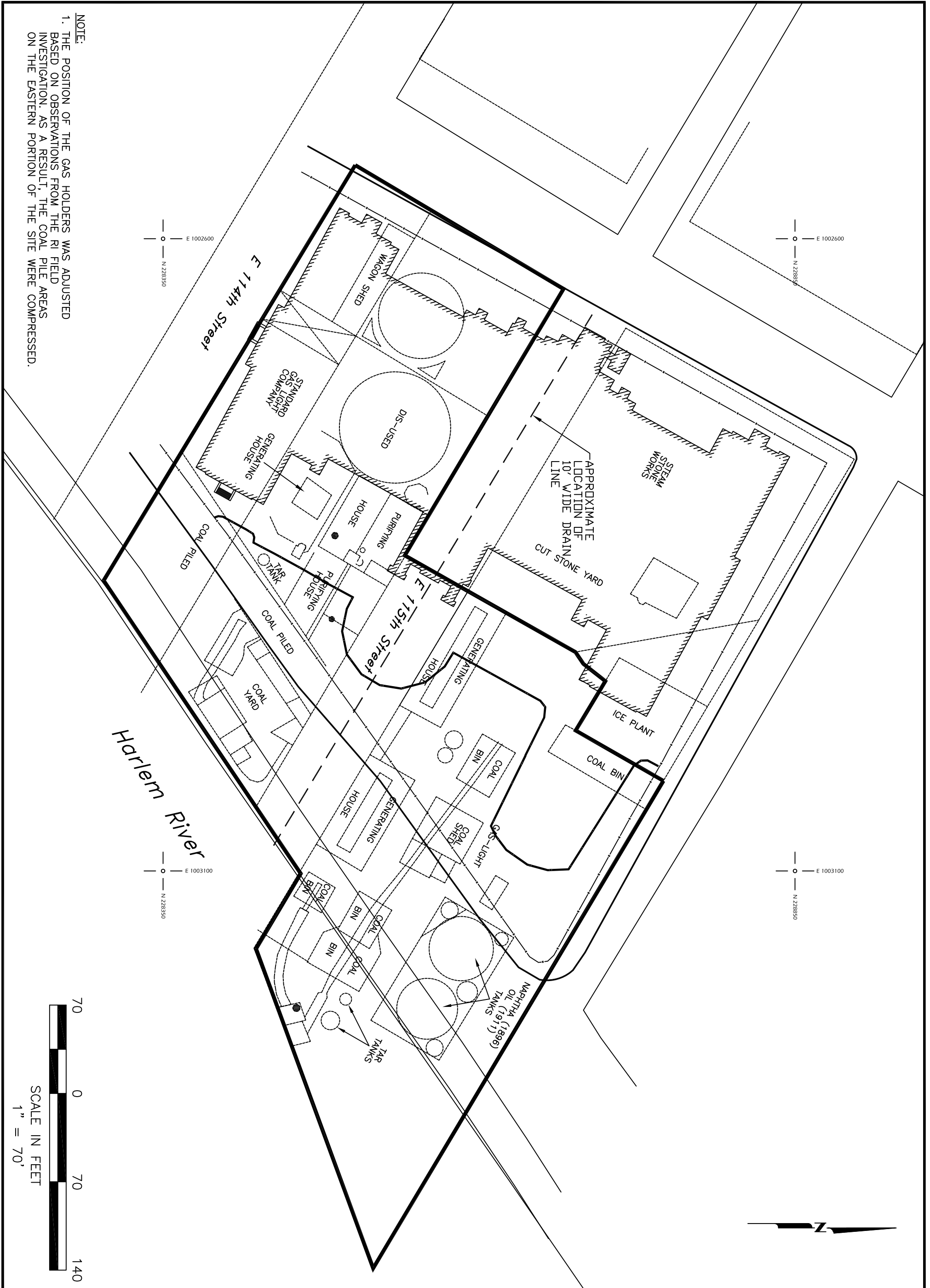
**FORMER MGP SITE
EAST 115th STREET
NEW YORK, NEW YORK**

FIGURE NUMBER

1.1

| | | |
|------------------|-------------------|------------------------------|
| DRAWN BY: KAG | DATE: 07/19/02 | PROJECT NUMBER: 01869-055 |
|------------------|-------------------|------------------------------|

NOTE:
 1. THE POSITION OF THE GAS HOLDERS WAS ADJUSTED
 BASED ON OBSERVATIONS FROM THE RI FIELD
 INVESTIGATION. AS A RESULT, THE COAL PILE AREAS
 ON THE EASTERN PORTION OF THE SITE WERE COMPRESSED.



HISTORIC SITE FEATURES
 CONSOLIDATED EDISON
 EAST 115th STREET FORMER MGP
 NEW YORK, NY

| | | |
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| SCALE: 1"=70' | DATE: 3/09 | PROJECT NUMBER: 01869-115-800 |
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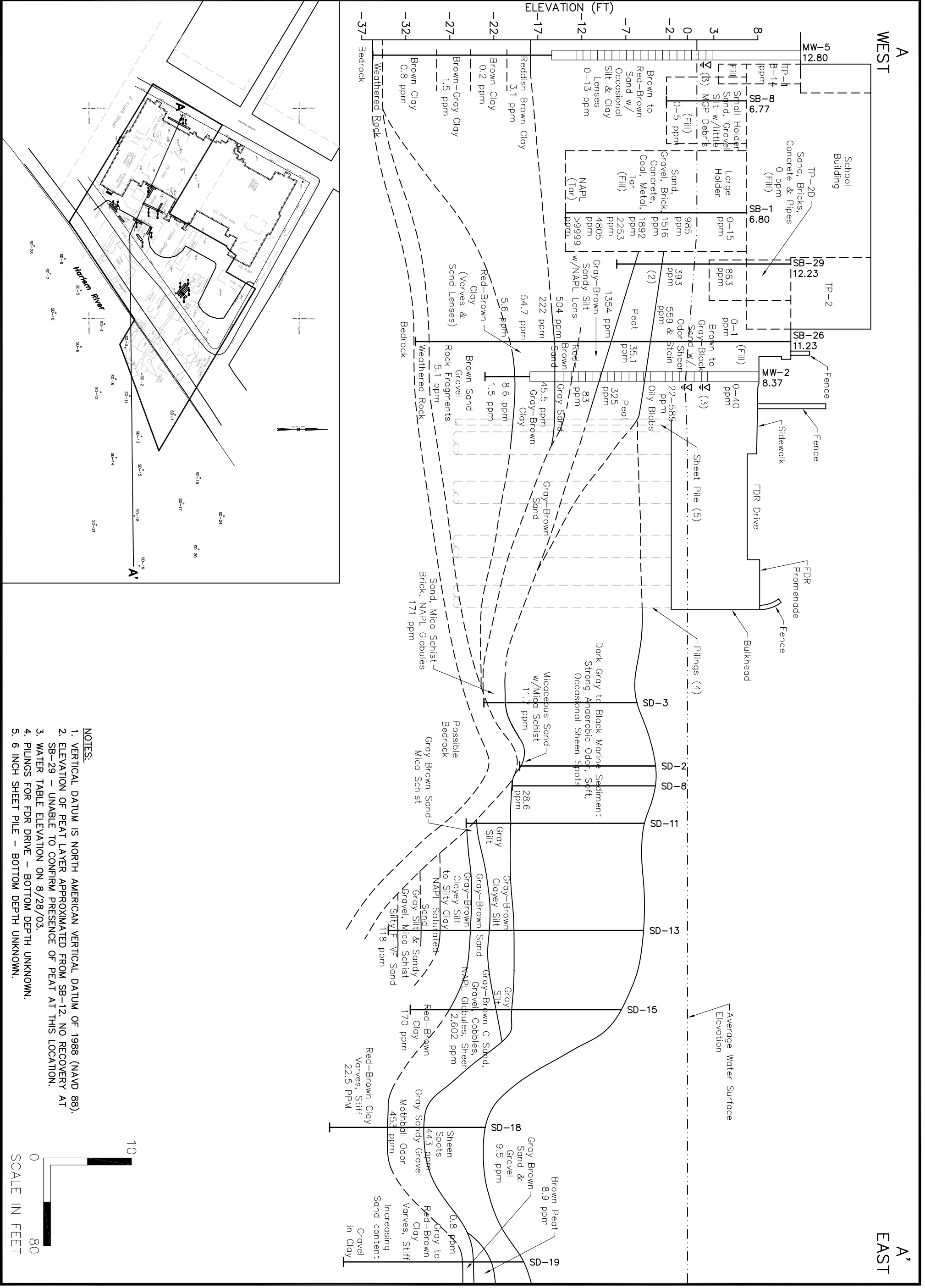
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| | NO.: | DESCRIPTION: | DATE: | BY: |
| DRAWN BY: K.P.B. | | | | |
| CHECKED BY: C.M. | | | | |
| APPROVED BY: C.M. | | | | |

FIGURE NUMBER:
12

SHEET NUMBER:
1



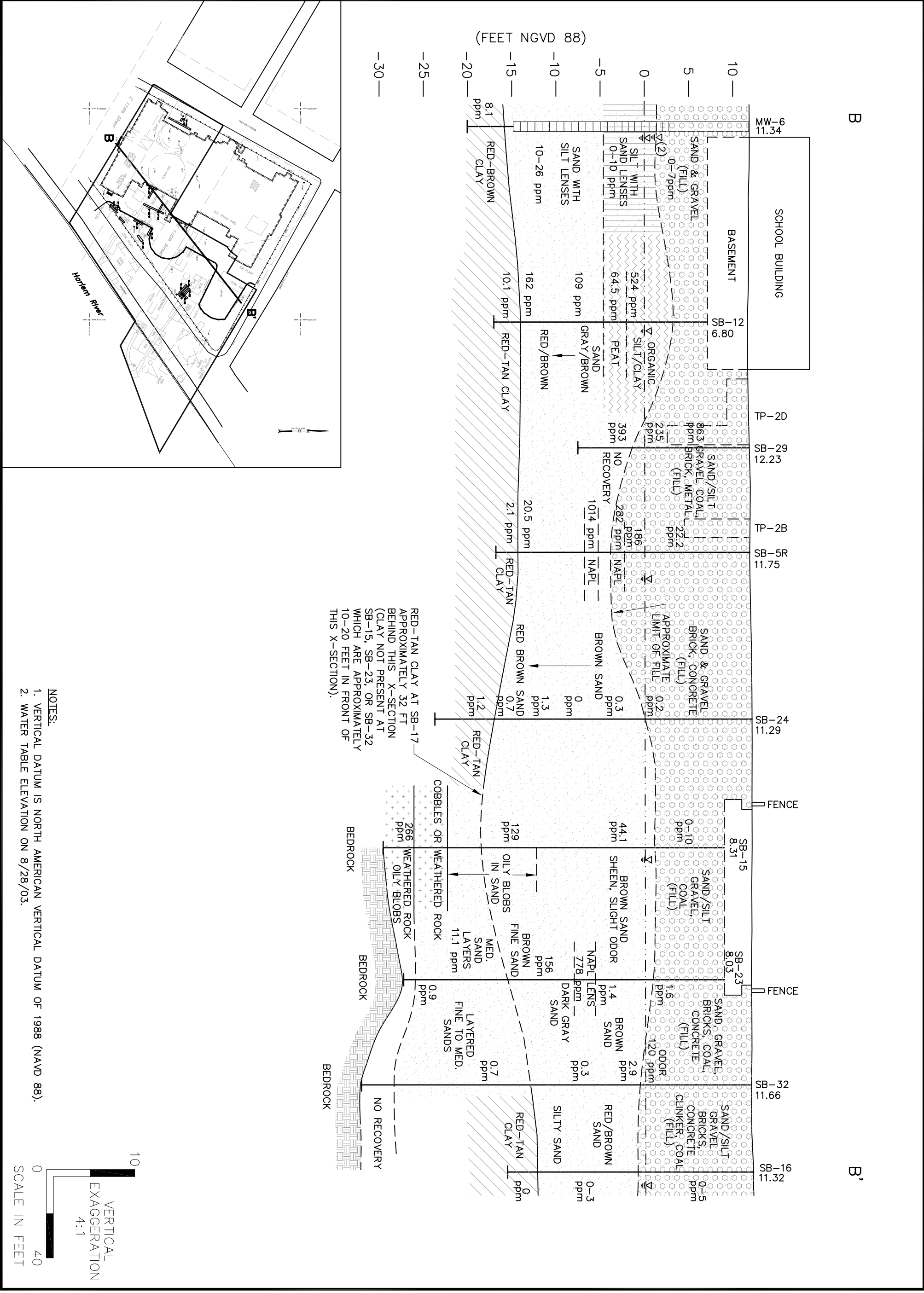
SEDIMENT CORE CROSS-SECTION A-A'
CONSOLIDATED EDISON
EAST 115th STREET FORMER MGP
NEW YORK, NY

SCALE: AS SHOWN DATE: 6/05 PROJECT NUMBER: 01869-089-0410

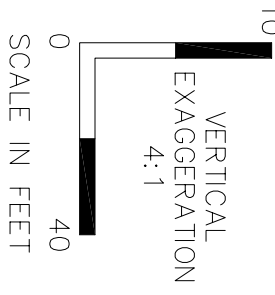
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| APPROVED BY: | | | |
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- NOTES:**
1. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
 2. WATER TABLE ELEVATION ON 8/28/03.



| | | | | | | | |
|---|--|-------|--|----------------------|-----------|--------------|-------|
| <p>1.4</p> <p>FIGURE NUMBER:</p> | <p>CROSS SECTION B-B' EAST 115TH STREET FORMER MGP NEW YORK, NY</p> | | <p>ENSR CORPORATION 2 TECHNOLOGY PARK DRIVE WESTFORD, MASSACHUSETTS 01866 PHONE: (978) 589-3000 FAX: (978) 589-3100 WEB: HTTP://WWW.ENSR.COM</p> | DESIGNED BY: | REVISIONS | | |
| | SCALE: | DATE: | | PROJECT NUMBER: | NO.: | DESCRIPTION: | DATE: |
| SHEET NUMBER: 1 | AS SHOWN | 6/05 | 01869-089-0410 | DRAWN BY: K.P.B. | | | |
| | | | | CHECKED BY: S.O. | | | |
| | | | | APPROVED BY: D.S. | | | |

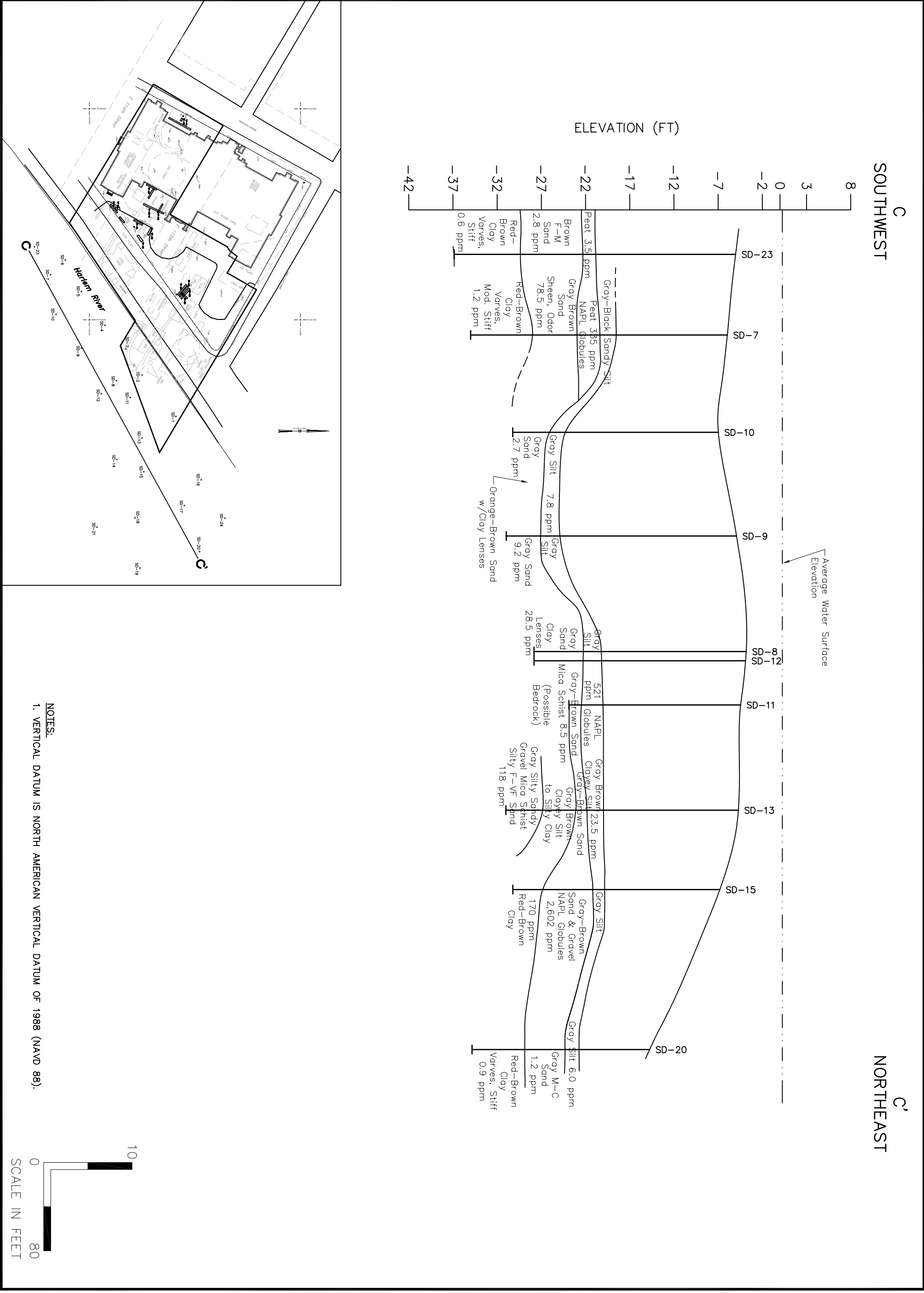


FIGURE NUMBER:
1.5

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SEDIMENT CORE CROSS-SECTION C-C'
CONSOLIDATED EDISON
EAST 115th STREET FORMER MGP
NEW YORK, NY

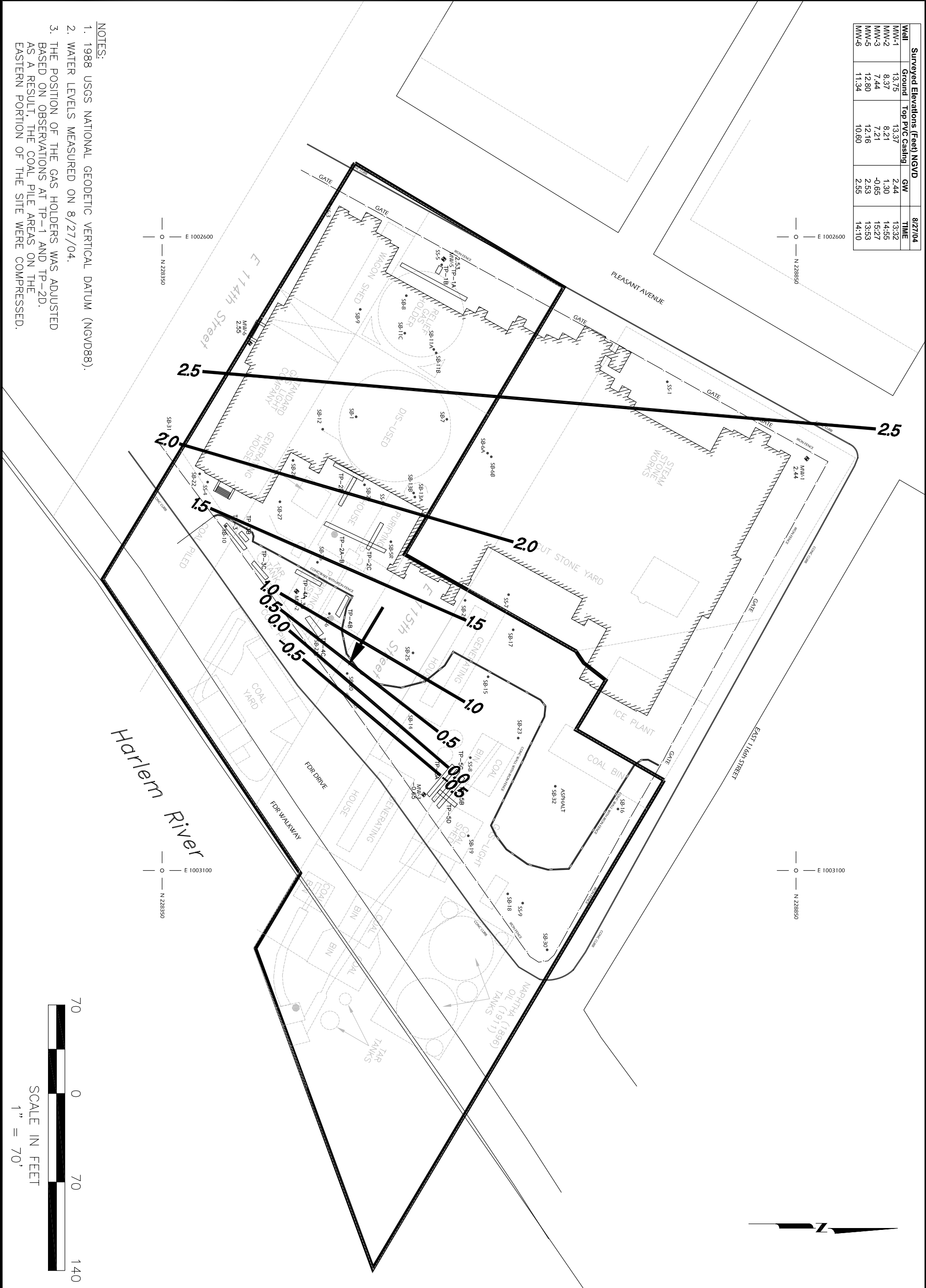
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| SCALE: AS SHOWN | DATE: 6/05 | PROJECT NUMBER: 01869-089-0410 |
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| K.P.B. | | | | |
| CHECKED BY: | | | | |
| S.O. | | | | |
| APPROVED BY: | | | | |
| X | | | | |

| Well | Ground | Top PVC Casing | GW | 8/27/04 |
|------|--------|----------------|-------|---------|
| MM-1 | 13.75 | 13.37 | 2.44 | 13.32 |
| MM-2 | 8.37 | 8.21 | 1.30 | 14.55 |
| MM-3 | 7.44 | 7.21 | -0.65 | 15.27 |
| MM-5 | 12.80 | 12.16 | 2.53 | 13.53 |
| MM-6 | 11.34 | 10.60 | 2.55 | 14.10 |



NOTES:

1. 1988 USGS NATIONAL GEODETIC VERTICAL DATUM (NGVD88).
2. WATER LEVELS MEASURED ON 8/27/04.
3. THE POSITION OF THE GAS HOLDERS WAS ADJUSTED BASED ON OBSERVATIONS AT TP-1 AND TP-2D. AS A RESULT, THE COAL PILE AREAS ON THE EASTERN PORTION OF THE SITE WERE COMPRESSED.

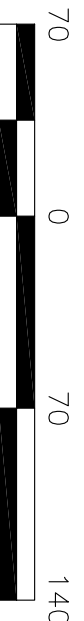


FIGURE NUMBER:

1.6

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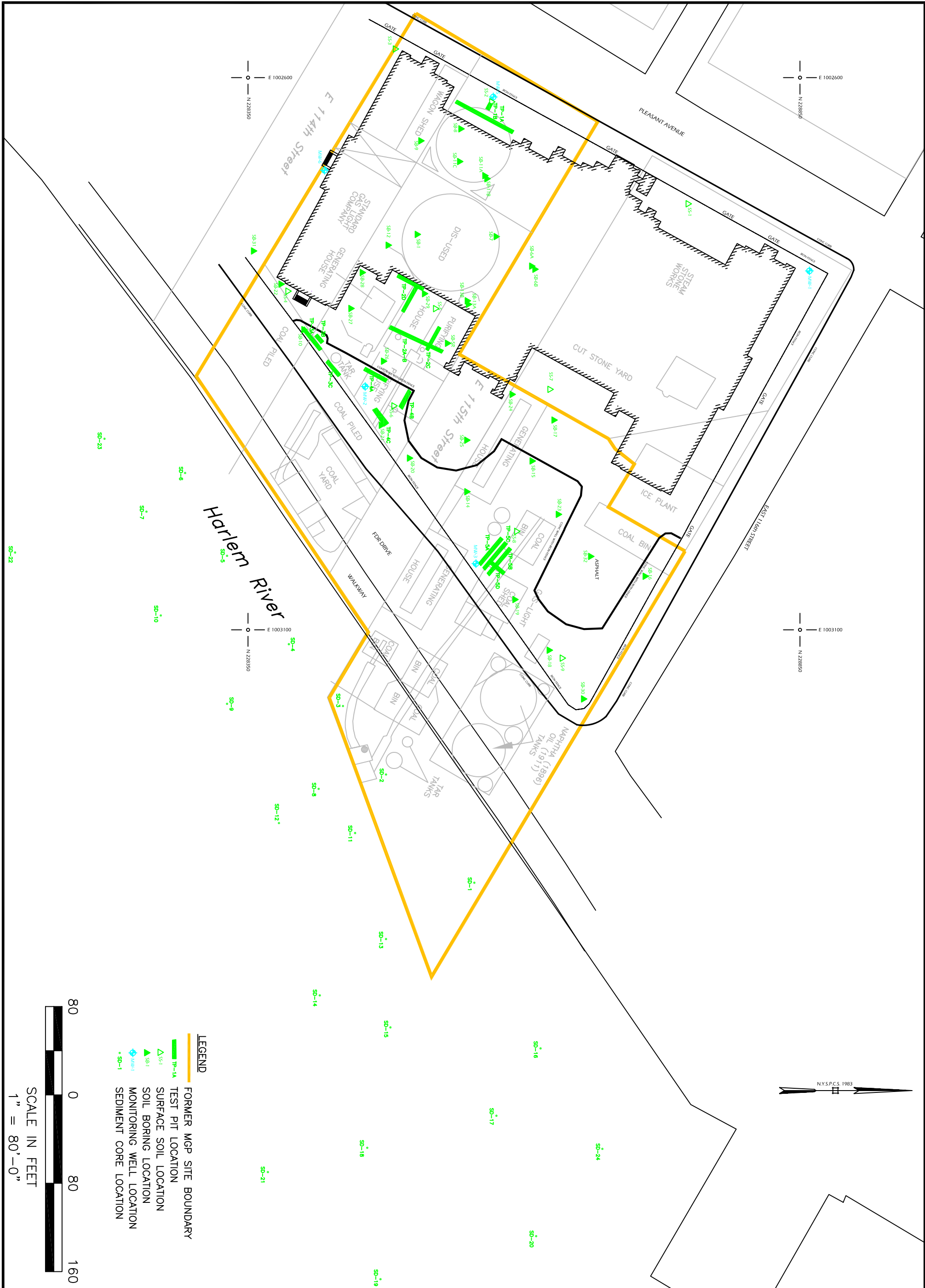
1

| | | |
|--|-------|-----------------|
| WATER TABLE MAP CONSOLIDATED EDISON EAST 115TH STREET FORMER MGP NEW YORK, NY | | |
| SCALE: | DATE: | PROJECT NUMBER: |
| 1" = 70' | 6/05 | 01869-089-0410 |

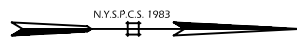
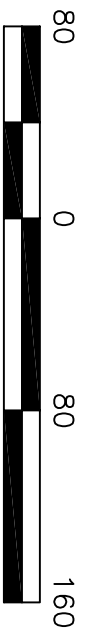
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| D.S. | | | | |



- LEGEND**
- FORMER MGP SITE BOUNDARY
 - TEST PIT LOCATION
 - ▲ SURFACE SOIL LOCATION
 - ▲ SOIL BORING LOCATION
 - ⊕ MONITORING WELL LOCATION
 - SEDIMENT CORE LOCATION

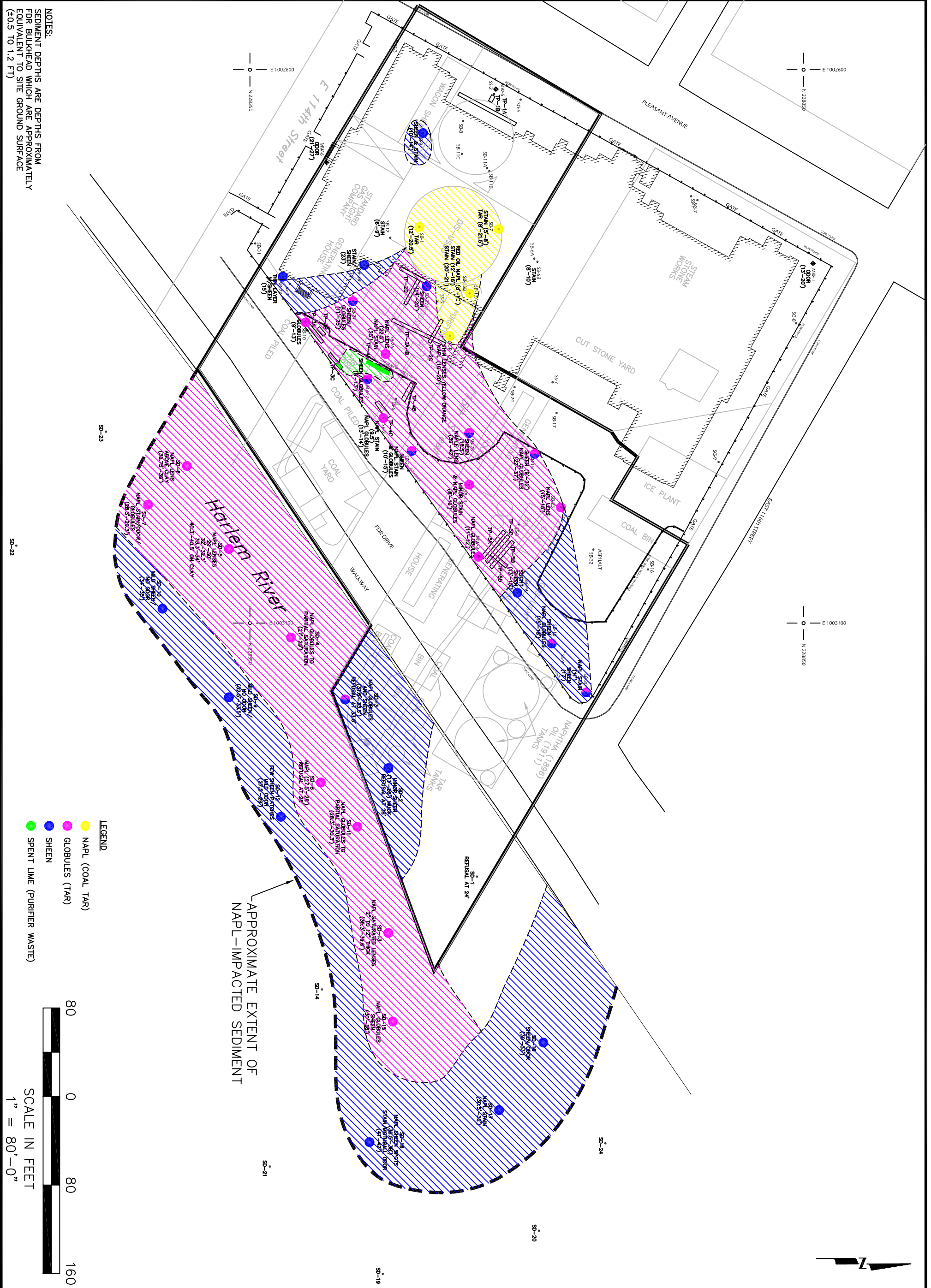


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|--------------------|
| 17 |
| FIGURE NUMBER: |
| SHEET NUMBER: 1 |

| | | |
|--|---------------|-----------------------------------|
| RI SAMPLING LOCATIONS CONSOLIDATED EDISON EAST 115TH STREET FORMER MGP NEW YORK, NY | | |
| SCALE: 1" = 80' | DATE: 6/05 | PROJECT NUMBER: 01869-089-0410 |

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| DRAWN BY: K.P.B. | | | | |
| CHECKED BY: S.O. | | | | |
| APPROVED BY: S.O. | | | | |



NOTES:
 SEDIMENT DEPTHS ARE DEPTHS FROM
 FDR BULKHEAD WHICH ARE APPROXIMATELY
 EQUIVALENT TO SITE GROUND SURFACE
 (±0.5 TO 1.2 FT)

LEGEND

- NAPL (COAL TAR)
- GLOBULES (TAR)
- SHEEN
- SPENT LIME (PURIFIER WASTE)

APPROXIMATE EXTENT OF
 NAPL-IMPACTED SEDIMENT



FIGURE NUMBER:

1.8

SHEET NUMBER:

1

EXTENT OF NAPL
 CONSOLIDATED EDISON
 EAST 115th STREET FORMER MGP
 NEW YORK, NY

| | | |
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| SCALE: 1" = 80' | DATE: 6/05 | PROJECT NUMBER: 01869-089-0410 |
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2.0 Exposure Assessment

The NYSDEC *Draft DER-10* specifies a qualitative exposure assessment that evaluates *if a site poses an existing or potential hazard to the exposed or potentially exposed population*. This section presents that assessment for the East 115th Street Former MGP Site.

2.1 Potentially Exposed Populations

The 115th Street Former MGP Site is currently used as a public school and surrounded by urban residential and commercial buildings. The property is currently covered either by the school building, concrete driveways, parking or sidewalks, the FDR Drive and associated walkway, or grass. Currently, potentially exposed human populations to site media include students, teachers, administrators, and nearby residents. Construction workers may also be potentially exposed should future construction occur at the Site.

MGP impacts have been observed at depth in sediments in the Harlem River adjacent to the Site. Currently, no human or ecological benthic populations are exposed to impacted sediments. Construction workers and ecological receptors may potentially be exposed should dredging of impacted sediments occur in the future.

2.2 Potential Exposure Pathways

The current Site use allows for the following potential exposure pathways:

Indoor Air – The school building is located over areas of the former MGP including the former gas holders. NAPL has been observed in one of the gas holders. Additionally, MGP constituents were observed in soil, groundwater, and soil gas beneath the building. While constituents present in these media have the potential to volatilize into building air, the building indoor air assessment, based on three rounds of indoor air sampling, showed that MGP constituents are not currently impacting the air in the building.

Soil Gas – MGP constituents have been observed in soil gas beneath the school building. However, soil gas samples collected near the north and east property boundaries along Pleasant Avenue and East 116th Street, in the only two areas bordered by buildings, contained only one constituent, naphthalene, that may be typically (though not uniquely) associated with MGP sources. Other constituents that could be associated with MGP operations, including benzene, were detected in these soil gas samples at low concentrations, close to the range of typical indoor air background values. Based on the low levels of these and other detected compounds, and the distance to the buildings, the potential for subsurface MGP vapor intrusion into the buildings located across East 116th Street and Pleasant Avenue is considered low.

Surface Soils – Students, teachers, administrators, and local residents may come in contact with surface soils. Current access to the Site is unrestricted and although fences are present they are not sufficient to prevent residents from coming in contact with soils. PAHs and inorganics were detected in some surface soil samples at concentrations above NYSDEC RSCOs (NYSDEC, 1994). However, concentrations of PAHs and metals are similar to those found in a recent background study conducted in Manhattan (Characterization of Soil Background PAH and Metals, Manhattan, New York, RETEC, 2007). The presence of these constituents in surface soil may be the result of urban pollution possibly associated with the adjacent FDR Drive and streets.

Subsurface Soils – If future construction were to occur at the Site, construction workers might potentially contact subsurface soils. Other receptors are unlikely to directly contact subsurface soils. Purifier waste (spent lime) and NAPL at the water table were observed in subsurface soils during the RI. The analytical results for the purifier material, however, show that all detected constituents were present at concentrations below the NYSDEC RSCOs. Analytical results show the presence of VOCs, SVOCs, and inorganics above

NYSDEC RSCOs near and below the water table. However, concentrations of these constituents were significantly lower in soils above the water table.

Groundwater – Groundwater in the area of the Site is not used for drinking water and, based on the conductivity of the water and elevated sodium concentrations, is brackish and would not be considered potable. Direct contact with groundwater, therefore, would likely only be by a construction worker. Groundwater from the Site is also discharging to the Harlem River, so groundwater discharge and potential NAPL migration are potential exposure pathways. Although a layer of separate phase NAPL was not observed in any of the monitoring wells up to one year after their initial installation, sheen was observed in development water from MW-2 and MW-3 located near the downgradient property boundary, and a small quantity (bead) of NAPL was observed on the fluid level tape when it was removed from MW-2. These observations indicate that although NAPL is present beneath the water table, it is not present and/or it is not sufficiently mobile to migrate into and accumulate in a well.

Sediment – Visible MGP impacts have been observed in sediment within the Harlem River to the southeast of the Site. These impacts are limited to depths ranging between 14 and 27 feet below the sediment surface. At these depths the impacts are confined by the overlying sediments and there is no ongoing release to surface water. If future dredging were to occur at the Site, construction workers might potentially contact impacted sediments. Additionally, during dredging, sediments might be suspended which might impact ecological receptors. The MGP sediment impacts are believed to be located below the biologically active zone, so they are not impacting potential ecological benthic receptors.

2.3 Contaminant Fate and Transport

MGP related constituents are present at the former 115th Street MGP Site. Potential sources include NAPL in one of the former gas holders, other potential NAPL sources associated with the MGP process in the general area of the gas holder, and purifier waste.

NAPL was not observed until the water table in areas of the Site around and downgradient of the gas holder containing NAPL and, therefore, appears to have migrated to these areas (Figure 1-8). Dissolved phase and NAPL migration are potential transport mechanisms at the Site. Groundwater at the Site discharges to the Harlem River, which is located downgradient and adjacent to the Site.

NAPL was also observed at depth in sediments adjacent to the Site. It appears that the NAPL migrated from the Site to this area in the subsurface. NAPL and dissolved phase migration are potential transport mechanisms for NAPL within the sediments adjacent to the Site, although on-going discharge of NAPL into the Harlem River is unlikely.

3.0 Remedial Goals, Remedial Action Objectives, and SCGs

The NYSDEC *Draft DER-10* specifies that the AAR should include a discussion of Remedial Action Objectives (RAOs) and Standards, Criteria, and Guidance (SCGs). This section presents that discussion for the East 115th Street Former MGP Site.

3.1 Remedial Goals

The primary remedial goal for the areas of East 115th Street Former MGP Site affected by MGP-related impacts is to restore these areas to the conditions that existed before the MGP-related contamination occurred to the extent feasible without unduly interfering with the manner in which the areas are presently used, or endangering the health or safety of the users of the properties or the surrounding community. If this goal cannot be met, the alternative remedial goal for the Site is to ensure that the MGP-related contamination does not present a threat to human health or the environment considering the manner in which the property is used and to develop and implement the necessary remedial actions to remediate the areas to a level that is protective of public health and the environment for such uses.

3.2 Remedial Action Objectives

RAOs by media are presented below (source - *Draft DER-10*).

Soil

RAOs for Public Health Protection

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

RAOs for Environmental Protection

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

Groundwater

RAOs for Public Health Protection

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards

RAOs for Environmental Protection

- Prevent migration of contaminants to surface water
- To the extent feasible and consistent with safety and other concerns identified above, undertake the treatment and/or removal of MGP source materials

Sediment

RAOs for Public Health Protection

- Prevent direct contact with contaminated sediments
- Prevent surface water contamination which may result in fish advisories

RAOs for Environmental Protection

- Prevent releases of contaminants from sediments that would result in surface water levels in excess of ambient water quality criteria
- Prevent impacts to biota from ingestion/direct contact with sediments causing toxicity or impacts from bioaccumulation through the marine or aquatic food chain

Surface Water

RAOs for Public Health Protection

- Prevent ingestion of water impacted by contaminants
- Prevent contact or inhalation of contaminants from impacted water bodies

RAOs for Environmental Protection

- Restore surface water to ambient water quality criteria for the contaminant of concern
- Prevent impacts to biota from ingestion/direct contact with surface water causing toxicity and impacts from bioaccumulation through the marine or aquatic food chain

3.3 Applicable Standards, Criteria and Guidance Values

The remedy evaluation portion of the AAR must consider applicable SCGs. The NYSDEC *Draft DER-10* includes a complete list of SCGs. SCGs for soil and groundwater include the NYSDEC RSCOs (*TAGM #4046*, NYSDEC, 1994) and the NYSDEC *Division of Water Technical and Operational Guidance Series - Water Quality Standards (WQS) - 6 NYCRR 700 to 706* (NYSDEC, 1998). These SCGs represent available criteria and guidance used by the NYSDEC to evaluate soil and groundwater quality. It should be noted, however, that neither the NYSDEC TAGM #4046 RSCOs or WQS are directly applicable to the Site. The Site property is not used for residential purposes and groundwater is not used as a drinking water source, nor are either of these conditions likely in the future. The NYSDEC TAGM #4046 RSCOs and WQS are provided as SCGs for comparison purposes only. For sediments samples, the remedy portion of the AAR considers SSCs as presented in the *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999a).

Since the original drafting the AAR report, NYSDEC has created additional clean-up values as part of 6 NYCRR PART 370. The PART 370 criteria include varying goals depending on site use (residential, residential restricted, industrial, etc). These goals may be applicable if site use changes in the future and alternative remediation approaches are considered.

3.3.1 Soil

The NYSDEC RSCOs and Eastern USA Background Concentrations are presented in *Technical and Administrative Guidance Memorandum #4046* (TAGM #4046, NYSDEC, 1994). TAGM #4046 RSCOs are

conservative values that were developed to be protective of human health residential exposure conditions and to be protective of groundwater quality assuming that groundwater is used as a source of drinking water. The following background values were developed based on information from *Background Concentrations of 20 Elements in Soil with Special Regard for New York State* (McGovern, 1988). Primary metals detected in soil at the Site and background values are as follows:

Aluminum – 25,000 mg/kg

Calcium – 35,000 mg/kg

Lead – 37 mg/kg

Magnesium – 4,000 mg/kg

Manganese – 5,000 mg/kg

Potassium – 43,000 mg/kg

Sodium – 8,000 mg/kg

The RSCOs for detected constituents in soils are summarized in Table 3-1.

3.3.2 Groundwater

Constituents in groundwater were compared to the NYSDEC *Division of Water Technical and Operational Guidance Series - Water Quality Standards*. Criteria were obtained from 6 NYCRR 700 to 706 (NYSDEC, June 1998), an errata sheet dated January 1999 (NYSDEC, 1999b), and an April 2000 addendum (NYSDEC, 2000). Standards and guidance values are available for different groundwater classifications and different endpoints. For the purpose of this report, values for protection of human health (drinking water) and aesthetics (fresh water) were used. These standards and guidance values are protective of groundwater quality assuming that groundwater is used as a drinking source. For some compounds, groundwater criteria are available for both human health (drinking water) and aesthetics (fresh water). In these cases, the lower criterion is selected to compare against Site data.

The WQS for detected constituents in groundwater are summarized in Table 3-2.

3.3.3 Sediments

Sediment analytical chemistry results were compared to the NYSDEC SSC as presented in the *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999a). The SSC are intended as screening criteria for determination of contamination, which can be identified by the exceedance of the SSC by a contaminant in sediment. The screening criterion is partitioned into five primary levels of protection for Equilibrium Partitioning (EP)-based sediment criteria and two levels of protection for metals. Once a site is found to be contaminated, further studies are required to quantify risk and determine if remedial measures are necessary. Although attainment of the SSC provides “maximum assurance of environmental protection,” it is not necessary in all cases and at all times to achieve these criteria through remediation efforts.” Several PAHs and metals contaminants found in the Site sediments could be attributed to naturally occurring or other non-MGP related sources. Contaminants at the Site will be further evaluated on a site-specific basis should they exceed the SSC.

As per the guidance document, in order to conduct screening, the NYSDEC SSC for organic compounds must be adjusted for each sediment sample based on that sample’s specific total organic carbon (TOC) value. Screening values for inorganic compounds do not require any adjustments. Table 3-3 presents applicable NYSDEC SSC contaminants as presented in the *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999b).

Table 3-1

**NYSDEC Recommended Soil Clean-Up Objectives for Detected Constituents
East 115th Street Former MGP
Consolidated Edison, New York, New York**

| Compound | NYSDEC Recommended Soil Cleanup Objective | Units |
|--|---|-------|
| BTEX Compounds | | |
| BENZENE | 0.06 | mg/kg |
| ETHYLBENZENE | 5.5 | mg/kg |
| TOLUENE | 1.5 | mg/kg |
| XYLENES, TOTAL | 1.2 | mg/kg |
| Volatile Organic Compounds (VOCs) | | |
| 1,2-DICHLOROETHENE (TOTAL) | 0.3 | mg/kg |
| ACETONE | 0.2 | mg/kg |
| CARBON DISULFIDE | 2.7 | mg/kg |
| STYRENE | NA | -- |
| TETRACHLOROETHENE | 1.4 | mg/kg |
| TRICHLOROETHENE | 0.7 | mg/kg |
| Total VOCs (Including BTEX) | 10 | mg/kg |

Table 3-1 (Continued)

**NYSDEC Recommended Soil Clean-Up Objectives for Detected Constituents
East 115th Street Former MGP
Consolidated Edison, New York, New York**

| Compound | NYSDEC Recommended Soil Cleanup Objective | Units |
|--|--|--------------|
| Polycyclic Aromatic Hydrocarbons (PAHs) | | |
| 2-METHYLNAPHTHALENE | 36.4 | mg/kg |
| ACENAPHTHENE | 50 | mg/kg |
| ACENAPHTHYLENE | 41 | mg/kg |
| ANTHRACENE | 50 | mg/kg |
| BENZO(A)ANTHRACENE | 0.224 | mg/kg |
| BENZO(A)PYRENE | 0.061 | mg/kg |
| BENZO(B)FLUORANTHENE | 1.1 | mg/kg |
| BENZO(GHI)PERYLENE | 50 | mg/kg |
| BENZO(K)FLUORANTHENE | 1.1 | mg/kg |
| CHRYSENE | 0.4 | mg/kg |
| DIBENZO(A,H)ANTHRACENE | 0.014 | mg/kg |
| FLUORANTHENE | 50 | mg/kg |
| FLUORENE | 50 | mg/kg |
| INDENO(1,2,3-CD)PYRENE | 3.2 | mg/kg |
| NAPHTHALENE | 13 | mg/kg |
| PHENANTHRENE | 50 | mg/kg |
| PYRENE | 50 | mg/kg |
| Semi-Volatile Organic Compounds (SVOCs) | | |
| 2-NITROPHENOL | 0.33 | mg/kg |
| 3,3'-DICHLOROBENZIDINE | NA | -- |
| BIS(2-ETHYLHEXYL) PHTHALATE | 50 | mg/kg |
| DIBENZOFURAN | 6.2 | mg/kg |
| Total SVOCs (Including PAH compounds) | 500 | |

Table 3-1 (Continued)

**NYSDEC Recommended Soil Clean-Up Objectives for Detected Constituents
East 115th Street Former MGP
Consolidated Edison, New York, New York**

| Compound | NYSDEC Recommended Soil Cleanup Objective | Eastern USA Background | Units |
|-------------------|--|-----------------------------------|--------------|
| Inorganics | | | |
| ALUMINUM | 25000 | 33000 | mg/kg |
| ANTIMONY | NA | NA | -- |
| ARSENIC | 7.5 | 12 | mg/kg |
| BARIUM | 300 | 600 | mg/kg |
| BERYLLIUM | 0.16 | 1.75 | mg/kg |
| CADMIUM | 1 | 1 | mg/kg |
| CALCIUM | 35000 | 35000 | mg/kg |
| CHROMIUM | 10 | 40 | mg/kg |
| COBALT | 30 | 60 | mg/kg |
| COPPER | 25 | 50 | mg/kg |
| CYANIDE | NA | NA | -- |
| IRON | 2000 | NA | mg/kg |
| LEACHABLE PH | NA | NA | -- |
| LEAD | 37 | 500 | mg/kg |
| MAGNESIUM | 4000 | 5000 | mg/kg |
| MANGANESE | 5000 | 5000 | mg/kg |
| MERCURY | 0.1 | 0.2 | mg/kg |
| NICKEL | 13 | 25 | mg/kg |
| POTASSIUM | 43000 | 43000 | mg/kg |
| SELENIUM | 2 | 3.9 | mg/kg |
| SILVER | N/A | NA | -- |
| SODIUM | 8000 | 8000 | mg/kg |
| THALLIUM | NA | NA | -- |
| VANADIUM | 150 | 300 | mg/kg |
| ZINC | 20 | 50 | mg/kg |

Table 3-2

**Water Quality Standards for Detected Constituents in Groundwater
 East 115th Street Former MGP
 Consolidated Edison, New York, New York**

| Compound | NYSDEC Water Quality Standards | Units |
|--|---|--------------|
| BTEX Compounds | | |
| BENZENE | 1 | ug/l |
| ETHYLBENZENE | 5 | ug/l |
| TOLUENE | 5 | ug/l |
| XYLENES, TOTAL | 5 | ug/l |
| Volatile Organic Compounds (VOCs) | | |
| 1,2-DICHLOROETHENE (TOTAL) | 5 | ug/l |
| ACETONE | 50 | ug/l |
| CARBON DISULFIDE | 60 | ug/l |
| CHLOROFORM | 7 | ug/l |
| METHYLENE CHLORIDE | 5 | ug/l |
| TETRACHLOROETHENE | 5 | ug/l |
| TRICHLOROETHENE | 5 | ug/l |

Table 3-2 (Continued)

**Water Quality Standards for Detected Constituents in Groundwater
 East 115th Street Former MGP
 Consolidated Edison, New York, New York**

| Compound | NYSDEC Water Quality Criteria | Units |
|--|--|--------------|
| Polycyclic Aromatic Hydrocarbons (PAHs) | | |
| 2-METHYLNAPHTHALENE | NA | -- |
| ACENAPHTHENE | 20 | ug/l |
| ACENAPHTHYLENE | NA | -- |
| ANTHRACENE | 50 | ug/l |
| BENZO(A)ANTHRACENE | 0.002 | ug/l |
| BENZO(A)PYRENE | 0 | ug/l |
| CHRYSENE | 0.002 | ug/l |
| FLUORANTHENE | 50 | ug/l |
| FLUORENE | 50 | ug/l |
| NAPHTHALENE | 10 | ug/l |
| PHENANTHRENE | 50 | ug/l |
| PYRENE | 50 | ug/l |
| Semi-Volatile Organic Compounds (SVOCs) | | |
| 4-METHYLPHENOL | 1 | ug/l |
| CARBAZOLE | NA | -- |
| DI-N-BUTYL PHTHALATE | 50 | ug/l |
| DIBENZOFURAN | NA | -- |

Table 3-2 (Continued)

**Water Quality Standards for Detected Constituents in Groundwater
 East 115th Street Former MGP
 Consolidated Edison, New York, New York**

| Compound | NYSDEC Water Quality Criteria | Units |
|---------------------|--|--------------|
| Inorganics | | |
| ALUMINIUM | NA | -- |
| ANTIMONY | 3 | ug/l |
| ARSENIC | 25 | ug/l |
| BARIUM | 1000 | ug/l |
| BERYLLIUM | 3 | ug/l |
| CALCIUM | NA | -- |
| CHROMIUM | 50 | ug/l |
| COBALT | NA | -- |
| COPPER | 200 | ug/l |
| CYANIDE - AMENABLE | NA | -- |
| CYANIDE - AVAILABLE | NA | -- |
| CYANIDE | 200 | ug/l |
| IRON | 300 | ug/l |
| LEAD | 25 | ug/l |
| MAGNESIUM | 35000 | ug/l |
| MANGANESE | 300 | ug/l |
| NICKEL | 100 | ug/l |
| POTASSIUM | NA | -- |
| SELENIUM | 10 | ug/l |
| SODIUM | 20000 | ug/l |
| THALLIUM | 0.5 | ug/l |
| VANADIUM | NA | -- |
| ZINC | 5000 | ug/l |

Table 3-3a
NYSDEC Sediment Screening Criteria (SSC) for Non-Polar Organic Compounds
East 115th Street Former MGP
Consolidated Edison, New York, New York

| Contaminant | LogK _{ow} | Salt-SW Fresh-FW Both-FS | Levels of Protection | | | | | | | |
|--------------------------------|--------------------|--------------------------------|------------------------------|-------------------|-------------------------------------|-------------------|---------------------------------------|-------------------|--------------------------|-------------------|
| | | | Human Health Bioaccumulation | | Benthic Aquatic Life Acute Toxicity | | Benthic Aquatic Life Chronic Toxicity | | Wildlife Bioaccumulation | |
| | | | Water Qual Criteria | Sediment Criteria | Water Qual Criteria | Sediment Criteria | Water Qual Criteria | Sediment Criteria | Water Qual Criteria | Sediment Criteria |
| | | | µg/l | µg/gOC | µg/l | µg/gOC | µg/l | µg/gOC | µg/l | µg/gOC |
| BTEX Compounds | | | | | | | | | | |
| Benzene | 2.0 | FS | 6.0 | 0.6 | | | | | | |
| Benzene | 2.13 | FW SW | | | 760 670 | 103 90 | 210 190 | 28 26 | | |
| Ethylbenzene | 3.15 | FW SW | | | 150 41 | 212 58 | 17 4.5 | 24 6.4 | | |
| Toluene | 2.69 | FW SW | | | 480 430 | 235 211 | 100 92 | 49 45 | | |
| Xylene | 3.15 | FW SW | | | 590 170 | 833 240 | 65 19 | 92 27 | | |
| PAH Compounds | | | | | | | | | | |
| Benzo(a)pyrene ¹ | 6.04 | FW SW | 0.0012 0.0006 | 1.3 0.7 | | | | | | |
| Flourene | 4.18 | FW SW | | | 4.8 23 | 73 348 | 0.54 2.5 | 8 38 | | |
| Isopropylbenzene (cumeme) | 3.66 | FW | | | 23 | 105 | 2.6 | 12 | | |
| 2-methylnapthalene | 3.86 | FW SW | | | 42 48 | 304 348 | 4.7 4.2 | 34 30 | | |
| Napthalene | 3.37 | FW SW | | | 110 140 | 258 328 | 13 16 | 30 38 | | |
| Pyrene | 5.32 | FW | | | 42 | 8775 | 4.6 | 961 | | |
| Anthracene | 4.45 | FW | | | 35 | 986 | 3.8 | 107 | | |
| Benz(a)anthracene ¹ | 5.61 | FW | | | 0.23 | 94 | 0.03 | 12 | | |
| 1,2,4-trimethylbenzene | 3.75 | FW SW | | | 290 170 | 1631 956 | 33 19 | 186 107 | | |
| Phenols, total unchlorinated | 2.0 | FW | | | | | 5.0 | 0.5 | | |
| Total PAH ² | 2.0 | FW | | | | | | 4000 | | |

Note:

SSC taken from the "Technical Guidance for Screening Contaminated Sediments" NYSDEC, 1999.

Where SSC was not provided in the technical guidance, the associated contaminant space has been left blank.

¹These values also apply to benzo(b)flouranthene, chrysene, indeno(1,2,3-cd)pyrene, and methylbenz(a)anthracene.

²The PAH SSC is parts per billion, dry weight

Table 3-3b
NYSDEC Sediment Screening Criteria (SSC) for Metals
East 115th Street Former MGP
Consolidated Edison, New York, New York

| Metal | Lowest Effect Level µg/g (ppm) | Severe Effect Level µg/g (ppm) |
|-----------|-----------------------------------|-----------------------------------|
| Antimony | 2.0 | 25.0 |
| Arsenic | 6.0 | 33.0 |
| Cadmium | 0.6 | 9.0 |
| Chromium | 26.0 | 110.0 |
| Copper | 16.0 | 110.0 |
| Iron (%) | 2.0% | 4.0% |
| Lead | 31.0 | 110.0 |
| Manganese | 460.0 | 1100.0 |
| Mercury | 0.15 | 1.3 |
| Nickel | 16.0 | 50.0 |
| Silver | 1.0 | 2.2 |
| Zinc | 120.0 | 270.0 |

Note:

Units are presented in µg/g, or ppm, except for iron, which is listed as a percentage.

SSC taken from the "Technical Guidance for Screening Contaminated Sediments" NYDEC, 1999.

4.0 Development of Remedial Action Alternatives

This section describes the remedial action alternatives evaluated for the Site in this AAR and also evaluates each alternative against criterion included in NYSDEC's Draft Technical Guidance for Site Investigation and Remediation (*Draft DER-10*).

4.1 Introduction

Remedial alternatives for the Site have been divided into three categories:

- Impacted Soil and Groundwater (below school building and outside),
- Impacted Subsurface Vapors, and
- Impacted Sediments in the Harlem River.

The unique aspects of soil/groundwater remediation under the building are discussed as part of the overall soil/groundwater remediation issues.

Con Edison and ENSR developed a preliminary list of remedial technologies for impacted Soil/Groundwater and Impacted Vapors. This preliminary list was presented to NYSDEC, New York City Department of Education (DOE), and representatives of the New York City's Mayor's Office at a meeting on November 9, 2005. Subsequent to that meeting, evaluation of impacted sediments was added to the media of concern. A general list of potential alternatives for sediments was developed based on United States (US) Environmental Protection Agency (EPA) guidance (Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, US EPA, 2005). The final list of technologies is as follows:

- Impacted Soil and Groundwater
 - No Action
 - Institutional Controls (included as part of all the options considered)
 - In-Situ Thermal Treatment
 - In-Situ Chemical Treatment
 - Excavation (under school building) and Off-site Disposal
 - Excavation (outside of school building) and Off-site Disposal
 - In-Situ Stabilization
 - Barrier (Cut-off) Wall and NAPL Recovery System – Downgradient of Property Boundary Along FDR Drive
 - Recovery Wells/Trenches
 - Complete Containment (Physical Barriers with Pump and Treat)
 - Permeable Reactive Barriers
- Impacted Subsurface Vapors
 - No Action

- Institutional Controls (included as part of all the options considered)
- Monitoring
- Passive Venting
- Active Venting
- Vapor Barriers
- Sediments
 - No Action
 - Institutional Controls
 - Monitored Natural Recovery
 - Capping
 - Dredging

For each technology a description and conceptual approach is provided. Technologies are then evaluated against six criteria. The six criteria are discussed below.

Overall Protection of Public Health and the Environment

Overall Protection of Human Health and the Environment consider how the remedial alternative prevents or mitigates potential risks. Current site conditions as well as possible future conditions are considered. This evaluation criterion also considers long-term effectiveness of the alternative.

As discussed previously in this report, current conditions do not appear to pose a significant risk to human health or the environment. Changes in site use could potentially result in exposure scenarios that would result in a significant risk. Alternatives that maintain the current condition of no significant risk or permanently reduce or eliminate exposure pathways under any reasonable future site use without causing significant risks during implementation are rated as “Good.” A “Fair” rating is applied to alternatives that provide adequate protection of human health and the environment but have one or more potential drawbacks. Drawbacks would include factors such as reliance on long-term maintenance or institutional controls, and uncertainty regarding the final levels of contamination. A “Poor” rating applies to alternatives that do not protect against reasonably foreseeable future exposures to site contaminants or may increase the likelihood of certain exposure scenarios (e.g., increased contaminant mobility or toxicity). A rating of “Unacceptable” is given to alternatives that, on balance, pose more risks to Human Health and the Environment than no action.

Compliance with Standards, Criteria, and Guidance (SCGs)

Compliance with SCGs addresses whether the remedy will meet the remedial goals and SCGs presented in Section 3. General remedial objectives are to provide protection of human health and the environment consistent with current and intended use of the property. Considering the use of the property as a school, conducting remedial activities in a manner that will not endanger the public is of paramount importance. The most relevant SCGs for soil remediation are the RSCOs of 10 mg/kg total volatile organics (TVOC), 500 mg/kg total semi-volatile organics (TSVOCs). RSCOs for individual VOCs and SVOCs are also relevant. Under current conditions, indoor air goals are achieved. Maintaining acceptable indoor air levels is a key remedial goal. A rating of “Good” is given to alternatives that are expected to achieve all the remedial goals and either achieve the SCGs or is expected to result in significant (90% or more) reductions in current concentrations. A rating of “Fair” is given if an alternative will achieve the remedial goals but is not expected to achieve the SCGs. A rating of “Poor” is given if an alternative is not expected to achieve most of the remedial goals and SCGs.

Long-Term Effectiveness and Permanence

Long-term Effectiveness and Permanence evaluates the magnitude of remaining risks and the adequacy and reliability of controls. Alternatives received a rating of “Good” if there is a reasonable expectation that the primary treatment goals can be reached. Alternatives that do not require maintenance of any on-going site controls generally were rated higher than alternatives that required on-going maintenance activities. Alternatives that completely remove or completely destroy contaminants received a better rating than alternatives that change the chemical composition or rely on containment. If an alternative has been successfully implemented at another MGP site under similar conditions and demonstrated long-term effectiveness, the technology generally receives a rating of “Good.” A rating of “Fair” was given to alternatives that had a reasonable expectation of providing a permanent remedy. Alternatives with a “Fair” rating may result in contaminants remaining in place and may require long-term maintenance of controls. A “Poor” rating was given to alternatives that do not remove or treat contaminants, do not provide adequate controls to prevent future exposure scenarios, or rely on on-going maintenance of controls that will be difficult to assure. A rating of “Unacceptable” is given to technologies that have been tested under similar conditions and were found to be ineffective.

Reduction in Toxicity, Mobility and Volume

Reduction in Toxicity, Mobility, and Volume (TMV) considers the amount of contaminants that are permanently destroyed, immobilized, or otherwise treated. The degree to which the treatment may be irreversible and the nature and amount of treatment residuals are considered. Alternatives that remove contaminants from the Site or that fully treat (i.e., mineralize) contaminants received a rating of “Good.” A rating of “Fair” was provided to alternatives that immobilize contaminants, reduce contaminants to less toxic forms, or provide only partial treatment. Treatment alternatives that are reversible or provide no significant reduction in toxicity, mobility, or volume received a rating of “Poor.” A rating of “Unacceptable” was given to technologies which under similar circumstances increased the toxicity, mobility, or volume of contaminants.

Short-Term Effectiveness

Short-term effectiveness evaluates potential risks to the public, remediation workers, and the environment during implementation of the remedy. The duration of remedial activities is also considered. Alternatives with minimal intrusive site work received a rating of “Good” for short-term effectiveness. Alternatives that pose short-term risks that can be effectively managed received a rating of “Fair.” Alternatives received a rating of “Poor” if they present significant short-term risks and the ability to fully control these risks is uncertain. In general, alternatives that include bringing partially treated or untreated contaminants to the surface received a rating of “Fair” if potential exposures are short and easily controlled. If contaminants are brought to the surface over a long period of time and exposures are difficult to control a rating of “Poor” was given to the alternative. A rating of “Unacceptable” is given to technologies that, despite implementation of control technologies, would still present unacceptable risks to receptors.

Implementability

Implementability considers potential obstacles to construction of the remedy at the Site. The availability of personnel and equipment to implement the remedy is considered as is the need for permits and the likelihood of obtaining regulatory approvals. Site owner acceptance of the alternative is also a key implementability issue. The expected effectiveness and ability to monitor the effectiveness of the alternative are also considered. To a large degree, implementability is evaluated based on case studies of this technology under similar circumstances. Alternatives that are known to have been successfully implemented at similar sites received a rating of “Good.” Alternatives that are likely to be implemented successfully but where uncertainty exists in terms of effectiveness, ability to confirm treatment, or require extensive permitting received a rating of “Fair.” A “Poor” rating was given to alternatives that are expected to be difficult. A rating of “Unacceptable” is given to alternatives that are not possible to implement. For this Site, alternatives that require the school to be

closed are considered “Unacceptable” for implementability. If work can be completed during the brief summer recess, an alternative that requires indoor work could possibly still be implemented.

Cost

An estimation of capital and operational costs for the alternatives is provided for reference and comparison.

Community Acceptance

Community acceptance will be evaluated at a later time as part of the public hearings which are part of the Citizen Participation Plan.

4.2 Impacted Soil and Groundwater

The primary remedial goal for impacted soil and groundwater is to prevent NAPL migration and dissolved-phase constituents in groundwater migration to the adjacent Harlem River. Removal of sources of contamination to the extent feasible is also an important goal. Nine alternatives will be evaluated for soil and groundwater. As discussed in each section some technologies apply only to the source material beneath the building and other technologies apply only to the area outside the building:

- Alternative 1 – No Action (applies to both under school building and other side areas)
- Alternative 2 – In-Situ Thermal Treatment (primarily applies to source material under school building)
- Alternative 3 – In-Situ Chemical Oxidation (primarily applies to source material under school building)
- Alternative 4a – Excavation Under School Building
- Alternative 4b – Excavation Outside of School Building
- Alternative 5 – In-Situ Stabilization (outside of school building)
- Alternative 6 – Barrier Wall and NAPL Recovery System Downgradient Property Boundary (outside of school building along FDR Drive)
- Alternative 7 – Recovery Wells/Trenches (outside school building)
- Alternative 8 – Physical Barriers with Pump and Treat (360 degree complete containment wall)
- Alternative 9 – Permeable Reactive Barriers (outside school building)

All of the remedial alternatives presented above (except for No Action) would include institutional controls. Institutional controls may include implementing soil management and health and safety plans for any subsurface excavation work, restrictions on the use of groundwater, and incorporating issues related to soil and groundwater contamination into the design and construction of any new facilities at the Site.

The area to be evaluated includes soil and groundwater beneath a portion of the School building and soil and groundwater in the area between the School building and the FDR Drive. These areas are discussed in more detail below.

Impacted materials beneath the school building include material present in the main gas holder, impacted soil in the vicinity of the main gas holder, and groundwater. Impacted areas are shown in Figure 4-1. The main

gas holder appears to be the primary source of MGP contaminants at the Site. Physical features of the main gas holder and nearby media include the following:

- Diameter estimated to be 90 feet.
- From the basement floor to the apparent bottom of the gas holder is 20 feet.
- The design of the gas holder is not known with certainty, but based on test pitting around the smaller gas holder and boring logs within the main gas holder, the holder walls are believed to be brick and the holder bottom is concrete.
- The total volume of material in the main gas holder is 4,700 cubic yards and includes debris (bricks, wood, and concrete). The first 5 or 6 feet of soil below the basement floor does not appear to be impacted.
- Based on examination of soil cores, NAPL is believed to be present within the main gas holder from approximately 14 to 20 feet below the basement floor. The amount of NAPL in and around the gas holder cannot be estimated with certainty, but it is likely that thousands of gallons of NAPL are present.

Impacted soil and NAPL are also expected to be present in the area around the main gas holder. As shown in Figure 1-8, the estimated total surface area of impacted soil in and around the main gas holder is 160 by 160 feet. The estimated total volume of impacted soils, assuming soil is impacted from 6 feet to the clay layer at 25 feet is 18,000 cubic yards. Remedial design work may include additional soil borings to better define the impacted area underneath the building.

Groundwater is present at approximately 5 to 6 feet beneath the basement floor. Due to the presence of NAPL, groundwater beneath the building is expected to be impacted with VOCs and SVOCs at levels exceeding the SCGs. Soils below the water table consist of sand with silt and clay lenses to a depth of 25 feet below the basement floor. The clay unit may serve as an aquitard. Bedrock is present at approximately 40 feet below the basement floor. Cross sections showing soil types are provided in Figures 1-3 and 1-4.

Use of the school building includes summer schools; the only time when the school does not host students is a two-week period during the summer. According to the school design drawings (Foundation Plan, Benjamin Franklin HS Manhattan, May 13, 1940) the building rests on 240 piling clusters. Piling clusters consist of one to six individual pilings. Pilings were driven as hollow steel tubes to bedrock then cleaned-out and filled with concrete. Estimated quantities in the design drawings indicate that the depth to bedrock estimated in 1940 is similar to that observed in the Supplemental RI. Piling clusters are present every 28 feet (or less) along the outside walls of the building. A tighter spacing of pile clusters is present within the building. At least 4 pile clusters are present within the footprint of the main gas holder. It is not known if these piles pierce the gas holder floor. The basement floor is 8 to 12 inches in thickness with steel rod reinforcements.

The area for remediation between the school building and the FDR Drive and is bounded to the north by 116th Street and to the south by 114th Street. The area is approximately 55,000 square feet or 1.25 acres. The area immediately adjacent to the school is raised 3 or 4 feet above the area adjacent to the FDR Drive, and is roughly 75% paved. The raised area includes paved walkways and courtyard areas with grass and trees. The areas adjacent to the FDR Drive are mostly grass covered. A fence, trees, and walkway separate the property boundary from the FDR Drive.

Known utilities in this area include buried low voltage electrical lines servicing the light poles in the area and a "sewer" drain that runs west to east approximately through the center of the area. The sewer drain is large (10 feet wide by 5 feet high, based on Triborough Bridge Authority Design Drawings, November 12, 1935) and will be a significant obstacle during remediation. Built prior to 1935, the drain may have been a combined storm

and sanitary drain. At the present time the drain is probably just a storm drain. The storm drain runs underneath the FDR Drive and discharges to the Harlem River. Other utilities, probably abandoned, may be present along the old alignment of 115th Street. Several buried utilities are also present just east of the school property under the walkway and a fiber optic cable enters the Site at the corner of 116th Street and Pleasant Avenue.

Because remedial activities may be conducted close to the FDR Drive, a brief review of construction details for the FDR Drive was conducted. The base of the FDR Drive is a concrete slab supported by wooden piles on 4 to 6 foot centers. A sheet pile wall is located between the school property and the FDR Drive. The sheet pile wall was driven to a depth of 16 feet below the mean low water level (probably not to bedrock). Wooden pilings and braces are bolted to the sheet pile wall. While the available drawings are not entirely clear, there appears to be a gap in the wall along the old alignment of 115th Street. It appears that remedial activities could be conducted on school property relatively close to the FDR Drive without impact to the roadway. However, this tentative conclusion must be verified with test pits to confirm subsurface features and by assessment by a geotechnical engineer. Additionally, it appears that remedial activities can not be safely performed under the FDR Drive or adjacent walkway.

Soil below the pavement and grass in this area consists of fill (building debris, brick, concrete, metal, clinker and coal), to 6 to 18 feet deep. Beneath the fill layer is a sand layer of 10 to 15 feet in thickness. Silt and peat was also observed in some areas below the fill layer. Soil types beneath the sand layer vary significantly. A clay layer is present below the sand layer in the area immediately downgradient of the main gas holder. The clay layer is present at 25 to 30 feet below the surface. Below the clay is another layer of sand then bedrock. The clay layer is not present in the central portion of the Site or the eastern side of the Site at the corner of East 116th Street and the FDR Drive. In the central area, relatively permeable soils are present to bedrock. In the eastern portion of the Site, peat and silt layers are present at approximately 16 feet below ground surface. Bedrock is generally encountered at 30 to 40 feet below the ground surface.

Odors and soil staining indicative of MGP impacts were encountered in most of the soil borings in the area east of the school building. NAPL globules and sheen were also noted in several borings. In general, MGP impacts were not observed above the water table in the top 10 feet of soil. In most cases, MGP impacts were also not observed or were greatly diminished below the clay and peat layers. Where clay or peat was not present, MGP impacts were noted at the bedrock surface. Outside the building, significant accumulations of NAPL have not been observed in the monitoring wells and soil staining is generally limited to a few feet. While MGP impacts are evident throughout the area, large accumulations of NAPL do not appear to be present outside the building footprint.

Remedial alternatives for soil and groundwater will have to consider impacts to the people that use the School and potential impacts to the structure itself. These issues are key considerations in the evaluation of each alternative. Alternatives that require that the school be shut down are not acceptable for implementability. Alternatives that involve the long-term (over two weeks) installation and operation of equipment (injection wells, piping electrical service, etc.) are also not compatible with school use and are not acceptable. As discussed in the evaluation of each technology, the approach to applying the technology considers limitations of site access.

4.2.1 Alternative 1 - No Action

This alternative does not include any remedial activities or institutional controls; therefore, the impacted soil and groundwater would remain in their current conditions, without any changes in constituent concentrations occurring. Because the No Action alternative does not include any institutional controls, it is possible that future activities could lead to exposure to soil and groundwater. The No Action alternative includes five-year remedy reviews. This alternative serves as a baseline condition against which other remedial alternatives are compared.

A summary of the No Action Alternative for Groundwater is as follows:

1. Size and configuration of process options: None
2. Time for remediation: None
3. Spatial requirements: None
4. Options for disposal: No waste would be generated
5. Permit requirements: None
6. Limitations or other factors necessary to evaluate the alternative: None
7. Beneficial and/or adverse impacts on fish and wildlife resources: No action would not change current conditions and would have no impact on fish and wildlife resources

Following is a summary of the evaluation of this alternative:

Overall Protection of Human Health and the Environment: This alternative is rated “Unacceptable.” The No Action alternative does not involve any remedial activities or institutional controls; therefore, potential risks to human health and the environment are not reduced. Current conditions do not appear to pose an unacceptable risk. However, No Action does not provide any control of future activities, such as extraction and use of groundwater, which may create an exposure pathway. Because this alternative does not control future activities that may lead to any unacceptable exposure, this alternative is rated as “Unacceptable.”

Compliance with Standards: This alternative is rated as “Poor.” This alternative does not comply with the chemical-specific groundwater goals. This alternative does not remove or treat grossly contaminated saturated soils or free product to the extent feasible.

Long-term Effectiveness and Permanence: This alternative is rated as “Poor.” This alternative does not provide long-term risk controls.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is rated as “Poor.” Treatment activities are not included in the No Action alternative. Consequently, no reduction of toxicity, mobility, or volume of contamination would occur.

Short-term Effectiveness: This alternative is rated as “Good.” Because there is no remedy implementation, there would be no additional risks to surrounding community, workers, or the environment. This option requires no time to implement.

Implementability: This alternative is rated as “Good.” This alternative is easy to implement from a technical standpoint. Regulatory support is needed to perform the five-year remedy reviews.

Cost: There are no capital costs associated with this alternative. The only O&M cost is associated with 5-year remedy reviews and is estimated to be \$10,000 every five years. Over a 30-year period, the estimated cost is \$60,000.

4.2.2 Alternative 2 - In-Situ Thermal Treatment (ITT)/NAPL Recovery

During the ITT process, soil, groundwater, and NAPL are heated in-place. Typically, heat is applied through a series of tightly-spaced wells (15-foot spacing or less). There are three basic means of heating: steam injection, electrical resistance, and thermal conductance. With steam injection, steam is generated above ground and injected into the subsurface. A vapor extraction system is used to recover vapors and excess steam. Steam injection is often used in conjunction with NAPL recovery wells. Use of steam injection improves NAPL recovery by heating and mobilizing NAPL. Electrical resistance heating involves installation of

electrodes and creating an electrical current between the electrodes. Resistance to electrical flow causes the soil and water to heat up. A vapor extraction system is used to recover vapors and any steam that is generated in the subsurface. Electrical resistance heating can also be used to improve NAPL recovery via pumping wells. Typically the maximum temperature achieved with steam injection and electrical inductance heating is 212°F. Thermal conductance heating utilizes heater elements in wells to directly heat subsurface soils. Temperatures of 600°F or more can be achieved with thermal conductance heating.

ITT could be designed to accomplish three types of goals. These goals are presented below from the least aggressive to the most aggressive goal:

- **Enhanced NAPL Removal:** Any of the three heating methods could be used to increase the amount of NAPL (tar) materials that could be pumped out of the main gas holder and from the surrounding soils. When heated, the tar becomes much less viscous and is easier to extract. Pumping out the tar, even after heating, would not remove all of the tar as some tar would remain adhering to the soil and debris. However, heating and pumping might be successful at removing all of the mobile tar and reducing subsurface vapor concentrations. Relatively mild heating (to 160°F, based on ENSR experience at similar sites) would be required for enhanced NAPL recovery. The duration of heating and extraction of NAPL is not known.
- **Removal of Volatiles:** MGP tar consists of a mixture of hydrocarbons. Lower molecular weight hydrocarbon compounds such as benzene and toluene are relatively volatile. Heavier weight hydrocarbons, such as long chain aliphatics and polyaromatics compounds are much less volatile. In theory, heating could be used to drive off the more volatile compounds in the tar, while the heavier compounds would be left in place. The remaining heavier and less volatile compounds would not be volatile and would not cause elevated subsurface vapor concentrations. Also, removal of volatiles would render the tar immobile. The temperature and treatment time required to drive off the volatiles is not known. A bench-top treatability test would be needed to determine the optimal temperature, treatment time, and appropriate treatment standard. Because the practical heating limits are 212°F for steam heating and electrical resistance heating, these technologies might not be adequate for volatiles removal.
- **Complete Treatment of Tar:** At very high temperatures (estimated to be 600°F or more) the tar could be completely destroyed or removed. Some of the tar components would be volatilized and be captured in the vapor recovery system. Other components of the tar would thermally degrade in place. Conductance heating is the only thermal treatment technology expected to be able to reach the temperatures required for complete tar removal. This technology would require several hundred heater wells and several months to complete. As discussed in more detail in this section, full thermal treatment would displace students and therefore is “unacceptable” for implementability.

The treatment goals for ITT and the specific heating method (steam, electric, or conductance) would be determined in the remedial design phase. Full-scale treatment by ITT would require the installation and long-term operation of several hundred vertical heater wells inside the building. Full-scale ITT can not be conducted without closing the school and, therefore, will not be considered further. Use of horizontal drilling might allow the positioning of treatment equipment outside the building and allow ITT treatment without closing the school. ITT treatment via horizontal wells might be effective at enhancing NAPL removal and removal of volatiles. However, a sufficiently dense grid of horizontal wells for full thermal treatment can not be installed. Further, reaching the very high temperatures (over 600°F) for complete treatment while the building is occupied is not considered to be practical.

The area being considered for treatment is shown in Figure 4-1. Figure 4-2 shows a cross-sectional view of a conceptual ITT system for the Site. While it would be possible to apply ITT treatment both within the footprint

of the building and in the outside areas, the evaluation of ITT will focus on its possible use inside the building footprint. The area inside the building footprint appears to contain the most NAPL material and therefore is the focus of evaluations for source removal.

To better assess the feasibility and pros and cons of ITT treatment, ENSR prepared a Pilot Study Work Plan for ITT Treatment. The Pilot Study Workplan provides a detailed assessment of how ITT might be implemented. To prepare the Pilot Study Workplan, ENSR worked with vendors specializing in horizontal drilling and in ITT technologies. The Pilot Study Work Plan is provided as Appendix A.

A summary of the limited ITT process is as follows, additional details are provided in the Pilot Study Work Plan:

1. Size and configuration of process options: A limited ITT approach might include horizontal wells drilled from outside the building that reach into the gas holder underneath the building. The horizontal wells would likely be drilled at various depths and would include heater wells, NAPL/groundwater recovery wells, and vapor extraction wells. The heating process could potentially create light non-aqueous phase liquid (LNAPL). Thus, LNAPL recovery wells would be included in the design. Extensive piping and electrical conduits are required to service the wells. Aboveground equipment would include vapor treatment (carbon vessels or thermal oxidizer), and water treatment facilities (storage tanks, pumps, carbon vessels). Equipment to service the horizontal wells would be located outside the building in a fenced in area.
2. Time for remediation: Two to three years would be required for ITT implementation. During this period the volume of NAPL recovery and concentration of recovered vapors would be monitored. ITT treatment would be terminated when NAPL recovery and vapor recovery tails off.
3. Spatial requirements: Work inside the building would be limited to installing temporary vertical borings to help guide the horizontal drilling and monitoring during ITT operation. The vertical boring installation would have to be limited to a few weeks a year during summer recess. An area of about 50 by 50 feet in the outside courtyard area would be fenced in. Process equipment would be located in the outside area.
4. Options for disposal: In the early phases of ITT, NAPL would be removed by pumping. The volume of NAPL is not known but may be several thousand gallons. The NAPL would be treated off site at a regulated facility. Spent activated carbon from vapor treatment and groundwater treatment would be sent to an off-site regeneration facility. Several thousand pounds of spent carbon would be generated. Well tailings and other construction waste would be characterized and sent to an appropriate off-site facility.
5. Permit requirements: A permit to discharge treated water to surface water or a Publicly Owned Treatment Works (POTW) would be required. Also, any air treatment equipment would be required to meet substantive permit requirements. Electrical, plumbing, and construction permits might also be required.
6. Limitations or other factors necessary to evaluate the alternative: A bench top study using soil and NAPL from the Site is suggested. Materials from the Site would be subjected to various heating conditions. Factors such as residual volatiles after heating and NAPL mobility after heating would be measured. From this study the temperature and duration of heating could be estimated. A geotechnical evaluation of the building is necessary to design the horizontal drilling program.

7. Beneficial and/or adverse impacts on fish and wildlife resources: Implementation of ITT under the building would have no impact on fish and wildlife.

Overall Protection of Public Health and the Environment

ITT is rated as “Fair” for Overall Protection of Public Health and the Environment. Current site conditions do not pose a significant risk to public health or the environment. Thus, the potential net benefit from application of the ITT process is small. ITT would reduce potential future exposure to vapors by reducing volatile components of the NAPL. Treatment would be permanent. The degree of treatment possible under site conditions is not known. It is not likely that ITT treatment can reduce contaminant levels to the point where the need for institutional controls to prevent uncontrolled exposure to subsurface materials is eliminated.

Compliance with Standards, Criteria and Guidance

ITT is rated as “Fair” for this criterion. The general remedial goals of maintaining a condition of no significant risk under current conditions has already been achieved. ITT might be capable of significantly reducing sub-slab vapor concentrations and removing NAPL. Thus, the potential for unacceptable indoor air concentrations occurring in the future would be reduced. ITT would significantly reduce TVOC concentrations in soil. However, achieving the RSCO of 10 mg/kg at all locations might not be practical. Additionally, achieving the 0.06 mg/kg RSCO for benzene is probably not feasible with ITT. ITT would also reduce SVOC levels through removal of NAPL and thermal degradation. Achieving the RSCO of 500 mg/kg TSVOCs and 50 mg/kg for individual SVOCs is not likely. Thermal treatment may be considered to comply with section 4.1(d) of *Draft DER-10* which requires removal of sources of contamination to the extent feasible.

Long-Term Effectiveness and Permanence

ITT is rated as “Fair” for this criterion. This technology has been used successfully for similar contaminants (MGP residuals in a gas holder). However, the technology has not been applied previously in an occupied school. Removal of volatiles would reduce potential future risks from vapors. Less volatile compounds might also be reduced or destroyed depending on how aggressively ITT is implemented. Given the site conditions, ITT would not be capable of removing all the NAPL and vapors. Thus, engineering controls or other measures would be needed to mitigate exposures related to vapors. As the ITT process is irreversible, remedial goals achieved through ITT would be met into the future.

Reduction of Toxicity, Mobility, or Volume with Treatment

ITT rated as “Good” for this criterion. Toxic compounds of the NAPL, particularly volatiles, would be removed. Some components of the NAPL would be destroyed in place; other organics would be treated during carbon regeneration resulting in their complete destruction. In theory, less aggressive treatment would remove volatiles and render the NAPL immobile. ITT would reduce the volume of NAPL and NAPL-impacted soil. Long-term engineering controls or institutional controls related to NAPL migration would still be necessary. Long-term controls related to vapor intrusion into the building might also be unnecessary. Because ITT might not completely destroy or remove all of the MGP material, long-term institutional controls to prevent excavation and worker contact with subsurface soils might be needed.

Short-Term Effectiveness

ITT is rated as “Poor” for this criterion. The process would involve bringing heated NAPL and vapor to the surface. The process also involves high temperatures and use of high voltage electricity. Exclusion of the public from certain areas and engineering controls are required to control these hazards. Engineering controls include a vapor recovery and treatment system, keeping treatment areas inside the building under negative pressure, overflow controls for storage vessels, and interlocks for process equipment. Fencing and walls would be used to prevent public access to outside areas where process equipment would be deployed. The

ITT process has been safely used at several sites, although ENSR is not aware of situation where ITT was used in an occupied school. Full treatment would take two to three years to complete.

Implementability

ITT is rated as “Poor” for this criterion. The conventional approach to ITT treatment of using a large number of vertical wells can not be used at this site and is not proposed. Instead, use of horizontal wells installed from outside the building is evaluated. Even this approach would require extensive work that might be disruptive of school operations. Work would include fencing in part of the courtyard, excavation along the building footing, horizontal drilling, installation of electrical service to the heater wells, and construction of a water treatment system. Considering the building design, the viability of horizontal drilling is not known with certainty. Pilings and pile caps under the building would have to be avoided. Due to the density of the pilings, avoiding them might not be possible. Because the building is supported by pilings, hitting and damaging a piling must be avoided. The floor might be damaged and require replacement. Settling of soils from heating and removal of NAPL might occur. Review and approval by a geotechnical engineer and monitoring would be required. A permit to discharge treated water to surface water or a POTW would be required. Also, any air treatment equipment would need to meet substantive permit requirements. Electrical, plumbing, and construction permits might also be required although, no difficulties in obtaining these permits are anticipated.

Cost

The estimated capital cost for ITT treatment is \$2,000,000 to \$5,000,000 (for the less aggressive treatment). Operational costs would be \$500,000 to \$1,000,000.

4.2.3 Alternative 3 - In-Situ Chemical Oxidation, Surfactant Flushing, and Biodegradation (Chemical Treatment)

Chemical treatment can take several forms. As in the case of ITT Treatment, to assist in evaluating Chemical Treatment, ENSR worked with several vendors and compared various approaches. The results of this work and comparison were then incorporated into the Pilot Study Work Plan. The Pilot Study Work Plan identifies a combination of Surfactant Flushing followed by In-Situ Chemical Oxidation (ISCO) as the most viable approach for chemical treatment. Surfactant Flushing involves injection of a chemical designed to increase the solubility of NAPL. After injection, time is allowed for the surfactant to dissolve the NAPL and then the solution is pumped-out. In the ISCO process, oxidants are injected into the subsurface to react with contaminants. A wide variety of oxidants, additives, and delivery methods are available. Ideally, contaminants are broken down to non-toxic constituents. In this case, the desired end points would be carbon dioxide and water. The oxidation process primarily works for contaminants dissolved in water. However, the process often acts to desorb contaminants from soil and then treat those contaminants. ISCO and Surfactant Flushing can also promote conditions favorable for biodegradation of contaminants. Additionally, desorption of contaminants from soil might make contaminants more accessible to microbial degradation.

As with the ITT process, conventional chemical treatment requires the installation of several vertical injection wells in the treatment area. Installation of vertical wells inside the building and injection of chemicals with the building is not compatible with school operations and thus is not possible. A scaled-down approach which relies on horizontal wells for chemical delivery was evaluated in detail in the Pilot Study Workplan. This approach might not be capable of treating all the NAPL and impacted soil. However, it might be capable of facilitating the removal of NAPL, reducing the mobility of residual NAPL and reducing vapor concentrations.

To implement Chemical Treatment at the Site, a series of wells would be installed to serve as injection points. Horizontal wells drilled from the outside courtyard would be used. Liquid chemical mixtures would be injected via drums, tanks placed outside, or tanker trucks. Injections might be gravity feed or more likely pumped to achieve higher injection pressures. Several injection events are typically required. Injection of the treatment liquids would cause groundwater mounding, generation of heat, and possibly steam generation. Therefore,

installation of a vapor extraction system would be required to assure that the Chemical Treatment process does not release vapors into the building. Also, a groundwater/NAPL extraction system would need to be installed.

After each injection event, groundwater and soil monitoring would be conducted to evaluate the effectiveness of injection. Groundwater monitoring would include water elevations, NAPL measurements, and levels of dissolved phase liquids in groundwater. Increases in NAPL thickness and dissolved phase constituents might occur in the early phases of chemical injections. Soil sampling before injection and after each injection event would be performed to evaluate how much MGP material is being desorbed from the soil. In this application, the primary goal of treatment is to enhance the removal of NAPL. Thus, the design would include NAPL recovery wells both within and downgradient of the treatment area. NAPL thickness in monitoring and recovery wells would be measured. The amount of NAPL recovered would be monitored overtime. Chemical treatments would be discontinued when the rate of NAPL recovery dropped.

The effectiveness of Chemical Treatment is highly dependant on subsurface soil conditions and the nature of the contaminants present. Naturally occurring organic carbon, metals, and minerals present in the subsurface also have an effect on the effectiveness of Chemical Treatment. The often complex reactions, propelled by strong oxidants, are not fully understood. Although bench-top tests are useful, a well-designed on-site pilot test is often required to determine if Chemical Treatment will be effective.

Uniform delivery of the chemical reagent is also critical to successful applications. In heterogeneous soils, injected fluids find preferential pathways through permeable soils and can by-pass lower permeability soils containing significant concentrations of contaminants. For this Site, the treatment zone is estimated to be between 6 and 25 feet (6 to 19 feet MGP impacts, 19 to 25 feet NAPL) below the basement floor. Soils in this zone are not uniform, consisting of debris, sand, silts, clay, and peat. Because of differences in permeability and the thickness of the treatment zone, multiple injection events targeting multiple depths might be required to fully treat all areas. To be effective, the treatment fluid must fully penetrate and mix with the NAPL material. While this may be practical when small amounts of NAPL are present, it would be very difficult to get the treatment solution delivered and thoroughly mixed with a six foot thickness of soil or debris saturated with MGP materials. The presence of peat is also problematic. Naturally occurring organic compounds in the peat would use up oxidants in the treatment solution.

Chemical Treatment could be deployed either underneath the building, outside the building, or in both areas. These areas are depicted in Figures 4-2 and 4-4. For any of these scenarios, prior installation of a downgradient groundwater containment system is recommended. Because it appears that the primary remaining source material is in and around the gas holder underneath the building, the evaluation of Chemical Treatment will focus on that area.

A summary of the Limited Chemical Treatment process is as follows (additional details are provided in Appendix A):

1. Size and configuration of process options: Chemical Treatment under the building includes installation of several horizontal injection and extraction wells. Drums, storage tanks, or tanker trucks would be on site during injection events. Additional above ground equipment would include vapor treatment (carbon vessels or thermal oxidizer), and water treatment facilities (storage tanks, pumps, carbon vessels).
2. Time for remediation: One to two years would be required for construction and injection events. Chemical injections would be discontinued when NAPL recovery tails off. One to three years post-treatment monitoring might be conducted.

3. Spatial requirements: An area of about 50 by 50 feet in the outside courtyard area would be fenced in. Process equipment would be located in the outside area. Chemicals would be on site only during injection events and would not be stored on site.
4. Options for disposal: Spent activated carbon from vapor treatment and groundwater treatment would be sent to an off-site regeneration facility. Recovered NAPL would be sent for off-site treatment and disposal. Several thousand pounds of spent carbon would be generated. Well tailings and other construction waste would be characterized and sent to an appropriate off-site facility.
5. Permit requirements: An underground injection control (UIC) permit might be required. A permit to discharge treated water to surface water or a POTW would be required. Also, any air treatment equipment would be required to meet substantive permit requirements. Notification to the school and local fire department for the chemicals to be used is recommended.
6. Limitations or other factors necessary to evaluate the alternative: A bench-top study using soil and NAPL from the Site is suggested. An on-site pilot study is also recommended. A geotechnical evaluation of the building is necessary to design the horizontal drilling program.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Implementation of Chemical Treatment under the building would have no beneficial impact on fish and wildlife. The potential for Chemical Treatment to mobilize contaminants and impact fish and wildlife in the River requires evaluation. Mitigation measures (monitoring and groundwater capture) might be required.

Overall Protection of Public Health and the Environment

Chemical Treatment is rated as “Fair” for Overall Protection of Public Health and the Environment. Current site conditions do not pose a significant risk to public health or the environment. Chemical Treatment would reduce potential future exposure to vapors by reducing volatile components of the NAPL. Treatment would be permanent. The degree of treatment possible under site conditions is not known. It is not likely that Chemical Treatment can reduce contaminant levels to the point where the need for institutional controls to prevent uncontrolled exposure to subsurface materials is eliminated. Chemical Treatment is expected to increase the mobility of MGP residuals. The treatment design would need to include a groundwater/NAPL recovery system to capture mobilized MGP materials.

Compliance with Standards, Criteria and Guidance

Chemical Treatment is rated as “Fair” for this criterion. Chemical Treatment is expected to remove a significant mass of MGP material from the soil and groundwater. However, site conditions allow only a limited application of treatment chemicals. Thus, removal of all the NAPL and reduction of soil and groundwater levels to the SCGs is not expected to be possible. Partial breakdown of MGP components and generation of more mobile by products is a concern. A groundwater/NAPL recovery system would need to be included in the design to capture any mobilized MGP materials.

Long-Term Effectiveness and Permanence

Chemical Treatment is rated as “Fair” for this criterion. A portion of the MGP materials would be permanently destroyed. A significant amount of MGP materials would likely remain after chemical injections. Long term engineering (maintenance of the building floor and possibly a vent system) and institutional controls (no excavation in the area without safety measures) would be necessary to maintain a condition of no significant risk.

Reduction of Toxicity, Mobility, or Volume with Treatment

Chemical Treatment is rated as “Fair” for this criterion. The degree of NAPL removal by Chemical Treatment is not known. Ideally, Chemical Treatment would both break down MGP materials and allow enhanced recovery of significant amounts of NAPL. Chemical Treatment would, at least initially, increase the mobility of MGP materials. It is not known if by products produced by partial treatment would be more or less toxic than the parent compounds. MGP materials migrating from the treatment area would be captured in the groundwater/NAPL recovery system. In addition, the overall remedial strategy would include a containment system along the FDR Drive to prevent migration of contaminant off site.

Short-Term Effectiveness

Chemical Treatment is rated as “Fair” for this criterion. The process would involve use of strong chemicals and might cause an increase in vapor concentrations beneath the building. However, these risks are readily controlled. Only trained personnel would handle treatment chemicals. Chemicals would only be on-site during injection events. Injection areas would be cordoned off. Vapor generated during injection events would be captured by a sub-slab vent system. The process has been used safely at many sites. The duration of injection events is not known at this time.

Implementability

Chemical Treatment is rated as “Poor” for this criterion. Because it would require a large number of vertical wells inside the school and the school would have to be closed, full-scale treatment can not be implemented. Limited treatment, using horizontal wells installed from the outside, might be feasible. Work would include fencing in part of the courtyard, excavation along the building footing, horizontal drilling, installation of injection and extraction wells, and construction of a water treatment system. Considering the building design, the viability of horizontal drilling is not known with certainty. Pilings and pile caps under the building would have to be avoided. Due to the density of the pilings, avoiding them might not be possible. Because the building is supported by pilings, hitting and damaging a piling must be avoided. Review and approval by a geotechnical engineer and monitoring would be required. An outside courtyard area would have to be fenced in and closed to the public during drilling of the horizontal wells and during injection events. These restrictions may not be acceptable to the school. An injection permit or similar approval from NYSDEC would be required. A permit to discharge treated water to surface water or a POTW would be required. Also, any air treatment equipment would be required to meet substantive permit requirements. Notification and approval to use oxidant chemicals at the Site from the School and fire department would be necessary. Damage to the steel support pilings under the building from contact with the treatment chemicals is a potential problem.

Cost

The capital cost for Chemical Treatment is estimated to be \$2,000,000 to \$3,000,000. Operation and monitoring costs are estimated to be \$250,000 to \$300,000.

4.2.4 Alternative 4a - Excavation and Off-Site Disposal of Source Material Under School Building

Excavation and off-site disposal of source materials under the school building (Excavation Under School Building) would consist of the following basic elements: site preparation; excavation shoring; dewatering; excavation of impacted soils; loading, transport, treatment, and disposal of impacted soil; backfilling; and site restoration. Each of these elements is discussed in the paragraphs that follow.

Site preparation work would be extensive. The gas holder and impacted soils are located beneath a three story school building. Excavation work would proceed 25 feet below the school basement. Excavation without demolishing the building is not possible. Removing the building would require closing the school and grounds,

obtaining demolition permits, removal of asbestos, removal of utilities and certain equipment (boilers), knocking down the building, and removal of debris. For this three-story building of 250,000 square feet, permits and demolition work would take over 1 year to complete. An estimated 10,000 cubic yards or more of debris would be generated. The floor and foundation in the excavation area would then be removed. Additional site preparation activities would include putting up fencing, setting up site trailers, erosion controls, soil stockpile areas, soil loading areas, decontamination stations, and baseline air monitoring.

The depth of excavation (over 25 feet) and soil types indicate that shoring of the excavation would be required. Steel sheet piling driven to bedrock would most likely be used. The presence of subsurface debris, pilings, and pile caps would slow down the sheet driving work. An estimated 32,000 square feet of sheeting would be driven.

Dewatering of the excavation area would be conducted after driving the sheet piling and throughout the excavation and backfilling work. Sump wells would be dug at various locations within the excavation area and submersible pumps would be installed. Water would be pumped into an on-site treatment system consisting of settling tanks (typically 20,000 gallons), filtration to remove silt, and treatment to remove contaminants (air stripping and/or carbon filtration). Treated water would be discharged to the POTW or to a surface water body. Permits for the treatment system would be required. Sampling and analysis of the treated water would also be required. The required capacity of the dewatering system is not known with certainty but is probably in the range of 100 gallons per minute.

Excavation would proceed after the groundwater is drawn down. The pilings that supported the building would have to be removed. A method to remove the pilings without allowing NAPL to move deeper below ground would have to be developed. Measures to mitigate odor, noise, and dust during excavation would be deployed. A fence line monitoring program would be used to identify any potential vapor impacts to the public. The shallow soil is not contaminated and would be set aside for reuse as backfill. Contaminated soil would be placed in lined and covered stockpile areas on site or directly loaded into trucks. Soil that remains excessively wet might require addition of stabilization agents prior to shipment. Soil samples would be collected from the pit bottoms and analyzed to confirm that all MGP waste was removed.

Excavated soils would most likely be sent to an off-site treatment facility permitted to receive MGP wastes. Typically, MGP wastes are thermally treated then transported to a landfill or reused in asphalt mixtures. Waste characterization sampling would be conducted. Documentation would include waste profile sheets and waste manifests. Soils would be loaded on site into trucks. The trucks would be inspected, decontaminated as necessary, and covered prior to leaving the Site. An estimated 18,000 cubic yards (900 truck loads) of soil would be removed.

Once the excavation depth is reached and a clean bottom is confirmed by sampling, the excavation would be backfilled. Common borrow from a clean off-site source would be used. The backfill would be compacted as necessary to support any future buildings.

Site restoration would begin with filling to the required grade and stabilizing surface soils. Remediation support equipment (water treatment system, soil stockpile areas, decontamination area, and site trailers) would be removed. The Site would then be ready for construction of a new school.

A summary of the Excavation Under School Building Alternative is as follows:

1. Size and configuration of process options: Specialized heavy equipment would be needed for removal of the existing school. 32,000 square feet of sheet piling would be needed. A 100 gallon-per-minute groundwater treatment system would be needed. Soil stock pile and equipment decontamination areas would be needed. 900 truck loads of soil would be removed.

2. Time for remediation: Excavation would require 4 to 7 years to complete. This includes 6-months to 1 year to obtain permits and demolish the school, six-months to 1 year to complete excavation and backfilling, and 2 to 4 years to replace the school.
3. Spatial requirements: The entire school property would be needed for excavation and support areas. The estimated excavation area is 3.2 acres.
4. Options for Disposal: Spent activated carbon from vapor treatment and groundwater treatment would be sent to an off-site regeneration facility. Several thousand pounds of spent carbon would be generated. An estimated 18,000 cubic yards of soil would be sent to an off-site treatment facility.
5. Permit requirements: Permits would be required for demolition and reconstruction of the school. A permit to discharge treated water to surface water or a POTW would be required.
6. Limitations or other factors necessary to evaluate the alternative: Use of the school would be lost for 4 to 7 years. This may not be acceptable to the Department of Education and local residents. The demolition and excavation work would have significant impacts to the community (noise, odors, dust, vibrations, and truck traffic containing hazardous materials). These conditions may not be acceptable to the community.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Implementation of Excavation under the building would have no impact on fish and wildlife.

Overall Protection of Public Health and the Environment

Excavation Under School Building is rated as “Good” for Overall Protection of Public Health and the Environment. Excavation would provide a permanent and long-term remedy by removing MGP materials from the Site. Excavation would bring contaminants to the surface. Potential exposures to the public during excavation include exposure to dust and odor and potential spills. Current conditions at the Site do not pose a risk to human health or the environment.

Compliance with Standards, Criteria and Guidance

Excavation Under School Building is rated as “Good” for this criterion. Soil and NAPL exceeding the remedial goals and SCGs would be removed. As with any deep excavation, removing all soil exceeding the relatively low RSCOs (0.06 mg/kg for benzene and 0.061 for benzo(a)pyrene) would be difficult. However, Excavation is expected to remove most of the soil exceeding the RSCOs. Excavation may be considered to comply with Section 4.1(d) of *Draft DER-10* which requires removal of sources of contamination to the extent feasible.

Long-Term Effectiveness and Permanence

Excavation Under School Building is rated as “Good” for this criterion. Excavation has proven to be effective at other MGP sites. MGP materials would be permanently removed from the Site and treated at an off-site facility. No engineering or institutional controls would be needed to maintain a condition of no significant risk after Excavation.

Reduction of Toxicity, Mobility, or Volume with Treatment

Excavation Under School Building is rated as “Good” for this criterion. MGP materials would be removed from the Site. Off-site thermal treatment would destroy the organic fraction of the MGP wastes. Residual contaminants after thermal treatment would be immobilized or isolated in a landfill or in an asphalt matrix.

Short-Term Effectiveness

Excavation Under School Building is rated as “Poor” for this criterion. The work entails 4 to 7 years of intensive construction work in an urban area. Building demolition has the potential to generate physical hazards and dust problems. Excavation work would bring large volumes (18,000 cubic yards) of waste materials to the surface. Measures to control odors and dust during excavation would be required, including limiting the rate of excavation, applying water or foaming agents, and covering soil stockpiles. A fence line air monitoring program would be required. Transport would include an estimated 900 truck loads containing hazardous materials. Control measures would include truck inspections and decontamination before leaving the Site, covering loads, and use of qualified trucking companies and drivers.

Implementability

Excavation Under School Building is rated as “Unacceptable” for this criterion. Extensive permitting would be required to demolish and replace the school. An estimated 1,500 students would be displaced for 4 to 7 years. Access and approval for this work by the Department of Education may not be granted. The debris and pilings in the excavation area would make installation of the shoring and excavation work slow and difficult.

Cost

The estimated cost of Excavation Under School Building, including tearing down and replacing the school, is \$75,000,000 to \$100,000,000.

4.2.5 Alternative 4b - Excavation and Off-site Disposal Outside of School Building

Excavation and off-site disposal of MGP-impacted materials in the area outside the school building (Excavation Outside of School Building) would consist of the following basic elements: site preparation; excavation shoring; dewatering; excavation of impacted soils; loading, transport, treatment, and disposal of impacted soil; backfilling; and site restoration. Each of these elements is discussed in the paragraphs that follow.

Provided appropriate setbacks and shoring were used, excavation of the outside areas could be conducted without demolition of the school building. Site preparation activities would include erecting fencing, setting up site trailers, erosion controls, soil stockpile areas, soil loading areas, decontamination stations, and baseline air monitoring. Buried and overhead utilities would also have to be relocated. The area outside the school building would not be available for public use during excavation.

The excavation depth would vary from 25 feet to 45 feet. Shoring, use of trench boxes, and other methods would be used to keep the excavation area open and to avoid undermining nearby structures. The presence of subsurface debris and old building foundations would slow down excavation work. Dewatering of the excavation area would be conducted throughout the excavation and backfilling work. Sump wells would be dug at various locations within the excavation area and submersible pumps installed. Water would be pumped into an on-site treatment system. The treatment system would consist of settling tanks (typically 20,000 gallons), filtration to remove silt, and treatment to remove contaminants (air stripping and/or carbon filtration). Treated water would be discharged to the POTW or to a surface water body requiring permits and sampling. The required capacity of the dewatering system is not known with certainty; the dewatering rate is expected to be very high (possibly several hundred gallons per minute) because the excavation depth is over 40 feet and reaches bedrock.

Excavation would proceed after the groundwater is drawn down. Measures to mitigate odor, noise, and dust during excavation would be deployed. A fence line monitoring program would be used to identify any potential vapor impacts to the public. The shallow soil is not contaminated and would be set aside for reuse as backfill. Contaminated soil would be placed in lined and covered stockpile areas on-site or directly loaded into trucks.

Soil that remains excessively wet may require addition of stabilization agents prior to shipment. Soil samples would be collected from the pit bottoms to confirm that all the MGP waste was removed.

Excavated soils would most likely be sent to an off-site treatment facility permitted to receive MGP wastes. Typically, MGP wastes are thermally treated then sent to a landfill or reused in asphalt mixtures. Waste characterization sampling would be conducted. Documentation would include waste profile sheets and waste manifests. Soils would be loaded on site into trucks. Trucks would be inspected, decontaminated as necessary, and covered prior to leaving the Site. An estimated 50,000 cubic yards (2,500 truck loads) of soil would be removed.

Once the excavation depth is reached and a clean bottom is confirmed by sampling, the excavation would be backfilled. Common borrow from a clean off-site source would be used. Site restoration would begin with filling to the required grade and stabilizing surface soils. Remediation support equipment (water treatment system, soil stockpile areas, decontamination area, and site trailers) would be removed. Walkways, grass areas, trees and other site features would be restored.

For this alternative, in addition to excavation of all soils exceeding RSCOs, the concept of limited excavation, focused on remaining MGP structures and the most impacted soil is also evaluated. The goal of limited excavation would be to remove, to the extent practical, concentrated areas of MGP materials, specifically NAPL above the water table. The evaluation of former MGP structure areas for potential excavation focused primarily on zones above the water table for the following reasons. First, former MGP structures encountered outside the school building appear to be primarily located above the water table. Second, any area below the water table, unless a fully enclosed structure, would most likely be recontaminated after excavation.

A summary of soil data for areas outside the school building is provided in Table 4-1. A map of sample locations and former MGP structures is provided as Figure 4-3. Site investigation test pits and soil borings were focused on various MGP structures identified from historical maps. These included generating houses, purifying houses, a tar tank, coal bins, and a coal shed. In general, debris (bricks, metal, concrete) were observed at all the test locations. Coal pieces, slag and/or a white material (possibly lime) were also observed in the test pits. Evidence of NAPL above the water table was observed at two locations: black staining and oily material at the TP-3 location (approximately 3 ft bgs) and pockets of black oil saturated stones and free product at the TP-4 location (approximately 5 ft bgs).

The extent of NAPL impacts above the water table appears to be limited to an approximately 2,000 square foot area encompassing TP-3 and TP-4a (NAPL was not detected in TP-4b and TP-4c). With an average depth to groundwater of 8 feet, the approximate volume of unsaturated soil in this area is approximately 600 cubic yards. If limited excavation is selected as a remedial alternative for the site, this area of NAPL above the water table may have to be further defined with additional test borings.

A summary of Excavation Outside of School Building Alternative is as follows:

1. Size and configuration of process options: For the complete Excavation, specialized heavy equipment capable of reaching 40 feet deep would be needed. It is anticipated that a 100-gallon-per-minute or more groundwater treatment system would be needed. Soil stockpile and equipment decontamination areas would be needed. 2,500 truck loads of soil would be removed. For a limited Excavation focused on shallow NAPL and MGP structures, specialized heavy equipment or dewatering would not be required (or would be minimal) and approximately 1,000 cubic yards of material (75 truck loads) would be removed.
2. Time for remediation: The complete Excavation and site restoration would require 1 to 2 years to complete. The limited Excavation would require approximately two months to complete.
3. Spatial requirements: For the complete Excavation, the entire area outside the school building and east of the school building would be needed for excavation and support areas. The estimated area is

1.25 acres. The limited Excavation would require an estimated 6,000 square feet of area including staging areas.

4. Options for Disposal: For the complete Excavation, spent activated carbon from vapor treatment and groundwater treatment would be sent to an off-site regeneration facility. Several thousand pounds of spent carbon would be generated. An estimated 50,000 cubic yards of soil would be sent to an off-site treatment facility. The limited Excavation would require off-site disposal of approximately 1,000 cubic yards of soil.
5. Permit requirements: Construction and utility relocation permits would be required. A permit to discharge treated water to surface water or a POTW would be required would also be required for the complete Excavation.
6. Limitations or other factors necessary to evaluate the alternative: While measures to control vapors, noise and dust would be taken, the school would probably have to be closed during portions of the excavation work. The demolition and excavation work would have significant impacts to the community (noise, odors, dust, vibrations, and truck traffic containing hazardous materials). These conditions may not be acceptable to the community.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Implementation of Excavation would have no impact on fish and wildlife.

Overall Protection of Public Health and the Environment

Complete Excavation Outside of School Building is rated as “Good” for Overall Protection of Public Health and the Environment. Complete Excavation would provide a permanent and long-term remedy.

Limited Excavation Outside of School Building is rated as “Fair” for Overall Protection of Public Health and the Environment since it would remove only a portion of the impacted area. Limited excavation may have some benefit in reducing the potential for utility workers to encounter impacted soil. However, Institutional Controls would still be required.

Compliance with Standards, Criteria and Guidance

Complete Excavation Outside of School Building is rated as “Good” for this criterion. Most of the soil and NAPL exceeding the remedial goals and SCGs would be removed. As with any deep excavation, removing all soil exceeding the relatively low RSCOs (0.06 mg/kg for benzene and 0.061 for benzo(a)pyrene) would be difficult. Excavation close to the school building and roads would not be possible. Therefore, some soil and groundwater exceeding the SCGs would remain in place.

Limited Excavation Outside of School Building is rated as “Fair” for this criterion since a limited amount of the soil and NAPL exceeding remedial goals and SCGs would be removed.

Long-Term Effectiveness and Permanence

Complete Excavation Outside of School Building is rated as “Good” for this criterion. Excavation has proven to be effective at other MGP sites. MGP materials would be permanently removed from the Site and treated at an off-site facility. No engineering or institutional controls would be needed to maintain a condition of no significant risk after full excavation. However, recontamination of excavated areas as MGP materials migrate from underneath the school is likely, unless measures to mitigate this problem are implemented.

The Limited Excavation Outside of School Building is rated as “Fair” for this criterion since a localized area would be remediated but engineering controls and/or institutional controls would still be required over the majority of the Site.

Reduction of Toxicity, Mobility, or Volume with Treatment

Complete Excavation Outside of School Building is rated as “Good” for this criterion. MGP materials would be removed from the Site. Off-site thermal treatment would destroy the organic fraction of the MGP wastes. Residual contaminants after thermal treatment would be immobilized or isolated in a landfill or in an asphalt matrix.

The Limited Excavation Outside of School Building is rated as “Fair” for this criterion since a limited amount of MGP material present would be removed.

Short-Term Effectiveness

Complete Excavation Outside of School Building is rated as “Poor” for this criterion. The work entails 1 to 2 years of intensive construction work in an urban area. Excavation work would bring large volumes (up to 50,000 cubic yards) of waste materials to the surface. Measures to control odors and dust during excavation would be required. Control measures might include limiting the rate of excavation, applying water or foaming agents, and covering soil stockpiles. A fence line air monitoring program would be required. Transport would include an estimated 2,500 truck loads containing hazardous materials. Control measures would include truck inspections and decontamination before leaving the Site, covering loads, and use of qualified trucking companies and drivers. Excavation would create a 40 foot deep pit, therefore, requiring measures to prevent undermining of the nearby roads and buildings. Due to the physical hazards, odor, dust, noise, vapors, and vibrations it is expected to be necessary to close the school for most of the excavation work, estimated to be one year.

The limited Excavation Outside of School Building option is rated as “Fair” since it has the same short-term risk discussed above; however, due to the smaller scale of the excavation, short-term risks could be more easily managed.

Implementability

Complete Excavation Outside of School Building is rated as “Unacceptable” for this criterion. Excavation would likely require that the school be closed for one year. Access and approval for this work by the Department of Education may not be granted. Although the FDR Drive is supported on pilings, excavation to 40 feet (which is potentially below the bottom of pilings) may be impractical.

For the limited Excavation Outside of School Building option, the smaller scale of limited excavation and shallower excavation depth greatly facilitates the limited excavation. Limited excavation is rated “Fair” for implementability.

Cost

The estimated cost for the complete Excavation Outside of School Building option is \$15,000,000 to \$20,000,000. The estimated cost for the limited Excavation Outside of School Building option is \$150,000 to \$250,000.

4.2.6 Alternative 5 – In-Situ Stabilization (ISS) for Area Outside the Building

In the In-Situ Stabilization (ISS) alternative, the remedial action objectives for soil would be met by creating a solid soil/concrete mix. The remedial action would occur in three phases. In the preparation phase, major obstructions such as concrete debris and any remaining MGP substructures would be removed by conventional excavation. Buried utilities would also be removed to the extent feasible. Although NAPL contamination present in the unsaturated soils would be removed to the extent practical by a combination of

excavation and pumping, it does not appear that the levels of NAPL in this area would require removal. The excavation would be conducted in a manner which controls the emission of dust, odors, and VOCs.

In the second phase, ISS would be conducted. A conceptual view of ISS shown in Figure 4-5. Impacted soils in the outside area would be augered and mixed with pozzolanic agents. A hood would cover the augers and vapors released during the process would be collected and treated. This process would be designed and controlled to produce overlapping columns of solidified soil, resulting in a monolithic solidified mass. The permeability of this mass would be such that groundwater would be substantially unable to penetrate it, thus the migration pathway of MGP constituents to groundwater would be greatly reduced if not eliminated. Similarly, the migration pathway of volatilization of contaminants in the saturated zone into soil gas would be effectively removed. Since the migration of MGP constituents from the solidified mass would be largely eliminated, the MGP materials would be substantially unavailable to affect human health or the environment. A notice would be placed in the property deed describing the location and characteristics of the solidified material.

The third phase would be site restoration including final grading, addition of 2 feet of clean soil, and seeding or other appropriate surfacing. The paved areas, lighting, trees, and grass areas would be restored.

For this remedial alternative, it is estimated that approximately 40,000 to 50,000 cubic yards of soils would be solidified or removed. In areas where a competent clay layer is present and NAPL is not below it, ISS would proceed two feet into the clay unit. In other areas, ISS would proceed to bedrock. For scheduling purposes, it is estimated that this activity can be completed in one construction season; two construction seasons would be required if soil mixing is conducted beneath a sprung structure. Duration of field activities can be compressed if the use of multiple soil mixing rigs is deemed appropriate and site conditions allow the use of more than one soil mixing rig with support equipment.

The solidification process results in an increase in soil volume, typically ranging from ten percent (10%) to thirty percent (30%). The potential variation in soil swelling created can be attributed to soil types and ratios of reagents added. Some of the additional material could be used to fill low areas. Volume increases and site grading considerations might require raising the overall elevation of the work area, or off-site transport and disposal of some excess material.

Unlike ISCO and excavation, ISS-treated areas would not become re-contaminated from upgradient (under the building) areas. Neither groundwater nor NAPL would flow into the solidified mass. Because of the large area solidified, groundwater modeling would be needed to determine changes in groundwater flow and the potential for groundwater mounding. A drainage system around or through the solidified mass might be needed.

A summary of ISS Process Alternative is as follows:

1. Size and configuration of process options: ISS would include the use of at least one shallow soil mixing rig, excavators and probably a jet grout injection rig to address impacts in areas where accessibility is a concern. Soil mixing activities could be conducted within a sprung structure if dust and vapor issues are a concern. Support equipment on site would include large vessels for storage of admixtures, a batch plant to mix the admixtures prior to injection, vapor treatment equipment (carbon vessels and encapsulant accessories), electrical hardwiring of site equipment, grout pumps, piping, and a water source with appropriate hoses capable of supplying large quantities of water daily.
2. Time of remediation: ISS activities could be completed in one year – two years if ISS is to be conducted within a sprung structure(s).
3. Spatial requirements: The entire ISS work area (1.25 acres) would be fenced off or otherwise isolated prior to commencing site activities. Within the fenced area, an area 30 feet by 50 feet would be used for ISS support equipment and materials. The active zone where soil mixing occurs is approximately

20 feet by 30 feet. If a sprung structure is used, the size of the structure would be based on site requirements.

4. Options for disposal: During the pre-excavation phase of the ISS process, rubble and debris and clean overburden are anticipated to be sent to a municipal landfill. Impacted soils would be sent to either a certified landfill or a regulated Low Temperature Thermal Desorption (LTTD) facility. If encountered, NAPL would be pumped and disposed of off site at a regulated treatment facility. During soil mixing activities, excess mixed soils (fluff material) would probably be sent to a landfill or a LTTD facility. Spent activated carbon generated during air treatment operations would be sent to an off-site regeneration facility.
5. Permit requirements: Air treatment equipment would be required to meet substantive permit requirements. Electrical and construction permits may be required. Transportation permits for mobilizing large equipment to the Site would likely be necessary. Local ordinances may limit noise levels and work hours. A UIC permit may be required.
6. Limitations or other factors necessary to evaluate the alternative: A laboratory treatability study using impacted soils from the Site is suggested. Site soils would be subjected to various ratios of cementitious admixtures to optimize the reagent ratios to the Site soils. It is recommended that the optimized mix be used during a pilot study to verify the efficacy of the mix with site conditions. Groundwater modeling to address changes in groundwater flow as a result of stabilization is recommended.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Implementation of ISS in the area outside the school building would have no adverse impact on fish and wildlife resources. The use of ISS would have long-term beneficial impacts on the Harlem River ecosystem by limiting the availability of mobile NAPL that could potentially migrate to the river.

Overall Protection of Human Health and the Environment

ISS is rated as “Good” for this criterion. Contaminants in the overburden would be contained by solidification. Either a 2-foot layer of clean fill material or capping material (e.g., asphalt or concrete) would be placed over the solidified mass, further reducing the risk of contact. A deed notice would provide additional protection. The potential for MGP materials to migrate from the overburden soils to the river would be eliminated. Short-term risks from construction activities would be significant and would require mitigation measures.

Compliance with Standards, Criteria, and Guidance

ISS is rated as “Fair” for this criterion. ISS would not remove or treat the MGP materials. VOCs and SVOCs would not be reduced to levels below the SCGs. However, ISS treatment of impacted soils would immobilize the MGP constituents. By immobilizing these constituents, ISS is anticipated to greatly reduce migration of NAPL from the Site towards the river. ISS does not destroy the contaminants and, therefore, only addresses the remedial goals by eliminating the exposure pathways. Contaminants within the solidified soil are permanently isolated and not available for exposure to human or environmental receptors.

Long-Term Effectiveness and Permanence

ISS is rated as “Fair” for this criterion. ISS has been implemented at several MGP sites where post-treatment sampling results after several years have confirmed the durability of the solidified mass. This alternative would provide long-term reliability for reducing direct exposure of the public or future site users to impacted surface and subsurface soil and would decrease the potential for migration of impacts to groundwater, surface water, and sediment. The ISS process would result in more stable soil with improved geotechnical properties. The long-term durability of ISS in contact with saline water is not fully understood. Contact with untreated NAPL from upgradient (the gas holder under the building) might also affect the long-term durability of the stabilized material. Because the ISS process greatly reduces soil permeability it may measurably alter groundwater flow.

Groundwater modeling should be performed to address potential drainage or diversion systems that may be necessary if this remedy is selected.

Reduction of Mobility, Toxicity, or Volume Through Treatment

ISS is rated as “Good” for this criterion. ISS does not reduce the toxicity of the contaminant and the volume of material would increase. However, ISS has been demonstrated to be effective in immobilizing contaminants within a low-permeability solidified matrix preventing future migration. ISS is effective for both NAPL and dissolved phase constituents.

Short-Term Effectiveness

ISS is rated as “Fair” for this criterion. During the implementation of this corrective action alternative, measures would be taken to monitor and reduce the potential for air emissions. Although most of the treatment occurs below ground, a significant amount of material would be brought to the surface during the excavation phase to remove obstructions. Odors and emissions generated during the preliminary excavation phase of the work would be minimized with the use of engineering controls. Impacted materials would be transported in such a manner as to prevent releases during transport off site. During the ISS phase, odors, dust, and emissions would be collected and treated using a steel hood which surrounds the mixing augers. Air monitoring at the perimeter of the Site would be performed to ensure air quality standards are met. Measures would be taken to control the route and allowable hours for transport of materials on to and off of the Site. These mitigation measures have been used with effectiveness at several other MGP sites where ISS was the primary remedial method used.

Direct contact with impacted material during the initial excavation phase would be minimized by use of heavy equipment to perform the excavation and loading activities. Direct contact with impacted material during ISS is anticipated to be minor since much of the heavily impacted material is below the ground surface and direct handling of the material is minimized. Workers involved in excavation and ISS activities would be expected to wear the appropriate personal protective equipment (PPE) as required in a site-specific health and safety plan.

Surface environmental impacts during the remedial actions would be addressed by use of spill prevention and control measures, and erosion control measures. Due to the expected volume increases, earthen or sandbag dikes would be used to prevent ISS material from migrating out of the ISS area.

Subsurface environmental impacts would be addressed directly during ISS activities. Available geotechnical data indicates that contamination ends at the top of a clay layer which exists over much of the Site. By drilling columns through the top two feet of the clay layer, remaining NAPL would not be exposed to permeable subsurface layers. In areas where the clay layer is not present, it is advisable to extend the column to competent bedrock.

It is anticipated that the ISS work would take one or two years to complete.

Implementability

ISS is rated as “Poor” for this criterion. Removal of source materials and subsurface structures is technically feasible using conventional excavation equipment. ISS is a readily available environmental engineering method that has been widely implemented and has been successfully implemented at other MGP sites under similar conditions. However, the presence of subsurface obstructions at the Site would be one of the biggest challenges for this alternative. It is important that as many underground obstructions are removed as practicable during the excavation phase of this alternative in order to minimize delays during soil mixing activities. Underground utilities, like the storm drain, would also be challenges for this alternative. ISS, like most construction activities, can be loud and disrupting to the school and the neighborhood. It is expected that the school can remain in session during the construction activities. Work close to the school would have to

occur during summer recess. If large utility corridors are present in the footprint of ISS activities, it is advisable that solidifying activities such as jet grouting or in-situ bucket mixing be performed rather than use of a soil mixing rig. Singular utility lines that can be replaced should be removed during site preparation activities. Swelling of the treated soils would probably necessitate the excavation and stockpiling or removal of some overburden materials in order to maintain the original surface soil elevation.

Meeting the requirements of the applicable regulatory agencies would be necessary. NYSDEC has approved the use of ISS at similar sites in New York State. The source material in soil would be removed or contained within a concrete mass so that only groundwater monitoring activities of the perimeter area need to be performed on a regular basis. The outside area would be fenced off and not accessible to the public for one to two years. This may not be acceptable to the Department of Education.

There are a relatively small number of qualified contractors available to perform ISS treatment which uses modified construction equipment with specialized attachments and features.

Cost

The estimated cost of ISS treatment in the area outside the school building is \$12,000,000 in capital cost. No ongoing operation and maintenance costs would be required.

4.2.7 Alternative 6 – Barrier Wall and NAPL Recovery System Downgradient Property Boundary (outside building, along FDR Drive)

A Barrier Wall (cut-off wall) and NAPL recovery system at the downgradient property boundary would be located along the FDR Drive is shown in Figure 4-4. This Barrier Wall would control the off-site migration of NAPL towards the Harlem River.

Installation of a Barrier Wall is a remedial technology capable of isolating the NAPL-impacted soils and containing the further migration of NAPL. The technology includes vertical barriers, such as water-tight sheet piling or a slurry wall (cement wall), to form a barrier against migration. The bottom of the wall would have to be keyed into a low permeability unit to prevent migration under the wall. In the absence of an impermeable base in the overburden, it would be necessary to construct the wall along the FDR Drive 30 to 40 feet deep and keyed into bedrock. While determining the wall design and construction method is beyond the scope of this report, use of a slurry wall is more likely than a sheet pile wall at this location. Keying sheet piling into the uneven bedrock surface may not be practical. Use of a slurry wall would probably provide a better seal.

Depending on the specific design, the Barrier Wall may impede groundwater flow and cause mounding of the groundwater, which can be addressed in three basic ways. First, groundwater modeling may show that the groundwater mounding would be negligible, would not impact the school building, and that groundwater can simply flow around the wall. This modeling may also indicate that the change in hydraulic gradient caused by the wall would not push NAPL around the wall. A second approach is to design gates in the wall or design the wall to allow water to flow over the top of the wall. The disadvantage of allowing water to flow over the wall is that any light NAPL that may be present would not be captured. Use of gates and locating NAPL collection sumps at the gates would allow groundwater to pass through the wall while enhancing NAPL removal. Use of a funnel and gate system might also allow for the use of an ozonation or in-situ method to treat dissolved phase constituents. Perforated wall sections, designed to allow capture of both LNAPL and DNAPL, can be designed. A third approach to address groundwater mounding would be to install extraction wells and pumps in front of the wall. In this scenario, water is pumped out in front of the wall to maintain the desired water elevation. Water pumped to the surface would require treatment and a permit for discharge (either to surface water or POTW). A primary disadvantage to active pumping is that whenever the pumps or treatment systems are not working, the water levels would rise. Indefinite operation of the pumping and treatment systems would be required which would make the pump and treatment option the most expensive approach. A relatively simple groundwater model could be used to help select the means to control groundwater mounding and to

design the wall. Based on experience designing similar cut-off walls, the gate system would require minimal maintenance, enhance NAPL recovery, and be relatively inexpensive.

Installation of the wall would begin with site preparation. For any wall type that is chosen, excavation to six feet or more would be required to remove subsurface debris and foundations known to be present at the proposed wall location. A 10-foot diameter storm drain transects the wall alignment. This drain would be uncovered and supported during construction. Excavation below the storm drain and injection of the slurry is feasible, but would require specialized equipment and be a slow process. Excavated material would most likely be sent off site for treatment and disposal.

A slurry wall, if selected as the Barrier Wall, can be installed to the proposed depth of 30 to 40 feet with hydraulic excavators. The expected trench width would be 2 to 5 feet. As the soil is removed by excavation, a bentonite clay slurry is pumped into the trench. The bentonite clay slurry stabilizes the excavation (keeps the walls from collapsing) and coats the excavation walls. By coating the excavation walls with the clay slurry, the potential for NAPL trapped in the shallow peat and natural clay layers to migrate downward during excavation is greatly reduced. Excavation and application of the slurry would proceed to the bedrock surface. The open excavation would then be backfilled with a soil/clay/cement mixture. Soil removed from the excavation could be blended with bentonite, cement and other additives to form the backfill mixture. Depending on the desired design capabilities, the wall can set up as a solid cement-like wall or a softer putty-like wall. In either case, the wall would be designed to be impermeable to water and MGP constituents.

If a sheet pile wall is chosen for the Barrier Wall, or for a portion of the Barrier Wall, the construction sequence would be slightly different. A trench 2 feet wide by 6 feet deep would first be constructed to get below obstructions. A vibratory hammer would then be used to drive interlocking sheets to the desired depth. Various methods are available for sealing the joints of the interlocking sheets.

Because some studies have shown that traditional bentonite slurries can be degraded over time by MGP NAPL, use of alternate materials such as attapulgite may be considered in the design phase. Use of soil from the excavation would also have to be carefully considered in the design. If there is too much NAPL in the soil, the slurry may not set up properly and the desired low permeability may not be achieved. Effects of the brackish groundwater (high conductivity and sodium content) and high concentrations of other dissolved phase inorganics (calcium, potassium) would also need to be considered when selecting the slurry mix for optimal longevity.

Modeling would be required to determine the impacts on groundwater flow created by the Barrier Wall. Based on the modeling results, a passive system (gates or overflow) or an active pumping system may be considered to prevent mounding.

A summary of Requirements for Barrier Wall Along FDR Drive Alternative is as follows:

1. Size and configuration of process options: The Barrier Wall would be 520 feet long and 30 to 40 feet deep (approximately 20,000 square feet). Twelve to 25 NAPL recovery sumps completed to 30 to 40 feet deep would be installed. Options to consider in the design phase to prevent groundwater mounding include a passive system (gates or overflow) allowing a NAPL-free groundwater to flow through the openings in the wall and/or an active pumping system.
2. Time for remediation: The Barrier Wall would take six months to one year to install. Operation and maintenance would continue indefinitely.
3. Spatial requirements: A minimum of a ten-foot wide area along the 520 foot wall alignment would be required. An additional staging area for raw materials, mixing equipment, excavation equipment, and excavated soil of 75 by 75 feet would be needed. The only visible features after construction would be 12 or 15 manholes for the NAPL recovery wells.

4. Options for disposal: Soil and debris excavated in the early phases of construction would be disposed of off site. An estimated 600 cubic yards of soil and debris would be generated in the initial excavation. Another 4,000 cubic yards of soil may be generated as the excavation and slurry wall installation proceeds to bedrock. Some, possibly most, of this soil can be blended into the slurry and form part of the wall. NAPL would be periodically removed from the NAPL collection wells. The NAPL would be treated off site at a regulated facility. The amount of NAPL that would be recovered is not known.
5. Permit requirements: Due to the proximity of the project to the FDR Drive, notification and approval by the highway authority may be required. An underground injection permit or an aboveground discharge permit for the active groundwater pumping system (if deemed necessary in the design phase) would be required.
6. Limitations or other factors necessary to evaluate the alternative: Soil borings along the proposed alignment of the wall are recommended to confirm the depth of bedrock. Excavation to confirm the location and design of subsurface features is also needed.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Seepage of slurry liquids from the wall to the river must be prevented. Once the wall is in place and MGP materials are prevented from reaching the river, a positive effect on fish and wildlife is possible.

Overall Protection of Public Health and the Environment

A Barrier Wall along the FDR Drive is rated as “Good” for Overall Protection of Public Health and the Environment. Current site conditions do not pose a significant risk to public health or the environment. Barrier walls have been successfully used at many MGP sites. Soil conditions along the FDR Drive and the storm drain crossing pose some challenges for installation of the wall. The Barrier Wall would be successful at reducing the potential for migration of NAPL towards the river. While use of a Barrier Wall and removal of MGP materials through collection sumps would remove some material, soil and groundwater conditions upgradient of the Barrier Wall are not expected to change significantly.

Compliance with Standards, Criteria and Guidance

A Barrier Wall along the FDR Drive is rated as “Fair” for this criterion. The wall would prevent the migration of NAPL towards the river. Concentrations of MGP materials upgradient and downgradient of the wall may gradually be reduced. However, the Barrier Wall would not result in achieving the SCGs.

Long-Term Effectiveness and Permanence

A Barrier Wall is rated as “Good” for this criterion. Barrier Walls are a proven technology for MGP sites and can be designed to last 100 years or more. Effectiveness would depend on reliable operation of the NAPL recovery system. Maintenance of the NAPL recovery system would likely have to continue indefinitely.

Reduction of Toxicity, Mobility, or Volume with Treatment

A Barrier Wall is rated as “Fair” for this criterion. The wall would not reduce the toxicity of MGP materials, but would result in the reduction of NAPL volume through removal in the sumps. The wall would reduce mobility of the NAPL by preventing flow towards the river.

Short-Term Effectiveness

A Barrier Wall is rated as “Fair” for this criterion. Use of the slurry wall method would bring significant amounts (5,000 cubic yards) of impacted soil to the surface. Although work would not be conducted immediately adjacent to the school building, work would be conducted within 50 feet of the School and within 50 feet of roadways resulting in potential odor, dust, and noise issues. Significant truck traffic would result from bringing in raw materials and removing unsuitable soils and debris. The duration of construction work is estimated to be one to two years.

Implementability

A Barrier Wall is rated as “Good” for this criterion. Although a geotechnical evaluation would be required, it appears that the wall can be installed without impact to the FDR Drive. Coordination of the barrier wall work with planned upgrades to the FDR Drive would be required. Trees along the sidewalk may have to be removed and replaced. Although the storm line crossing and working in a relatively tight space presents some technical challenges, slurry walls have been installed in similar circumstances. Addressing the potential for groundwater mounding, particularly under tidal conditions, would be a challenge. If an active groundwater pumping system is selected in the design phase, a water discharge permit or injection of treatment solution permit would be required.

Cost

The estimated cost of a containment wall along the FDR Drive without an active groundwater pumping system is \$3,000,000 to \$4,000,000. This cost includes 30 years of maintenance with a 5% net present value.

4.2.8 Alternative 7 - Recovery Wells/Trenches

Either recovery wells or trenches could be installed in the area outside the school building to remove mobile NAPL. At sites where a trench would be used, the trench would be excavated below the water table to or slightly below the deepest elevation of the NAPL. Gravel and a perforated pipe would be installed at the bottom of the trench. The bottom of the trench and the collection pipes would be sloped towards collection sumps located along the trench. Installation of a trench requires a continuous low permeability base for collection of NAPL. Otherwise NAPL in shallow areas would migrate into the trench and flow through the bottom of the trench. Because a continuous clay layer is not present at this Site, a seal using grout or other means would have to be created. While adapting site conditions to allow use of a collection trench may be possible, site conditions appear to favor use of vertical wells. Therefore, for the purposes of developing this alternative for evaluation, it is assumed that vertical wells would be installed. However, a disadvantage of using vertical wells is that gaps can occur between the wells.

Figure 4-4 shows potential NAPL recovery well locations and conceptual recovery well designs. Well locations might include one well located immediately downgradient of the potential source area (the main gas holder) and the remaining wells located on the school property along the FDR Drive. In this conceptual design, recovery wells along the FDR Drive are spaced 25 to 50 feet apart and a total of 12 to 24 wells are assumed. Actual spacing of the wells would be determined in the detailed design. Well spacing would be based on results of additional soil borings along the alignment of the extraction system and based on pumping tests. NAPL recovery wells would be installed to the clay layer, where present. The clay would provide an impermeable bottom and allow for accumulation of NAPL within the well. Well design and installation would be more complicated in the areas where clay is not present. If NAPL appears to be contained in the silt and peat units and is not present below these units, the collection wells would not be dug deeper than the silt and peat. After the borehole is completed, bentonite or other sealant would be installed to create an impermeable bottom. The well screen and casing material would then be installed. In cases where NAPL has reached the bedrock, the borehole would be advanced one or two feet into the bedrock. Again, the bottom of the borehole would be sealed before installation of the well screen and casing material (see Detail B of Figure 4-4).

Larger-diameter wells tend to make NAPL collection and detection easier. The conceptual design assumes 12-inch diameter wells. The number, design, and location of wells would be developed in more detail in the design phase. The recovery wells would be outfitted with NAPL pumps. The recovery wells would be periodically inspected for presence of NAPL. Accumulated NAPL would be removed by pumping and disposal off site.

The effectiveness of NAPL collection wells depends on the volume and mobility of NAPL present. Very little NAPL has been observed in existing monitoring wells. This would indicate that the recovery wells would not remove much NAPL. However, it is possible that pockets of mobile NAPL are present. If significant amounts of NAPL are present, NAPL recovery should occur in at least some of the 12 to 24 wells proposed. Recovery wells can remove mobile NAPL but a residual amount of NAPL would remain bound to the soil.

A summary of Recovery Wells Alternative is as follows:

1. Size and configuration of process options: The conceptual design includes 12 to 24 one-foot diameter recovery wells. This includes installation of one well immediately downgradient of the main gas holder and a row of wells 25 to 50 feet apart along the FDR Drive. Wells would be outfitted with NAPL pumps.
2. Time for remediation: Installation of wells would require less than one month. Inspection and removal of accumulated NAPL would continue indefinitely.
3. Spatial requirements: Well locations would have to be cordoned off during well installation. Wells would be completed beneath the ground surface.
4. Options for disposal: Well tailings (30 to 45 cubic yards) from construction activities would be characterized and disposed of at an appropriate off-site facility. NAPL accumulated in the recovery wells would also be sent to an off-site facility for treatment.
5. Permit requirements: None
6. Limitations or other factors necessary to evaluate the alternative: The amount of mobile NAPL in the outside area is not known with certainty. If minimal mobile NAPL is present, very little NAPL would be captured in the recovery wells.
7. Beneficial and/or adverse impacts on fish and wildlife resources: The alternative would have no impact on ecological receptors.

Overall Protection of Public Health and the Environment

Use of Recovery Wells is rated as “Good” for Overall Protection of Public Health and the Environment. Current site conditions do not pose a significant risk to public health or the environment. If mobile NAPL is present recovery wells would remove a significant amount of NAPL. With removal of NAPL, the potential for NAPL to reach the river would be reduced. However, recovery wells are not capable of removing all of the NAPL. Significant quantities of MGP materials would remain in place. Institutional controls would need to be implemented to prevent excavation and other potential exposures to impacted groundwater.

Compliance with Standards, Criteria and Guidance

Use of Recovery Wells is rated as “Fair” for this criterion. Removal of NAPL by Recovery Wells would reduce the potential for MGP materials to migrate to the river. Use of Recovery Wells would not result in achieving SCGs for VOCs or SVOCs in upgradient areas. The concentration of MGP materials in areas downgradient of the extraction system may be gradually reduced.

Long-Term Effectiveness and Permanence

Use of Recovery Wells is rated as “Fair” for this criterion. Mobile NAPL would be permanently removed from the system. The amount of NAPL potentially reaching the river would be permanently reduced. Recovery wells would not reduce levels of MGP material in the soil and groundwater to below the SCGs. Institutional controls would need to be implemented to prevent excavation and other potential exposures to impacted groundwater.

Reduction of Toxicity, Mobility, or Volume with Treatment

Use of Recovery Wells is rated as “Fair” for this criterion. Recovery Wells would reduce the volume and mobility of NAPL by removing NAPL from the system. However, Recovery Wells would not remove all NAPL and MGP materials. Recovery wells would also not change the toxicity of MGP materials. MGP materials would be prevented from migrating to downgradient areas.

Short-Term Effectiveness

Use of Recovery Wells is rated as “Good” for this criterion. Only a minimal amount of impacted soil would be brought to the surface during drilling and treatment plant operation. Potential impacts to the public during periodic removal of NAPL from recovery wells would be easily controlled. The duration of construction work would be short (less than a month).

Implementability

Use of Recovery Wells is rated as “Good” for implementability. Recovery Wells have been used at many MGP sites. Success of Recovery Wells is highly dependent on site conditions and the amount of mobile NAPL present. No technical or administrative barriers are known. Because the duration of construction is short, covers a small area, and is outside, disruption of school activities is expected to be minimal.

Cost

The estimated capital cost of Recovery Wells or Trenches is \$650,000. Operation and maintenance costs are estimated at \$100,000 per year. The total, therefore, is \$2,000,000 to \$3,000,000.

4.2.9 Alternative 8 - Physical Barriers with Pumping for Hydraulic Control (360 Degree Complete Containment Wall)

This Complete Containment Wall alternative would contain all groundwater and NAPL beneath the entire Site and not just the groundwater between the school building and the FDR Drive as described in alternatives 1 through 6. In this alternative, a containment wall around the entire Site coupled with limited groundwater extraction to maintain water levels would be installed, see Figure 4-6.

Installation of a containment wall is a remedial technology capable of isolating the NAPL-contaminated soils and preventing impacted groundwater from leaving the Site. The technology includes vertical barriers, such as tight sheet piling or a slurry wall (cement wall). The bottom of the wall would have to be keyed into a low permeability unit. In the western portion of the Site a clay unit is present at approximately 25 to 30 feet below the ground surface and appears to be at least 5 feet thick. A containment wall completed a foot or two into this clay would provide a vertical barrier to continued NAPL migration.

In the eastern portion of the Site, the clay unit is only 3-feet thick in places and is not present across a 160-foot section near the corner of 116th Street and the FDR Drive where MGP-impacted soil was observed at bedrock. In the absence of this clay, it would be necessary to construct the wall 30 to 40 feet deep and key it into bedrock.

As shown in Figure 4-6, the containment wall around the entire property would be approximately 1,690 linear feet long with the section along the FDR Drive being 520 feet. With an average estimated depth of 32 feet, the wall would be approximately 54,000 square feet.

The Complete Containment Wall would isolate the Site from surrounding groundwater flow and might create a contained area where groundwater would mound. If mounding occurred, active pumping wells would be required to maintain the current or a similar depth to water. Water pumped to the surface would require treatment and a permit for discharge either to the river or the POTW. Indefinite operation of the pump and treatment system would be required.

Careful sequencing of the work would be required so that the treatment system would be complete and fully operational in advance of completion and sealing of the containment wall. Sequencing would also have to take into consideration that installation of the subsurface piping from the treatment system to the pumping wells could interfere with the installation of the containment wall.

Groundwater modeling and calculations would be required as part of the design phase. Modeling would be used to determine the appropriate construction, quantity, radius of influence and optimal spacing of pumping wells as well as the design capacity of the treatment system.

While determining the wall design and construction method is beyond the scope of this report, use of sheet pile driving into the clay is likely the appropriate method for three sides of the property. A slurry wall is more likely the appropriate construction method along the FDR Drive where the clay layer or other confining unit is absent. Keying sheet piling into the uneven bedrock surface may not be practical. Use of a slurry wall would provide a better seal.

Installation of the wall would begin with site preparation. For any wall type that is chosen, excavation to six feet or more would be required to remove obstacles such as buried foundations, debris, and abandoned utilities. Numerous live utilities transect the wall alignment around the property. These include gas, electric, water, telephone and fiber optic lines and a 10-foot diameter storm line beneath the former 115th Street. The utility lines would need to be truncated and reconnected through the sheet piling. This would involve coordination with the utility companies to reroute temporary lines to avoid service interruption to the school during installation.

Installation of a slurry wall around the storm drain along Pleasant Avenue may be preferable to re-routing and then reconstructing the storm drain through the sheet pile wall. Excavation below the storm drain line and injection of the slurry wall along both Pleasant Avenue and FDR Drive is feasible and would require specialized equipment and be a slow process. Given the age and unknown construction of the storm drain line, reconstruction or replacement of portions of the line may be required.

A fuel oil underground storage tank (UST) of 10,000 or 20,000-gallon capacity is located on the western side of the school along Pleasant Avenue. The location of the UST may impact the alignment of the wall in this area.

Confirmatory utility surveys, including geophysics and possibly excavation, should be conducted during the pre-design phase in order to identify whether additional utilities or subsurface obstacles exist.

Excavated material would most likely be sent off site for treatment and disposal. If steel sheets are used, they would be driven with a vibratory hammer. Typically, 2 foot-wide interlocking sheets are driven. Various sealing methods for the joints are available. Assuming that all obstacles are removed and rerouting of the utility lines do not pose a delay, sheet pile driving an approximate 1,170 foot-long wall to 32 feet in depth would take approximately four months. Sealing the joints would take another two months. Because the school building is on pilings, vibration damage to the building is not likely to occur. However, the noise would be a problem for people in the school.

If a mix of sheet piling and slurry walls is used, careful evaluation of the sequence of installation would be required to ensure quality seals are achieved at the interfaces between the wall sections.

A slurry wall to the proposed depth of 30 to 40 feet can be installed with hydraulic excavators along the FDR Drive. The expected trench width would be 2 to 5 feet. As the soil is removed by excavation, bentonite clay slurry would be pumped into the trench. The bentonite clay slurry stabilizes the excavation (keeps the walls from collapsing) and coats the excavation walls. By coating the excavation walls with the clay slurry, the potential for NAPL trapped in the shallow peat and natural clay layers to migrate downward during excavation would be greatly reduced. Excavation and application of the slurry would proceed to the bedrock surface along the FDR Drive. The open excavation would then be backfilled with a soil/clay/cement mixture. Soil removed from the excavation could be blended with bentonite, cement and other additives to form the backfill mixture. Depending on the desired design capabilities, the wall can set up as a solid cement-like wall or a softer putty-like wall. In either case, the wall would be designed to be impermeable to water and MGP constituents.

Because some studies have shown that traditional bentonite slurries can be degraded over time by MGP NAPL, use of alternate materials such as attapulgite would be considered in the design phase. Use of soil from the excavation would also have to be carefully considered in the design. If there is too much NAPL in the soil, the slurry may not set up properly and the desired low permeability may not be achieved. Effects of the brackish groundwater (high conductivity and sodium content) and high concentrations of other dissolved phase inorganics (calcium, potassium) would also need to be considered when selecting the slurry mix for optimal longevity.

Installation of a 520-foot slurry wall along the FDR Drive and a 110 foot slurry wall along Pleasant Avenue would take six months to one year, mainly due to the time associated with working around the storm drain on both sides of the school.

A typical pumping/recovery well is shown in Figure 4-6. Depending on the diameter of the well, each well could be installed in one or two days. The wells would have sumps keyed into the clay unit or, where the clay unit is not present, have an impermeable barrier installed at the bottom of each well boring, have perforated sections to allow NAPL and water to enter, and closed bottoms to allow the collection of NAPL. Depending on the type of water treatment system selected, installation would take approximately two to three months.

The wall could be designed to be completed below ground. The only visible portions of the remediation system would be the groundwater treatment system and manholes for the pumping/recovery wells and the NAPL recovery sumps.

A summary of Requirements for 360 Degree Complete Containment Wall Alternative is as follows:

1. Size and configuration of process options: The containment wall would be 1,690 feet long (630 feet of slurry wall plus 1,060 feet of sheet pile wall) and 30 to 40 feet deep (54,080 square feet). Twelve to fifteen groundwater pumping/recovery wells completed to 30 to 40 feet deep would be installed. The dewatering flow rate is not known.
2. Time for remediation: The 360 Degree Complete Containment Wall would take two to three years to install. Operation (pump and treat with NAPL removal) would continue indefinitely.
3. Spatial requirements: Essentially the entire exterior area of the school property would be consumed by construction and staging activities. A minimum of a ten-foot wide area along the wall alignment would be required. This ten-foot wide area would be difficult to obtain along the front of the school building and in the southern corner where the building corner is only 12 feet from the fence of the FDR walkway. Additional staging areas for raw materials, mixing equipment, excavation equipment, and excavated soil of 75 by 75 feet would be needed. Visible features after construction would be the

groundwater treatment system and 12 or 15 manholes. An approximate 30-by-60-foot area would be required for the treatment system.

4. Options for disposal: Soil and debris excavated in the early phases of construction would be disposed of off-site. An estimated 700 cubic yards of soil and debris would be generated in the initial excavation. Another 4,000 cubic yards of soil might be generated as the excavation and slurry wall installation proceeded to clay or bedrock. Some, possibly most, of this soil could be blended into the slurry and form part of the wall. Groundwater and NAPL would be removed from the pumping wells on a periodic to continual basis depending on the rate of infiltration. The groundwater would be treated by the on-site treatment system and the NAPL would be treated off site at a regulated facility. The amount of NAPL that would be recovered is not known. The estimated quantity of groundwater to be treated on site is not known.
5. Permit requirements: Permission of the property owner would be required. Due to the proximity of the containment wall to the walkways and streets around the School, portions of the containment wall may be constructed beyond the school property boundary. Permission from the property owner(s) (City of New York and possibly others) would be required, and at a minimum, sidewalk and street opening permits would be required. Due to the proximity of the project to the FDR Drive, notification and approval by the highway authority might be required. Shutdowns of the streets surrounding the school are not anticipated, although traffic disruptions might occur along Pleasant Avenue and 116th Street and permits might be required. A permit for discharge of treated groundwater either to the river or the POTW would be required. There is a possibility that an air permit might be required depending on the type of groundwater treatment system installed.
6. Limitations or other factors necessary to evaluate the alternative: Soil borings along the proposed alignment of the wall are recommended to confirm the clay thickness where present, to more accurately define where the clay is absent, and to more accurately define the variable depth to bedrock. Soil borings and groundwater sampling are also recommended to the south of 114th Street to determine whether impacted groundwater extends beyond the property boundary to the south. Geophysical surveys and/or excavation to confirm the location and design of subsurface features and utilities would also be needed. Pumping tests to determine potential groundwater recovery rates are also recommended.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Seepage of slurry liquids from the wall to the river must be prevented. Once the wall is in place and MGP materials are prevented from reaching the river, a positive effect on fish and wildlife is possible.

Overall Protection of Public Health and the Environment

A 360 degree Complete Containment Wall is rated as “Good” for Overall Protection of Public Health and the Environment. Current site conditions do not pose a significant risk to public health or the environment. Containment walls have been successfully used at many MGP sites. Soil conditions along the FDR Drive and the storm drain crossing pose some challenges for installation of the wall. The containment wall would be successful at preventing off-site migration of impacted groundwater in the overburden materials. Because the amount of impacted groundwater moving towards the river may be small or insignificant, the benefit of installing the wall is uncertain. Surrounding the school with a sheet pile wall could potentially result in a greater potential for vapors to accumulate in the school building.

Compliance with Standards, Criteria and Guidance

A 360 degree Complete Containment Wall is rated as “Fair” for this criterion. The wall would prevent the off-site migration of impacted groundwater NAPL in overburden. Despite the pump and treat system, the wall would result in a significant reduction in contaminant concentrations in the soil or groundwater unless remedial actions were taken to address the source area beneath the building. The wall would not result in achieving or approaching the SCGs.

Long-Term Effectiveness and Permanence

A 360 degree Complete Containment Wall is rated as “Good” for this criterion. Containment walls are a proven technology for MGP sites and can be designed to last 100 years or more. The wall itself requires no maintenance; however, the groundwater treatment system would require regular maintenance indefinitely.

Reduction of Toxicity, Mobility, or Volume with Treatment

A 360 degree Complete Containment Wall is rated as “Fair” for this criterion. The wall would not reduce the toxicity of MGP material, but would result in the reduction of NAPL volume through removal via the pumping wells. The wall would reduce mobility of the NAPL by preventing off-site migration.

Short-Term Effectiveness

A 360 degree Complete Containment Wall is rated as “Poor” for this criterion. The containment wall around the entire property would be three times longer than the containment wall along the FDR Drive. Thus, the duration of site work and short-term impacts would be significantly greater with the 360 degree Complete Containment Wall alternative. Also, use of the slurry wall method would bring significant amounts (5,000 cubic yards) of impacted soil to the surface. Work would be conducted immediately adjacent (within 10-20 feet) to 900 linear feet of the school building on three sides, and within the walkways surrounding the school resulting in significant odor, dust, and noise issues. Due to the close proximity of work to the school building, noise, dust, and need to cut all subsurface and some above ground utilities, temporary closure of the school would probably be required. Traffic issues and the need to close parking areas around the school might also be a factor in the need to close the school during construction. Significant truck traffic would result from bringing in raw materials and removing unsuitable soils and debris. The duration of construction work is estimated to be six months to possibly over two years.

Implementability

A 360 degree Complete Containment Wall is rated as “Poor” for this criterion. The storm line crossing, presence of multiple live utilities, a fuel oil UST, and working in tight spaces up against an occupied school building present significant technical challenges. Slurry and sheet pile walls have been installed in similar circumstances. It is unlikely that this level of construction work within ten feet of the school can proceed without temporary closure of the school. While work inside the school is not required, noise, dust, and odors from the work would be a significant issue over the two-year construction period. Further, all buried utilities would have to be relocated during construction and temporary loss of utilities would be likely. Multiple permits would be required and permission from the property owner may be challenging. Although a geotechnical evaluation would be required, it appears that the wall could be installed without impact to the FDR Drive, or the school building. Trees and fencing along the sidewalk would have to be removed and replaced.

Cost

General estimate of costs are as follows: design and permitting costs are estimated to be \$250,000; construction costs are estimated to be \$11,600,000; and engineering/oversight/reporting costs are estimated to be \$1,150,000. The total estimated cost is \$13,000,000.

4.2.10 Alternative 9 – Permeable Reactive Barrier

Permeable Reactive Barriers (PRBs) are porous “barriers” that are placed in the path of a groundwater plume, in various configurations, typically as continuous reactive barriers (CRBs) or funnel and gate construction. The barrier, or at least the permeable portion of the barrier, contains a reactive or adsorptive medium that helps remove the contaminants from the plume as the groundwater flows through the barrier. The primary

advantage of PRBs is their passive operation and the resulting potential for long-term cost savings. Regardless of type, PRBs need to be keyed into a low permeability base layer.

CRBs are installed across the full cross section of a plume, do not impede groundwater flow, and eliminate groundwater mounding. Installation techniques consist of traditional excavation and backfill, caisson drilling, trenching, biopolymer slurry trenching, deep-soil mixing, high-pressure jetting, and hydraulic fracturing techniques.

Funnel and gate PRBs consist of a series of PRB sections or gates separated by impermeable vertical groundwater barriers or funnels (typically slurry walls, grouted sheet pile walls, Waterloo™ sheet piling, or HDPE composite walls) which direct the groundwater into the gates for treatment. Treatment vessels or reactors may be installed in place of reactive gates. The reactors can be installed in series or in parallel to permit the periodic change out of the treatment media or individual reactor(s) depending on the contaminants of concern and the rate at which the reactive properties of the treatment media are depleted. This approach is typically used where adsorptive media, particularly granular activated carbon (GAC), is used. Multiple CRBs or funnels and gates can be installed in series with different treatment media to treat groundwater impacted by multiple contaminants.

PRBs packed with GAC have been successfully used at former MGP sites, mainly in Europe where funnel and gate systems have been favored over the CRBs used in the United States. Literature indicates an apparent shift to CRB installations over funnel and gate-style walls in Europe, due to the difficulties associated with maintaining hydraulic containment at the edges of the funnels. Literature also indicates that former MGPs represent a very small percentage (maybe 10%) of the total number of sites with PRB installations worldwide. Despite this, PRBs packed with GAC appear to still be performing well at former MGP sites in Europe. Although information on PRB use at MGP sites is encouraging, PRB technology is still relatively young.

Prior to installation of a PRB at the Site, a detailed hydrogeologic study would be required to define seasonal variations in groundwater flow direction and velocity, hydraulic gradients, and hydraulic conductivity of the various subsurface strata. Seasonal dissolved phase concentrations of site-related constituents of concern (COCs) as well as concentrations of a number of additional inorganic compounds (alkalinity, ammonia, chloride, hardness, nitrate, nitrite, orthophosphate, sulfate, total dissolved solids, and total organic carbon) and geochemistry (pH, conductivity, temperature, dissolved oxygen, and redox potential) would also be required. The hydro/geochemical data would require horizontal and vertical resolution. Bench scale column reactivity tests would be required of site-specific groundwater and NAPL to help select the appropriate reactive barrier materials or mixtures, the required residence time within the barrier, and appropriate wall design and thickness.

PRBs require compliance and performance monitoring programs. The compliance monitoring ascertains compliance with goals at designated compliance points. The performance monitoring focuses on performance of the PRB itself. Ability to identify changes, such as loss of reactivity, decrease in permeability, changes in contaminant residence time within the reactive zone, and short circuiting or leakage through or beneath the wall(s) need to be incorporated into the monitoring program. Monitoring well clusters completed to multiple depths are typically installed with wells aligned along flow paths at locations upgradient, within and downgradient of the PRB. Downgradient monitoring points at the former 115th Street may need to be located within the fenced area and, therefore, necessitate installation of the PRB further from the property boundary.

Construction of a PRB begins with site preparation. Confirmatory utility surveys, including geophysics should be conducted during the pre-design phase in order to identify whether additional utilities or subsurface obstacles exist. For any PRB type that is chosen, excavation to six feet or more would be required to remove obstacles such as buried foundations, debris, and abandoned utilities. The condition of the 10-foot diameter storm line beneath the former 115th Street would also be assessed during this excavation. If any live utility lines are identified they would need to be truncated and reconnected through the sheet piling. This would involve coordination with the utility companies to reroute temporary lines to avoid service interruption during

PRB installation. Excavation below the storm drain line and installation of a PRB along FDR Drive is feasible but would require specialized equipment and be a slow process. Given the age of the storm drain line, reconstruction or replacement of portions of the line may be required. Installation of a slurry wall around the storm drain along the FDR Drive would likely be preferable to constructing a PRB around the storm drain, and would likely provide a better seal around the storm drain and reduce the potential for leaks and potential complications with the PRB. Installation of the PRB via alternative methods such as densely packed soil columns, soil mixing, etc. may facilitate installation along the FDR Drive and disturb less square footage on site.

A PRB wall to the proposed depth of 30 to 40 feet can be installed with a variety of techniques along the FDR Drive. The trench width would be determined by the bench scale tests but would be expected to range from 1 to 5 feet. Since the clay layer is not present beneath a portion of the boundary along the FDR Drive, the PRB would either tie into clay or bedrock.

Although a geotechnical evaluation would be required, it appears that the wall could be installed without impact to the FDR Drive. If steel sheets are used as funnels, they would be driven with a vibratory hammer. Because the school building is on pilings, vibration damage to the building is not likely to occur. However, the noise would be a problem for people in the school and possibly motorists on the FDR Drive. Trees along the sidewalk might have to be removed and replaced.

Excavated material would most likely be sent off site for treatment and disposal.

Because some studies have shown that traditional bentonite slurries can be degraded over time by MGP NAPL, use of alternate materials such as attapulgite should be considered in the design phase for the PRB and slurry wall components as appropriate. Effects of the brackish groundwater (high conductivity and sodium content) and high concentrations of other dissolved phase inorganics (calcium, potassium) would also need to be considered when designing the PRB.

A typical monitoring well cluster is shown in Figure 4-7. Depending on the overall construction, each well cluster could be installed in a day or two. The wells would be installed along a flow line at locations upgradient, within, and downgradient of the PRB.

The PRB could be designed to be completed below ground. The only visible portions of the remediation system would be manholes for the monitoring wells and access points to the reactive gates or treatment reactors, if installed.

A summary of Requirements for Permeable Reactive Barrier (PRB) Along FDR Drive Alternative is as follows:

1. Size and configuration of process options: The PRB along the FDR Drive would be 520 feet long and 30 to 40 feet deep (approximately 20,800 square feet), potentially with an 80-foot long slurry wall component around the storm drain line (3,200 square feet). Depending on the results of the hydrogeologic study, funnels might be required along significant stretches of the Site along 114th and 116th Streets. Multiple gates or reactors would likely be required if a funnel and gate system was installed. Three to six clusters of monitoring points completed to multiple depths would be installed upgradient, within and downgradient of the PRB.
2. Time for remediation: It is estimated to take two to three years to complete the hydrogeologic study, PRB suitability evaluation, bench scale testing, PRB design, and procurement of subcontractors. One to two years would be required for installation, depending on the design. Maintenance and monitoring would continue indefinitely. Ideally, the system would be installed to minimize maintenance and monitoring to the extent possible.
3. Spatial requirements: A minimum of a 10-foot wide area along the 520-foot wall alignment would be required. An additional staging area for raw materials, mixing equipment, excavation equipment, and

excavated soil of 75 by 75 feet would be needed. The only visible features after construction would be manholes for PRB access points.

4. Options for disposal: Soil and debris excavated in the early phases of construction would be disposed of off site. An estimated 1,155 cubic yards (520 x 10 x 6 feet) of soil and debris would be generated in the initial excavation. Depending on installation techniques, another 3,500 cubic yards (520 x 5 x 34 feet) of soil might be generated as the excavation and PRB installation proceeded. It is not likely that Site soils would be able to be used in the PRB construction. Installation techniques such as soil mixing or caisson drilling could be selected to reduce the volume of soil removed.
5. Permit requirements: Permission from the property owner would be required. Due to the proximity of the project to the FDR Drive, notification and approval by the highway authority might be required. A UIC permit might be required.
6. Limitations or other factors necessary to evaluate the alternative: Soil borings along the proposed alignment of the PRB are recommended to confirm the depth of bedrock and to further define where the clay is present. An extensive investigation with groundwater and geochemical modeling would be required to generate detailed hydrogeologic data necessary for the design phase. Geophysical surveys and/or excavation to confirm the location and design of subsurface features would also be needed. Bench scale column reactivity tests would be required of site-specific groundwater and NAPL to help select the appropriate reactive barrier materials or mixtures, the required residence time within the barrier, and appropriate wall design and thickness.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Once the wall is in place and impacted groundwater is prevented from reaching the river, a positive effect on fish and wildlife is possible.

Overall Protection of Public Health and the Environment

PRB along the FDR Drive is rated as “Good” for Overall Protection of Public Health and the Environment. Current site conditions do not pose a significant risk to public health or the environment. PRBs have been successfully used at MGP sites, mainly in Europe where funnel and gate systems have been favored. Soil conditions along the FDR Drive and the storm drain crossing pose some challenges for installation of the PRB. The PRB would be successful at reducing migration of impacted groundwater in the overburden. Because the amount of impacted groundwater moving towards the river may be small or insignificant, the benefit of installing the wall is uncertain. While use of a PRB with the potential use of passive collection sumps to remove NAPL will likely improve conditions, downgradient soil and groundwater conditions upgradient of the Barrier Wall are not expected to change.

Compliance with Standards, Criteria and Guidance

A PRB along the FDR Drive is rated as “Good” for this criterion. The wall would prevent the off-site migration of impacted groundwater in overburden which would result in a significant reduction in contaminant concentrations in groundwater downgradient of the wall. Based on the performance of PRBs at other sites including former MGPs, the wall could result in approaching or achieving WQS for select COCs and 90% reductions in concentrations of the other COCs should be achievable.

Long-Term Effectiveness and Permanence

A PRB along the FDR Drive is rated as “Fair” for this criterion. PRBs are a proven technology for MGP sites; however, the technology is relatively young compared to other remedial technologies and the longevity of PRBs is not well defined given that the oldest PRB is 10 to 15 years old. The level of maintenance depends largely on the treatment media used (frequency of change out or rejuvenation) and the construction of the PRB (number of gates or reactors versus a continuous reactive wall). Significant monitoring would be required in the first few years and can be reduced if the PRB is functioning properly. If NAPL collection sumps are

installed, periodic inspection and removal of NAPL from the sumps is required. If active pumping wells are required in a funnel and gate design, then indefinite pumping and treatment would be required.

Reduction of Toxicity, Mobility, or Volume with Treatment

A PRB along the FDR Drive is rated as “Fair” for this criterion. The wall would not reduce the toxicity of MGP material, but would result in the reduction of NAPL volume through removal in the sumps and/or gates. The PRB would also reduce concentrations of COCs in groundwater downgradient of the wall.

Short-Term Effectiveness

A PRB along the FDR Drive is rated as “Fair” for this criterion. The installation of the PRB could bring significant amounts (4,700 cubic yards) of impacted soil to the surface. The duration of construction work is estimated to be one to two years and would result in potential odor, dust, and noise issues. These exposure risks are easily controlled. Significant truck traffic would result from bringing in raw materials and removing unsuitable soils and debris.

Implementability

A PRB along the FDR Drive is rated as “Fair” for this criterion. Although a geotechnical evaluation would be required, it appears that the wall could be installed without impact to the FDR Drive. Trees along the sidewalk might have to be removed. Although the storm line crossing presents some technical challenges, PRBs have been installed under similar circumstances. Addressing the potential for groundwater mounding and bypass around or beneath the PRB, particularly under tidal conditions, would be a challenge. The PRB technology is fairly new and not fully developed and proven for MGP sites. A hydrogeologic study, bench-top studies of reagents, and a pilot study are recommended to assist in design of the alternative. The number of required permits is not significant. Approval from the property owner might be challenging but theoretically less challenging than for the containment wall alternative.

Cost

The estimated capital cost for a PRB is \$2,000,000 to \$3,000,000. This cost includes a hydrogeologic study, bench-top and pilot studies, design, permitting and engineering oversight. The estimated average cost for maintenance and monitoring of the PRB is \$50,000 per year. Over a thirty-year period, the cost of operation and maintenance is \$750,000 using a net present value discount of 5%. The total cost of a PRB is estimated to be \$3,000,000 to \$4,000,000. Because PRBs are an emerging technology, costs are difficult to estimate. Key factors such as bed life of the media are not known.

4.3 Impacted Subsurface Vapors

As a result of the presence of MGP materials beneath the school building, indoor air sampling and sampling of vapors beneath the floor has been conducted. Analysis of indoor air samples has shown that indoor air is not adversely impacted. However, samples collected from beneath the floor show that volatiles consistent with MGP materials are present in the subsurface. Five alternatives will be considered to reduce the potential for future vapor impacts in the building: No Action, Monitoring, Passive Venting, Active Venting, and Vapor Barriers.

The area of interest for impacted vapors is below the southern half of the building, covering an area approximately 240 feet by 160 feet or approximately 38,000 square feet. This area is an occupied basement area which includes a cafeteria, music room, boiler room, utility closets and hallways. The basement floor is 8 to 12 inches of poured and reinforced concrete, appears to be in good shape with no obvious cracks or holes, and is either covered with tile or is painted on a regular basis. High permeability gravel is present immediately beneath the floor. The water table is approximately 6 feet below the floor.

4.3.1 Alternative 1 - No Action

This alternative does not include any remedial activities or institutional controls; therefore, the concentration of subsurface vapor would not change. No activity designed to prevent potential migration of sub-slab vapor into buildings would be implemented. No monitoring of sub-slab vapor concentrations or indoor air would occur. This alternative, however, includes five-year remedy reviews. This alternative serves as a baseline condition against which other remedial alternatives are compared.

A summary of the No Action Alternative for Sediments is as follows:

1. Size and configuration of process options: None
2. Time for remediation: None
3. Spatial requirements: None
4. Options for disposal: No waste would be generated
5. Permit requirements: None
6. Limitations or other factors necessary to evaluate the alternative: None
7. Beneficial and/or adverse impacts on fish and wildlife resources: No action would not change current conditions and would have no impact on fish and wildlife resources

Following is a summary of the evaluation of this alternative:

Overall Protection of Human Health and the Environment: This alternative is rated “Unacceptable.” The No Action alternative does not involve any remedial activities or institutional controls; therefore, potential risks to human health and the environment are not reduced. Under current conditions indoor air does not pose a risk to human health. However, the No Action alternative does not provide any control of future activities that could lead to vapor intrusion into an on-site building. Because this alternative does not control future activities that may lead to vapor intrusion, this alternative is rated as “Unacceptable.”

Compliance with Standards: This alternative is rated as “Poor.” This alternative does not comply with appropriate NYSDOH and NYSDEC guidance.

Long-term Effectiveness and Permanence: This alternative is rated as “Poor.” This alternative does not provide long-term risk controls.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is rated as “Poor.” Treatment activities are not included in the No Action alternative. Consequently, no reduction of toxicity, mobility, or volume of contamination would occur.

Short-term Effectiveness: This alternative is rated as “Good.” Because there is no remedy implementation, there would be no additional risks to surrounding community, workers, or the environment. This option requires no time to implement.

Implementability: This alternative is rated as “Good.” This alternative is easy to implement from a technical standpoint. Regulatory support is needed to perform the five-year remedy reviews.

Cost: There is no capital costs associated with this alternative. The only O&M cost is associated with 5-year remedy reviews and is estimated to be \$10,000 every five years. Over a 30-year period, the estimated cost is \$60,000.

4.3.2 Alternative 2 - Monitoring

Indoor air monitoring assessment activities at the Site indicate that indoor air quality within the school is not currently being impacted by subsurface MGP-related impacts at the Site. Further, it has been observed that the potential for subsurface MGP vapor intrusion into neighboring buildings is considered low. However, the potential for future indoor air quality concerns exists because MGP constituents have been found in soils and soil gas beneath the southern portion of the school building.

In this alternative, Indoor Air Quality Monitoring would be conducted in accordance with recent New York regulatory documents, NYSDOH's *Guidance for Evaluating Soil Vapor Intrusion in New York State*, (NYSDOH, 2006), and NYSDEC's Program Policy, *Strategy for Evaluating the Potential for Vapor Intrusion at Remedial Sites in New York*, October 2006 (NYSDEC, 2006). This program would include a building inspection, indoor and ambient air sampling, and an evaluation of the indoor air sampling results. Because previous remedial investigations and indoor air quality assessments have been performed at the Site, further soil gas sampling and evaluation of potential off-site receptors would likely not be necessary.

A building inspection would occur as part of each indoor air sampling event. The focus of this inspection would be to determine if there are materials and supplies in the building that contain chemicals that might be detected during indoor air sampling activities. If potential sources of indoor air contamination are located, they would be removed from the building for the duration of the sampling event or noted in the building inspection log.

Indoor air and ambient air sampling would be conducted in the basement and first floor of the School, in general accordance with NYSDOH's *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH 2006). Sample locations for the indoor air and ambient air would be similar to locations used during previous investigations at the Site to determine if changes to indoor air quality have occurred since prior sampling events. Individually certified clean Summa canisters would be used during sampling events. Atmospheric conditions and other factors that could affect air sampling results would be documented.

Indoor air and ambient air samples would be analyzed via the methods used during previous indoor air quality assessments at the Site. The laboratory results, building inspection documentation, and sampling event field documentation would be compiled to evaluate whether constituents in indoor air were above Site ambient and background concentrations, and if so, whether they were associated with MGP sources.

A summary of the Indoor Air Monitoring Alternative is as follows:

1. Size and configuration of process options: None
2. Time of remediation: Not applicable; each sampling event typically takes 8 hours to complete.
3. Spatial requirements: None
4. Options for Disposal: No wastes are generated.
5. Permit requirements: None. Sampling methods and results would be presented to the NYSDOH, New York City Department of Education, and NYSDEC.
6. Limitations or other factors necessary to evaluate the alternative: None
7. Beneficial and/or adverse impacts on fish and wildlife resources: None

Overall Protection of Public Health and the Environment

Monitoring is rated as "Fair" for this criterion. Currently, indoor air concentrations are acceptable. Monitoring is an effective way to confirm that indoor air goals are met and to detect potential future indoor air issues. The

effectiveness of indoor air monitoring depends on the monitoring being conducted indefinitely into the future. Changes in the condition of the floor (damage or installation of perforations) or other building changes such as changes in the heating or ventilation could result in changes in indoor air conditions, which would be effectively monitored with this alternative. Indoor air monitoring would not reduce or eliminate the potential for future indoor air impacts.

Compliance with Standards, Criteria and Guidance

Monitoring is rated as “Fair” for this criterion. A monitoring program would be conducted to comply with appropriate NYSDOH and NYSDEC guidance. Monitoring would serve to confirm that indoor air goals were met. Monitoring would not result in a reduction in subsurface vapor concentrations.

Long-Term Effectiveness and Permanence

Monitoring is rated as “Poor” for this criterion. Institutional controls would have to be developed to assure that indoor air monitoring would continue indefinitely into the future. Monitoring would not provide containment or reduction in sub-slab vapor concentrations.

Reduction of Toxicity, Mobility, or Volume with Treatment

Monitoring is rated as “Poor” for this criterion. Monitoring would have no effect on the toxicity, mobility, or volume of MGP materials.

Short-Term Effectiveness

Monitoring is rated as “Good” for this criterion. Monitoring presents no short-term risks to the public. Monitoring is effective at determining current indoor air quality.

Implementability

Monitoring is rated as “Good” for this criterion. Minimal permits would be required. Monitoring has been conducted previously at the Site and there are no barriers to conducting future monitoring events. Monitoring would not be disruptive to school activities.

Cost

Monitoring over a 30-year period, using a 5% net present value, is estimated to cost \$125,000 to \$175,000.

4.3.3 Alternative 3 - Passive Venting

Passive venting is an indoor air mitigation technique used to prevent soil vapors that lie beneath a building from impacting the indoor air quality in the building. A conceptual venting system design is shown in Figure 4-8. Passive venting is effective when a pressure differential exists between the building and beneath the building. The venting system relieves this pressure and provides a pathway for vapors to be released harmlessly outside. If conditions exist where air pressure beneath the building is greater than local atmospheric pressure, soil vapors are pushed through the venting systems, thereby depressurizing the soil vapors beneath the building.

Passive venting is used after the bottom concrete slab of the building in question has been inspected and any defects sealed. Passive venting includes the installation of slotted pipe directly beneath the concrete slab, either vertically or horizontally, into the plume of soil vapor contamination. The pipe is then plumbed to discharge above roof level of the building. The number of installation and discharge points necessary for this venting to be effective is determined on a site-specific basis. The piping network used to vent soil vapors from

the building would be designed and installed to be as unobtrusive as site conditions permit. In this case, piping would run along or inside walls and through crawl spaces.

Subsurface soil conditions in the footprint of the school indicate that indoor air quality mitigation via sub-slab depressurization is feasible due to the granular fill below the basement concrete floor.

A summary of the Passive Venting Alternative is as follows:

1. Size and configuration of process options: Passive venting would be required only for the portion of the building above the MGP residuals. This area of approximately 38,000 square feet is estimated to require the installation at least thirty vertical vapor extraction points.
2. Time of remediation: Passive venting would mitigate potential soil vapor hazards; however, no remediation would be performed. Installation of the venting system would require approximately two months.
3. Spatial requirements: Minimal
4. Options for disposal: General construction debris generated during installation could be disposed of at a commercial landfill. Impacted soils, if generated, would be stored in approved drum(s) and disposed of at an off-site regulated facility.
5. Permit requirements: Concentrations of vapor in the vent exhaust would be measured. It is unlikely that any air permitting discharge would be required.
6. Limitations or other factors necessary to evaluate the alternative: Passive venting is only effective when a pressure differential exists between the sub-slab vapors and atmospheric conditions. Pressure testing would be performed in the building and beneath the basement floor to determine if such a differential exists. Further, testing to confirm that the vents are depressurizing the subsurface is recommended.
7. Beneficial and/or adverse impacts on fish and wildlife resources: None

Overall Protection of Public Health and the Environment

Passive venting is rated as "Good" for this criterion. The potential for vapors to migrate from the subslab to the indoors would be greatly reduced. Passive vents require minimal maintenance. However, institutional controls to prevent removal or damage of the vents would be required. Installation of the vents presents no significant short-term risks.

Compliance with Standards, Criteria, and Guidance

Passive venting is rated as "Fair" for this criterion. NYSDOH's document, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, October 2006 (NYSDOH, 2006) states that active venting is generally preferred. Passive venting might also be acceptable but would require justification based on site-specific conditions.

Passive venting would not reduce soil or groundwater concentrations to the SCGs.

Long-Term Effectiveness and Permanence

Passive venting is rated as "Good" for this criterion. This alternative could provide long-term reliability for reducing direct exposure of the building occupants for potential indoor air quality concerns. Institutional

controls to prevent removal or damage to the vent system would be required. Damage to the floor or changes in the heating and ventilation system in the future could potentially reduce the effectiveness of a passive venting system.

Reduction of Mobility, Toxicity, or Volume through Treatment

Passive venting is rated as “Fair” for this criterion. Passive venting has been demonstrated to be effective in preventing soil vapors from entering buildings. However, there would be no reduction in volume or toxicity of constituents within the soil matrix. Some minor removal of VOCs could occur during the process.

Short-Term Impacts and Effectiveness

Passive venting is rated as “Good” for this criterion. During the implementation of this mitigation alternative, measures would be taken to monitor and reduce the potential for air emissions. Direct contact with impacted material during the installation phase would be minimal. It is anticipated that the passive ventilation system could be installed and operational within a two month period.

Implementability

Passive venting is rated as “Poor” for this criterion. This technology is technically feasible and has been used successfully at other MGP sites. However, NYSDOH’s current policy is to not approve passive venting systems. This process uses conventional equipment that is readily available.

Cost

The estimated cost to install a passive vent system is estimated to be \$100,000. Operational costs over a 30 year period using a net present value discount of 5% are estimated to be \$25,000.

4.3.4 Alternative 4 - Active Venting

Active venting is an indoor air mitigation technique used to remove soil vapors that lie beneath a building and prevent vapors from impacting the indoor air quality in the building. Active venting and passive venting are very similar. As discussed previously, passive venting occurs when a pressure differential exists between the intake and exhaust of the venting system. Active venting is simply the addition of an energized electric fan placed in the exhaust pipe network to create sub-slab depressurization (SSD) conditions. If conditions exist where SSD occurs, soil vapors would be conveyed from the intake to the exhaust, thereby depressurizing the soil vapors beneath the building.

Active venting is used after the bottom concrete slab of the building in question has been inspected and any cracks or holes sealed. The process includes the installation of slotted pipe directly beneath the concrete slab either vertically or horizontally into the plume of soil vapor contamination. The pipe is then plumbed to discharge above roof levels of the building where the fan is installed. The number of installation and discharge points necessary for this venting to be effective is determined on a site-specific basis. The piping network used to vent soil vapors from the building would be designed to be as unobtrusive as site conditions permit. Fans would be located near the exhaust to minimize noise disturbance. A gage to easily confirm the system is working (air flow) would be installed.

Subsurface soil conditions in the footprint of the school indicate that indoor air quality mitigation via SSD is feasible due to the granular fill below the basement concrete floor.

A summary of Active Venting System Alternative is as follows:

1. Size and configuration of process options: Active venting is anticipated only for the portion of the building above the MGP residuals. This area of approximately 38,000 square feet is estimated to require the installation at least twenty vertical vapor extraction points. Individual vent lines could be tied together to decrease the number of fans needed.
2. Time of remediation: Active venting mitigates potential soil vapor hazards; no remediation is performed. Installation of an active venting system would require approximately two months.
3. Spatial requirements: Minimal
4. Options for disposal: General construction debris generated during installation can be disposed at a commercial landfill. Impacted soils, if generated, would be stored in approved drum(s) and disposed at an off-site regulated facility.
5. Permit requirements: Concentrations of vapor in pipe exhausts would be measured. It is unlikely that any permitting would be required.
6. Limitations or other factors necessary to evaluate the alternative: Pressure testing would be performed in the building and beneath the basement floor. In the pilot test one well would be installed and the radius of influence would be determined by several pressure gages. These data would then used to determine the spacing of vent wells and the pressure and flow requirements for the blowers.
7. Beneficial and/or adverse impacts on fish and wildlife resources: None

Overall Protection of Public Health and the Environment

Active venting is rated as “Good” for this criterion. Active venting is part of remedial action at several MGP sites. Active venting is proven reliable and effective. Short-term impacts during construction are minimal. This alternative would be protective of human health and the environment.

Compliance with Standards, Criteria, and Guidance

Active venting is rated as “Good” for this criterion. This method is consistent with NYSDOH’s document, “Guidance for Evaluating Soil Vapor Intrusion in the State of New York,” October 2006, which requires that indoor air mitigation methods include an impermeable barrier between a building’s occupants and impacted soil vapors, and that active soil vapor venting techniques be applied. Active venting would assure that indoor air SCGs continue to be met in the future.

Long-Term Effectiveness and Permanence

Active venting is rated as “Fair” for this criterion. This alternative could provide long-term reliability for reducing direct exposure of the building occupants for potential indoor air quality concerns. Active venting systems are easy to maintain and are very reliable. However, institutional controls are required to ensure that the system is not damaged or removed and that periodic inspection and maintenance of the system is conducted.

Reduction of Mobility, Toxicity, or Volume through Treatment

Active venting is rated as “Fair” for this criterion. Active venting has been demonstrated to be effective in obstructing soil vapors from entering buildings. However, there would be no reduction in volume or toxicity of constituents within the soil matrix. Some minor removal of VOCs could occur during the process.

Short-Term Impacts and Effectiveness

Active venting is rated as “Good” for this criterion. During the implementation of this mitigation alternative, measures would be taken to monitor and reduce the potential for air emissions. Direct contact with impacted material during the installation phase would be minimal. It is anticipated that the active ventilation system could be installed and operational within a two-month period.

Implementability

Active venting is rated as “Good” for this criterion. This technology is technically feasible and has been used successfully at other MGP sites. Similar systems have been approved in New York. This process uses conventional equipment that is readily available. Installation and operation of the active venting system would not disrupt school activities.

Cost

The estimated cost to install and operate an active vent system over a 30-year period using a net present value discount of 5% is \$100,000 to \$150,000. Because of the fewer wells required, the construction cost of an active system is less than that of a passive system. However, operational costs (electrical use, inspections, etc.) are higher with an active system.

4.3.5 Alternative 5 - Vapor Barriers

A vapor barrier is a physical barrier between the sub-slab vapors and the inside of the building. The School already has a thick concrete floor that is in good condition. The existing floor appears to be an effective vapor barrier. An additional vapor barrier might include installing a specialty sealant over the existing floor or pouring a second floor over the existing floor. Injecting a sealant beneath the existing floor might also be possible.

A summary of Vapor Barriers Alternatives is as follows:

1. Size and configuration of process options: Vapor barriers would be required only for the portion of the building that rests atop the MGP residuals. This area is approximately 38,000 square feet.
2. Time of remediation: The time to install the barrier would be highly dependent on the vapor barrier design chosen and would be at least three months and possibly much longer.
3. Spatial requirements: The 38,000 square foot basement area would most likely have to be vacated during installation of the vapor barrier.
4. Options for disposal: Minimal wastes would be generated
5. Permit requirements: Minimal permitting would be required
6. Limitations or other factors necessary to evaluate the alternative: An evaluation of the current floor would be conducted. In this evaluation specific points of vapor entry (if any) would be identified. A detailed review of construction drawings would be conducted. From these evaluations, the most effective vapor barrier designs could be developed.
7. Beneficial and/or adverse impacts on fish and wildlife resources: None

Overall Protection of Public Health and the Environment

Vapor Barriers are rated as “Good” for this criterion. At the current time it appears that the existing floor is an effective vapor barrier. This alternative would be protective of human health and the environment.

Compliance with Standards, Criteria, and Guidance

Vapor Barriers are rated as “Fair” for this criterion. The existing floor appears to be effective at achieving indoor air goals. Use of the floor alone, without monitoring or an active venting system, may not be acceptable to the NYSDOH or other agencies.

Long-Term Effectiveness and Permanence

Vapor Barriers are rated as “Good” for this criterion. This alternative could provide long-term reliability for reducing direct exposure of the building occupants for potential indoor air quality concerns. The current floor, consisting of over 8 inches of reinforced concrete, is expected to provide a long-term vapor barrier. Institutional controls to prevent damage to the floor would be required. Additional vapor barriers, such as spray-on sealant can have limited long-term effectiveness.

Reduction of Mobility, Toxicity, or Volume through Treatment

Vapor Barriers are rated as “Fair” for this criterion. Vapor barriers are demonstrated to be effective in obstructing soil vapors from entering buildings. However, there would be no reduction in volume or toxicity of constituents within the soil matrix.

Short-Term Impacts and Effectiveness

Vapor barriers are rated as “Good” for this criterion. Inspection and use of the existing floor as a vapor barrier poses no short-term risks. Installation of sealants often makes it necessary to vacate buildings for several days.

Implementability

Use of the existing floor as a vapor barrier is rated as “Good” for this criterion. However, installation of surface sealants or a new floor would be disruptive to the school and may not be acceptable to the school.

Cost

Assuming only costs associated with inspection and maintenance of the existing floor, the estimated cost over a 30-year period using a net present value discount rate of 5% is \$20,000 to \$50,000.

4.4 Impacted Sediments in the Harlem River

The following six alternatives will initially be considered for impacted sediments in the Harlem River:

- No Action;
- Institutional Controls;
- Monitored Natural Recovery;
- In-Situ Capping;
- In-Situ Treatment, and
- Removal by Dredging.

In this section a description of the river conditions and preliminary screening of the six general response measures is provided. In Sections 4.4.1 to 4.4.4 a description and evaluation of the four most promising alternatives is provided.

The Harlem River is a tidal strait that connects the Hudson River with the East River. The strait is approximately 8 miles long and has seven bridges. The tidal cycle has an approximately 4-foot elevation change and river water flows in both directions. The Harlem River is in a highly urbanized area and essentially all of the shoreline has been filled, hardened, or straightened (US Army Corps of Engineers, 2004). Portions of the shoreline have been re-naturalized and provide limited nursery habitat for fish and foraging habitat for birds (Army Corps of Engineers, 2004). Uses of the Harlem River include commercial and recreational navigation, and non-commercial fishing. Fishing advisories limiting consumption of fish have been issued by the New York State Department of Health. The fishing advisories appear to be related to impacts other than MGP constituents. Therefore, removal of the MGP impacted sediments adjacent to the Site would not result in the lifting of the fish advisory. River water quality is also degraded by storm water and combined sewer discharges.

In the immediate vicinity of the Site, the river is approximately 400 feet wide. A cross section of the Site and Harlem River bottom from the Site to the river channel is provided as Figure 1-3. Depth of the Harlem River varies from a few feet in the shoal area adjacent to the Site to approximately 20 feet in the channel area. The US Army Corps of Engineers, North Atlantic Division, New York District (USACOE) was contacted to obtain the past dredging history and future dredging plans. Dredging from 110th Street to the Triborough Bridge was conducted in 1931/32. The mid-1960s dredging was conducted in the area of 106th to 112th streets and in the mid-1970s from 103rd to 112th streets. It appears that the last dredging directly adjacent to the Site was in the 1930s. The desired depth for the Harlem River in the area of the site is 15 feet. Condition surveys by the USACOE indicate that the depth is greater than 15 feet. Also, ENSR's sediment sampling work showed the channel depth to exceed 20 feet. USCOE reports no plans for dredging the Harlem River in the area of the Site.

The FDR Drive and adjacent walkway is located between the Site and Harlem River and forms the western bank of the River. In this area the FDR Drive is on piers and the Harlem River front is a concrete bulkhead constructed on piles. As discussed later, active removal or treatment of sediments below the FDR and walkway is not considered to be implementable.

The sediment overburden thickness in the area of the Site ranges from 11 to 24 feet. Sediment material generally consists of a thick layer of fluffy black marine sediment which is underlain by an overburden consisting of a silt layer with varying amounts of sand and clay which is generally followed by a sand layer, and then a clay layer.

The extent of MGP impacts to sediments adjacent to the Site is depicted in Figures 1-3, 1-5, and 1-8. Sediment impacts are as follows:

- MGP impacted sediments are overlain by 14 to 27 feet of sediments that do not appear to be impacted by MGP materials.
- Visual MGP impacts suggesting the presence of NAPL (tar, sheen, globules, and staining) are present over an approximately 180 by 680 foot area. The thickness of the apparent NAPL ranges from 0.25 to 4 feet. An estimated 10,000 cubic yards of NAPL impacted sediments are present in the Harlem River adjacent to the Site.

As discussed in more detail in the Supplemental RI Report, PAHs, VOCs, and metals were detected in sediment samples collected around the areas depicted with visual MGP impacts. Concentrations of the primary MGP constituents (PAHs and BTEX) are much lower in samples collected outside the visibly impacted area. Samples outside the visibly impacted area exceed the NYSDEC SSC. Given the depth of

the impacted sediment (ranging between 14 and 27 feet below the sediment surface), the impacts are confined by the overlying sediments and there is no ongoing release to surface water.

- Visibly impacted sediments are isolated underneath 14 or more feet of sediment. At this depth it is unlikely there is an on-going release to surface water. The MGP impacted sediments are below the biologically active zone, so they are not impacting potential ecological benthic receptors. If left undisturbed, the impacted sediments are isolated from potential receptors and, therefore, do not present a complete exposure pathway.

There are six general types of response actions that are considered for contaminated sediments (*Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (US EPA, 2005)). The six general response actions and their applicability to the Site are as follows:

- *No Action* - By definition this response action involves no active remediation and assumes that contaminant concentrations would remain essentially unchanged. This alternative will be retained.
- *Institutional Controls* - Institutional controls may include access advisories, consumption advisories, fishing moratoriums, dredging moratoriums, work safe restrictions, and other non-engineered controls. These measures are designed to prevent exposure scenarios that may present unacceptable risks. This alternative is applicable to the Site conditions and is, therefore, retained.
- *Monitored Natural Recovery (MNR)* - Natural recovery includes natural processes such as dilution, dispersion, volatilization, biodegradation, adsorption, covering by natural sedimentation, and chemical reactions with soil materials which are used to reduce or isolate organic constituent concentrations. Contaminant levels would continue to be monitored on a regular basis to track attenuation. Sediment thickness might also be monitored to gauge the progress of natural covering. This alternative is potentially applicable to the Site and is retained.
- *Containment/Capping* - A variety of inert and reactive caps can be applied to cover and isolate impacted sediments. Because the MGP impacted sediments are already covered with 14 to 27 feet of unimpacted sediments, this remedy will not be retained for further evaluation.
- *Removal (Dredging)* - Removal includes physically excavating or dredging impacted sediments from the River. Removed sediments are then treated and disposed of at an off-site location. This alternative is highly scrutinized from a permitting perspective and is difficult of control in terms of re-suspension/mobilization of encapsulated constituents, temporary loss of habitat, and down river transport. While this process would be difficult and expensive to implement, it is the most direct way to reduce or eliminate MGP impacts in the sediment and is retained.
- *In-Situ Treatment* - In-situ treatment would employ biological, chemical, or thermal processes to treat the buried sediments in place. Site and contaminant conditions are not favorable for in-situ treatment. Delivery of the required reagents to the impacted sediments would be very difficult. Dispersion of the reagents in the generally low permeability but heterogeneous sediments would be very difficult. MGP NAPL consists of a mixture of compounds including high molecular weight aromatic compounds. These compounds are resistant to chemical and biological treatment. Thermal treatment of sediments below a river is not practical. In-situ stabilization has not been demonstrated in subaqueous sediments, especially in brackish waters. In-situ treatment of sediments at the Site is not feasible and has not been retained for further evaluation.

The four retained alternatives are discussed in more detail below.

4.4.1 No Action

This alternative does not include any remedial activities or institutional controls; therefore, the river sediment would remain in its current state, without any changes occurring. This alternative, however, includes five-year

remedy reviews. This alternative serves as a baseline condition against which other remedial alternatives are compared.

A summary of the No Action Alternative for Sediments is as follows:

1. Size and configuration of process options: None
2. Time for remediation: None
3. Spatial requirements: None
4. Options for disposal: No waste would be generated
5. Permit requirements: None
6. Limitations or other factors necessary to evaluate the alternative: None
7. Beneficial and/or adverse impacts on fish and wildlife resources: No action would not change current conditions and would have no impact on fish and wildlife resources.

Following is a summary of the evaluation of this alternative:

Overall Protection of Human Health and the Environment: This alternative is rated “Poor.” The No Action alternative does not involve any remedial activities or institutional controls; therefore, potential risks to human health and the environment are not reduced. However, sediments are isolated under 14 to 27 feet of sediment. Current conditions do not appear to pose an unacceptable risk. No Action does not provide any control of future activities, such as uncontrolled dredging, that may expose impacted sediment and create an exposure pathway. Because this alternative does not control future activities that may lead to exposure to buried sediment, this alternative is rated as “Poor.”

Compliance with Standards: This alternative is rated as “Poor.” This alternative does not comply with the chemical-specific sediment screening goals. This alternative does not remove or treat grossly contaminated sediments or free product to the extent feasible.

Long-term Effectiveness and Permanence: This alternative is rated as “Poor.” This alternative does not provide long-term risk controls.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is rated as “Poor.” Treatment activities are not included in the No Action alternative. Consequently, no reduction of toxicity, mobility, or volume of contamination would occur.

Short-term Effectiveness: This alternative is rated as “Good.” Because there is no remedy implementation, there would be no additional risks to surrounding community, workers, or the environment. This option requires no time to implement.

Implementability: This alternative is rated as “Good.” This alternative is easy to implement from a technical stand point. Regulatory support is needed to perform the five-year remedy reviews.

Cost: There is no capital costs associated with this alternative. The only O&M cost is associated with 5-year remedy reviews and is estimated to be \$10,000 every five years. Over a 30-year period, the estimated cost is \$60,000.

4.4.2 Institutional Controls

Institutional controls generally considered for impacted sediments include fish consumption advisories, fishing bans, ship draft/anchoring/wake controls, swimming restrictions, dredging restrictions, and structural

maintenance controls. Sediments impacted with MGP materials are buried and are unlikely to impact fish. Thus, fishing advisories and bans do not appear to be relevant to the MGP impacts. Fishing advisories have been issued for the Harlem River relative to other pollutants not related to the Site. Because the impacted sediments are buried by over 14 feet of overlying sediments, swimming restrictions, ship draft/anchoring/wake controls also do not appear to be relevant. Dredging of sediments for navigation, installation or maintenance of buried utilities lines, or installation or maintenance of structures such as retaining walls or bridges could disturb or otherwise bring to the surface impacted sediments. Agencies that may have the authority to impose waterway use restrictions include the Army Corps of Engineers, New York State, and the City of New York. Identifying the appropriate agencies, establishing the necessary legal documentation and enforcement of the restrictions would be required. Land use restrictions for shore activities and structural maintenance agreements are other tools to implement Institutional Controls.

A summary of the Institutional Controls Alternative for Sediments is as follows:

1. Size and configuration of process options: None
2. Time for remediation: It would take six months to a year to implement Institutional Controls.
3. Spatial requirements: None
4. Options for disposal: No waste would be generated
5. Permit requirements: Agreements with the USACOE, City of New York, State of New York and possibly private land owners along the river bank would be required.
6. Limitations or other factors necessary to evaluate the alternative: Further evaluation of the legal processes and issues related to restricting dredging and other activities in a river would be necessary.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Institutional Controls would prevent or control activities such as dredging that might adversely impact ecological receptors in the river.

The evaluation of Institutional Controls is as follows:

Overall Protection of Human Health and the Environment: This alternative is rated as “Fair.” Institutional Controls would effectively prevent the activities such as uncontrolled dredging that might lead to human or ecological exposure to buried sediments.

Compliance with Standards: This alternative is rated as “Poor.” This alternative does not comply with the chemical-specific sediment screening goals. This alternative does not remove or treat grossly contaminated sediments or free product to the extent feasible.

Long-term Effectiveness and Permanence: This alternative is rated as “Fair.” The Harlem River is a federally authorized navigation channel. The types of activities that potentially would expose buried sediments are highly regulated. Management of impacted sediments could be incorporated into any future designs for navigation dredging. While Institutional Controls are expected to be effective, effectiveness over a long period of time is not a certainty.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is rated as “Poor.” Treatment activities are not included in this alternative. Consequently, no reduction of toxicity, mobility, or volume of contamination would occur.

Short-term Effectiveness: This alternative is rated as “Good.” Because there is no physical site activity (other than possibly posting signs), there would be no additional risks to the surrounding community, workers or the environment during implementation. This option requires a relatively short period of time to implement (months).

Implementability: This alternative is rated as “Good.” This alternative is easy to implement from a technical standpoint. Identifying the appropriate agencies and establishing the necessary legal agreements is feasible. The envisioned water use restrictions do not appear to be inconsistent with current Site use. Thus, public and government agency resistance to the restrictions might not be insurmountable. It is not likely that future navigation dredging could be prohibited. However, establishing controls on the dredging methods and management of dredged spoils is feasible.

Cost: Developing and implementing the necessary legal agreements for Institutional Controls would cost an estimated \$50,000 to \$100,000. It is not known at this time if additional fees or assessments would be associated with implementing Institutional Controls.

4.4.3 Institutional Controls and Monitored Natural Recovery (MNR)

This alternative involves implementing Monitored Natural Recovery and Institutional Controls. Because Monitored Natural Recovery would be a very slow process, Institutional Controls are considered necessary to control activities that may expose impacted sediments. When considering alternatives for reducing potential human health and ecological exposures associated with the sediments it is important to recognize the capacity of natural processes within the system to reduce contaminant bioavailability and concentrations. Referred to as natural recovery, these processes within the river would be driven by physical mechanisms such as the mixing and in-place burial of contaminated sediments within depositional areas, with progressively cleaner sediments delivered from upriver erosional areas. This natural sedimentation process can effectively reduce the physical availability of constituents for potential transport downstream and similarly reduce the biological availability of constituents for potential exposure to human and ecological receptors. Constituents would gradually be sequestered deeper in the sediment bed, farther away from the sediment surface where they could otherwise be available for transport downstream or uptake within the food chain (Brown, 1999). The progressive covering of impacted sediments appears to be occurring for this Site. Other potentially significant mechanisms contributing to the natural recovery process may include adsorption, desorption, redox reactions, dilution, dispersion, hydrolysis, deposition, biodegradation, and bioturbation.

As indicated in recent sediment guidance (US EPA, 2005), there are a number of different natural processes that may reduce risk from contaminated sediment. The processes and their relative effectiveness for site conditions are as follows:

- The contaminant is converted to a less toxic form through transformation processes, such as biodegradation or abiotic transformations. MGP residuals consist of a mixture of organic (carbon-based) compounds. The lighter fractions are readily biodegraded or hydrolyzed. The heavier fractions are very slow to degrade. Over long periods of time (many years) MGP residuals become “weathered.” With weathering, the fraction of lighter organics is reduced and the MGP residuals become more viscous, less mobile, and less bioavailable. For this Site where the NAPL residuals are buried more than ten feet below a sediment layer, the weathering process is expected to be very slow.
- Contaminant mobility and bioavailability are reduced through sorption or other processes binding contaminants to the sediment matrix. MGP residuals are readily absorbed to sediment particles, especially in the case of the Harlem River where the total organic content of the sediments is expected to be relatively high.
- Exposure levels are reduced by a decrease in contaminant concentration levels in the near-surface sediment zone through burial or mixing-in-place with cleaner sediment. For the Harlem River, impacted sediments are buried by 14 to 27 feet of overlying sediments.
- Exposure levels are reduced by a decrease in contaminant concentration levels in the near-surface sediment zone through dispersion of particle-bound contaminants or diffusive or advective transport of

contaminants to the water column. This is not an important mechanism for the Harlem River. MGP residuals are not believed to be present in significant concentrations in the near surface.

Processes which reduce toxicity through destructive processes or reduced bioavailability through increased sorption usually are preferable to mechanisms that reduce exposure through natural burial or mixing-in-place because the destructive/sorptive mechanisms generally have a higher degree of permanence. However, many contaminants which remain in sediment are not easily transformed or destroyed. For this reason, risk reduction due to natural burial through sedimentation is more common and can be an acceptable sediment management option (US EPA, 2002b).

In general, natural systems have a substantial capacity to attenuate and recover from the presence of contaminants. Cerniglia (1992) noted that although the four- and five-ring pyrogenic PAHs may persist, the petrogenic two-ring PAH naphthalene may have a relatively short biological half-life in aerobic sediment.

The two primary advantages of MNR are its relatively low implementation cost and its non-invasive nature, especially compared with sediment dredging. While there are costs associated with the characterization necessary to evaluate natural recovery, the costs associated with implementing MNR are primarily associated with monitoring and not construction or other large capital up-front costs. MNR typically avoids physical disruption to the existing biological community, which is an advantage when harm to the existing benthic community due to sediment destruction may outweigh the risk reduction benefits of an active remedial option (i.e., dredging or in-situ capping).

The MGP materials in the Harlem River appear to be buried deep underneath other sediments. Assuming that the sediment exists in a stable stratigraphic context, the impacted sediments are present below the bioactive zone, and is therefore not bioavailable to benthic receptors or higher food chain receptors. In almost all benthic communities, biological activity is most intense in the uppermost portion of the sediment column and decreases with depth. This area of the most intense biological activity is referred to as the bioactive zone and is generally present within the top 15 cm (approximately 6 inches) of the sediment. Notwithstanding evidence for small spatial and temporal scale variation at a site, a general pattern of decreasing activity of benthic organisms with increasing depth down to 10 to 40 cm appears to be consistent across aquatic habitats (Clarke, et al., 2001).

As indicated on the US EPA Region III ecological risk assessment website (<http://www.epa.gov/reg3hwmd/risk/eco/index.htm>), the top 6 inches is generally the strata of interest in the risk assessment (e.g., screening data against benchmarks to identify potential for risk), although the deeper sediments need to be considered relative to the fate and transport to address the potential that excavation or storm events could expose contaminated sediments to the surface where they could impact receptors.

According to the US EPA (2002b), a number of natural and anthropogenic factors may affect sediment stability. Natural factors include tides, floods, seiches, hurricanes, ice thaw and ice dam induced scour, and bioturbation from micro- and macro-fauna. Anthropogenic factors include boat propeller wash and ship's wakes, ship grounding and anchor dragging, navigational dredging and channel maintenance, in-water construction of structures such as bridge supports, and intentional removal or breaching of hydraulic structures such as dams.

To the best of our knowledge, no detailed sediment stability analysis has been conducted on the Harlem River. Based on the observation of 14 to 27 feet of sediments overlying the MGP impacted sediments, it appears reasonable to assume that the area of the river near the Site is a depositional area. Further, the absence of MGP impacted materials near the surface and thick covering of unimpacted sediments indicates that a stable sediment cover is in place. It remains possible, however, that a future storm event or other event could create a scour condition and expose the buried sediments.

In some systems, bioturbation is one of the primary factors affecting sediment stability (US EPA, 2002b). Many bottom feeding organisms physically move sediment during feeding, locomotion, nesting, and shelter building; however, with regard to sediment stability analysis, the most significant concern is “mixing zone” movement of sediment in the top 5 to 15 cm. Although a detailed macroinvertebrate survey has not been conducted, it is likely that the community is composed of organisms generally present in mucky substrates. These organisms, most likely dominated by worms and oligochaetes, typically only bioturbate the top 2 to 3 cm of sediment (US EPA, 2002b). Impacted sediments are more than 10 feet below the sediment surface. Therefore, it is unlikely that bioturbation would play a major role in modifying sediment stability of the Harlem River.

Use of the natural recovery alternative as a risk management tool necessarily includes first conducting a sediment stability analysis, baseline monitoring and long-term monitoring. In the Harlem River case Institutional Controls to prevent human activities that would potentially expose buried sediments would also be necessary. As part of the MNR alternative at the Site, long-term sediment monitoring could be used to document reduction in constituent concentrations (declining trends) or an increase in thickness of the sediment cover. Sediment core dating could also be used to evaluate sediment stability and depositional rates. For the purpose of costing and comparison, it is assumed that the project life of this alternative would be 30 years.

A summary of the MNR/Institutional Controls Alternative is as follows:

1. Size and configuration of process options: None
2. Time for remediation: It is estimated that it would take six months to a year to implement Institutional Controls. Natural sedimentation (burial of impacted sediments) appears to have already occurred. Degradation of MGP materials in buried sediments is expected to be a very slow process.
3. Spatial requirements: Monitoring activities would require access to the river for a barge.
4. Options for disposal: No waste would be generated
5. Permit requirements: Agreements with the USACOE, City of New York, State of New York and possibly private land owners along the river bank might be required.
6. Limitations or other factors necessary to evaluate the alternative: Further evaluation of the legal processes and issues related to restricting dredging and other activities in a river would be necessary.
7. Beneficial and/or adverse impacts on fish and wildlife resources: Institutional controls would prevent or control activities such as dredging that might adversely impact ecological receptors. Natural sedimentation would isolate MGP material from ecological receptors and allow gradual recovery.

Following is a summary of the evaluation of this option:

Overall Protection of Human Health and the Environment: This alternative is rated as “Good.” This alternative relies upon natural processes for protection and, therefore, may provide a lower level of short-term protection, but may provide long-term protection. The occurrence of natural recovery processes would be established through stability analysis, ecological risk assessment, toxicity testing, and continued monitoring. In contrast to Institutional Controls alone, this alternative includes monitoring to demonstrate that impacted sediments remain isolated.

Compliance with Standards: This alternative is rated as “Fair.” This alternative would likely show that surface sediments are not significantly impacted with MGP constituents. Over a very long period of time, MGP residuals in deep sediments would degrade to less mobile and less bioavailable forms.

Long-term Effectiveness and Permanence: This alternative is rated as “Fair.” Sediment stability analysis and monitoring could be used to confirm that natural processes would not result in exposure of deeply buried

sediments. Institutional Controls proposed would prevent human activities from exposing deeply buried sediments.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is rated as “Fair” to “Poor.” The very gradual weathering of MGP residuals is expected to reduce mobility and toxicity. However, this is a very slow process under conditions of this Site.

Short-term Effectiveness: This alternative is rated as “Good.” Because physical site activity is limited to sediment sampling, there would be no additional risks to the surrounding community, workers or the environment during implementation.

Implementability: This alternative is rated as “Good.” Monitoring techniques, analytical laboratories and sediment stability models are readily available for implementation of the remedy. USACOE reports that the Harlem River is at its target navigation depth and there are no plans for dredging. Thus, implementing measures to control or prevent future dredging might not be difficult. Regulatory support would be needed to perform the five-year remedy reviews.

Cost: For the purpose of cost estimation it is assumed that MNR would include baseline bathymetric measurements, and a sediment stability analysis. Shallow sediment sampling might also be proposed as part of the remedial design. The estimated cost for the baseline work is \$150,000 to \$250,000. Monitoring for comparison to the baseline measurements would occur every five years at an estimated cost of \$75,000 per event. Implementation of Institutional Controls would cost an estimated \$50,000 to \$100,000. The total cost over a 30-year period is estimated to be \$575,000 to \$725,000.

4.4.4 Dredging

Dredging of MGP impacted sediments in the Harlem River would involve the following general steps:

- Address any on-going sources of impacts to the river: Sediments would become re-contaminated if on-going MGP or other impacts were not addressed.
- Design and Permitting: For a dredging project of this scope in a federal navigation channel, the design and permitting process would be extensive. Assessment of ecological impacts during and after dredging would be required. Impacts to the public would have to be assessed and public meetings would be required. Permits from the Army Corps of Engineers and other agencies would be required. A structural assessment of possible impacts to the FDR Drive and other structures in the area would be required. It is not possible to remove impacted sediments that may be present underneath the FDR Drive.
- Dredging of surface sediments: The average depth to impacted sediments is 20 feet. An estimated 90,000 cubic yards of overlying sediment with little or no MGP impacts would have to be removed to allow access to the MGP impacted sediments. Although these sediments would have minimal MGP impacts, physical properties (grain size) and chemical constituents from other sources (possible PCBs and mercury) would probably make these dredged sediment unsuitable for on-site reuse. Hydraulic dredging from a barge would probably be used for this project.
- Dredging of MGP Impacted Sediments: An estimated 10,000 cubic yards of MGP impacted sediments would be removed.
- Silt and Sheen Controls: Measures would have to be designed and put into place to mitigate sediment dispersion during dredging. As the MGP impacted zone was reached, additional measures to control the generation of sheen would be needed.

- Dewatering of Sediments and Water Management: A large land-based area might be required for dewatering of sediment prior to disposal. A water treatment plant might be needed to treat excess water prior to discharge.
- Sediments Disposal: On-site treatment is unlikely to be feasible. Dredged sediments would likely require treatment and disposal at land-based facilities.
- Replacement with suitable substrate: Some backfilling with clean sediments with properties conducive to reestablishment of appropriate flora and fauna would be required.

Some impacted sediments are located below the FDR drive and the river walkway. Dredging of this area is not considered to be implementable.

A summary of the dredging alternative is as follows:

1. Size and configuration of process options: Large scale dredging equipment including a dredge, service barge, piping, barge for sediment transport, and land area for dewatering and sediment processing would be needed.
2. Time for remediation: It would take six months to a year of permitting and one to two years of site work.
3. Spatial requirements: Land area might be required to dewater and process dredged sediments. Docking and loading/unloading space would be required. Parts of the river would be closed during dredging.
4. Options for disposal: An estimated 90,000 cubic yards of overlying sediments would be dredged. This material might contain low levels of PCBs, mercury, or other constituents not related to the MGP operations. Options for disposal include dewatering and upland landfill disposal and aquatic disposal. Aquatic disposal would most likely include some form of containment of the dredged material after placement. An estimated 10,000 cubic yards of MGP impacted materials would also be generated. Dewatering and off-site thermal treatment would be a likely disposal option for this material. The material might also be suitable for asphalt batching or landfill disposal.
5. Permit requirements: Extensive permitting would be required prior to dredging. Permits for the USACOE, US EPA and the State of New York would be required.
6. Limitations or other factors necessary to evaluate the alternative: The potential for recontamination of sediments following dredging would need to be assessed. Continuing sources of impacts to sediments would first need to be mitigated.
7. Beneficial and/or adverse impacts on fish and wildlife resources: In the short term, dredging would displace or kill existing flora and fauna. Resuspension of impacted sediment might also have adverse impacts in the short term. Because the impacted sediment appears to already be isolated, it is not clear that dredging would provide long-term beneficial impacts to fish or other aquatic life.

Evaluation of the Dredging Alternative is as follows:

Overall Protection of Human Health and the Environment: This alternative is rated as “Fair.” Dredging would remove coal tar NAPL/grossly impacted sediment. This alternative might not be very protective in the short-term due to resuspension of materials and destruction of the benthic community. Because the impacted sediments are already buried and not isolated, it is not clear what overall benefit dredging would have.

Compliance with Standards: This alternative is rated as “Good.” This alternative would remove grossly impacted sediments to the extent feasible. Because sediments underneath the FDR are not accessible, all impacted sediments would not be removed. A dredging permit would be required under the Clean Water Act

(CWA) Section 404 and the Rivers and Harbors Act. Water from the dewatering process would be required to meet substantive requirements of CWA Sections 404 and 401 for discharge back to the river. Off-site disposal of dredged sediment is guided by RCRA regulations.

Long-term Effectiveness and Permanence: This alternative is rated as “Good.” This alternative has a high long-term effectiveness due to removal of grossly impacted sediments. Long-term operation and maintenance would not be required after removal.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is rated as “Good.” Grossly impacted sediment would be removed from the Site. The volume of MGP materials would be reduced. During dredging, a short-term increase in mobility is expected as silt is released to the water column and a sheen is released from the disturbed MGP materials.

Short-term Effectiveness: This alternative is rated as “Poor” to “Unacceptable.” In the short term, dredging would destroy the benthic community (e.g., amphipods, marine worms, clams, mussels) and disrupt fish migration and fish habitat. Several seasons would likely pass before the benthic community returned to its current condition. The dredging activity itself is also likely to release contaminants that are currently sequestered in deep sediments and effectively capped with a layer of cleaner sediments. Control measures such as resuspension can be used to prevent off-site migration of resuspended particles. Recreational use of the river would be curtailed for 1 to 2 years. Dredging would probably remobilize MGP materials located underneath the FDR Drive causing the dredged area to become re-contaminated. On balance, the potential long-term benefits may be out weighed by the short-term adverse impacts.

Dredging presents potential short-term risks to remediation workers and members of the community. However, these risks can be managed through proper planning and implementation. A health and safety plan would be required to identify and control specific risks to remediation workers. Qualified remediation contractors would be required to developed work procedures, engineering controls, and monitoring programs to address these risks. Potential impacts to members of the community include air emissions during excavation and spills/accidents associated with trucks transporting contaminated sediment. During dredging, use of the riverfront walk might have to be suspended due to structural safety concerns or odors. Air emissions could be minimized by covering stockpiles, using vapor suppressing foam or sand as necessary. An air monitoring program might also be implemented. Potential problems associated with truck transport could be mitigated by using a qualified trucking firm, inspecting and decontaminating trucks before they leave the Site, using a tracking pad, and assuring that loads are covered. This alternative would require 1 to 2 years of site work to complete.

Implementability: This alternative is rated as “Poor.” Equipment, materials, and services for dredging are widely and readily available for implementation of the remedy. The permitting process and review by the community might reveal insurmountable obstacles to implementation. Permits from the Army Corps of Engineers and for water discharge would be needed. Curtailment of recreational use of the Harlem River and use of the riverfront walk might be unacceptable to the public. A relatively large land area (10 to 20 acres) would probably be needed for the dewatering of the estimated 100,000 cubic yards of sediments to be dredged. The trade-off between minimal long-term benefits and adverse short-term impacts might make the project unacceptable to the public or the regulatory agencies. Potentially impacted sediments beneath the FDR drive are not accessible and can not be removed.

Cost: The general estimate of costs is as follows: Design and permitting - \$500,000; environmental dredging of 100,000 cubic yards of sediment - \$10,000,000 (\$100 per cubic yard); dewatering and disposal of 90,000 cubic yards of overlying sediments - \$6,750,000 (\$100 per cubic yard); dewatering and disposal of 10,000 cubic yards of MGP impacted sediments - \$1,500,000 (\$150 per cubic yard); backfill surface sediments - \$500,000; and engineering/oversight/reporting - \$1,000,000. The total estimated cost is \$20,000,000.

**Table 4-1
Soil Data Summary near MGP Features
East 115th Street Former MGP
Consolidated Edison, New York, New York**

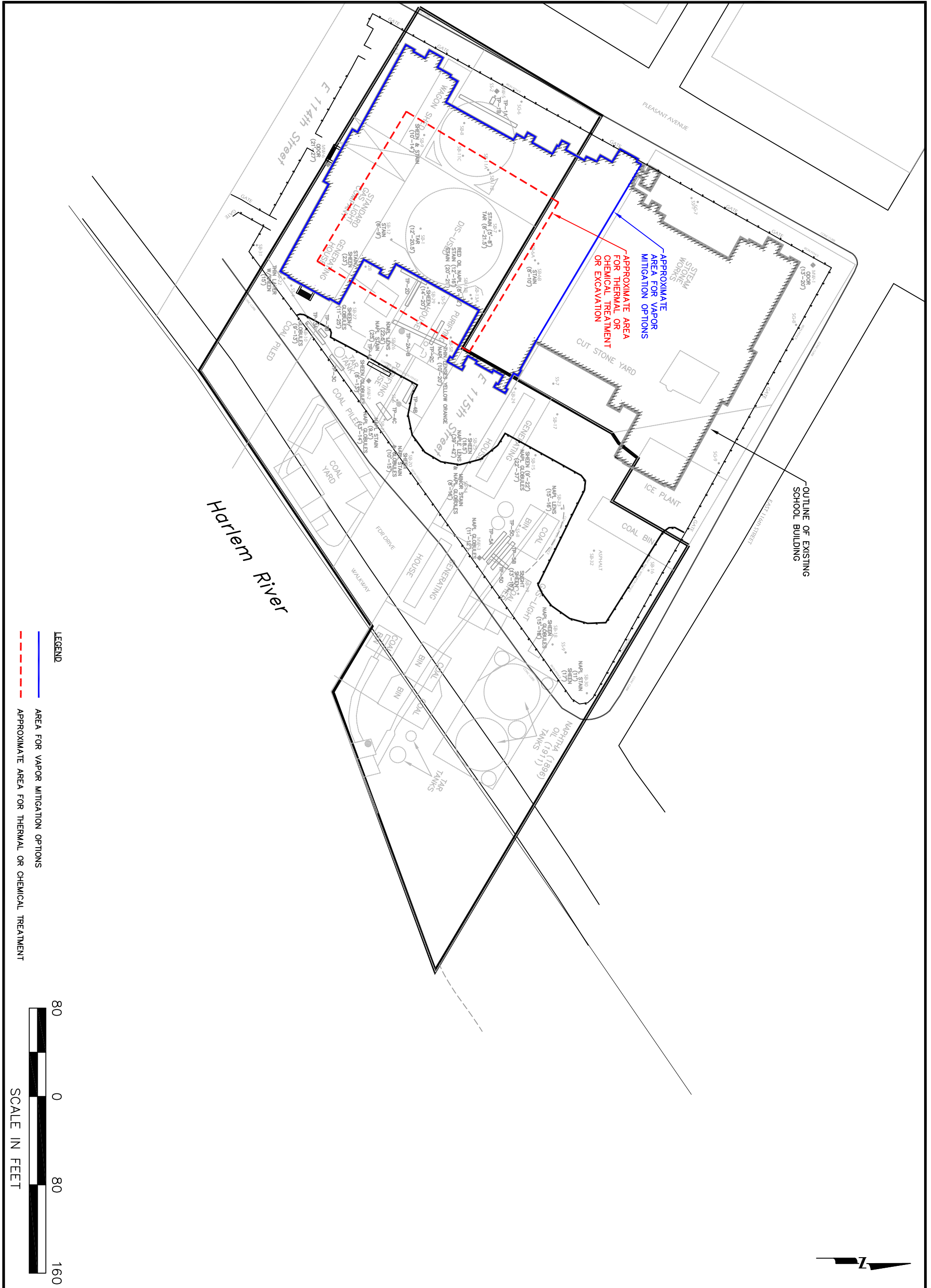
| MGP Feature | Location | Test Pits and Borings | Visual Observations (above or at water table) | Depth to Water Table (feet) | Max PID* | Max TVOCs* | Max TSVOC* |
|----------------------------------|---|--|---|-----------------------------|----------|------------|------------|
| Small Gas Holder | West of main building | TP-1, SS-2 , MW-5 | No visual evidence of impacts, minor amounts of brick, coal, and other debris. No NAPL observed above water table. | ~12 | 13.2 | <0.5 | 154 |
| Purifying House/Generating House | Immediately east of main building, southern area | TP-2 SS-5, SB-28, SB-29 | Debris, asphalt, white material, floor/walls of MGP structures (2 to 9 feet), ACM pipe (2 feet). No NAPL observed above water table. | ~15 | 863 | 3 | 118 |
| Tar Tank | East of main building, southern area | TP-3, SB-27, SB-10 | Debris (0-6 feet), black staining (3 feet), black oily material (7 feet), sheen (at water table at 7 feet), white ash (4.5 feet). | ~7-10 | 495 | <0.5 | 17 |
| Purifying House | East of main building, southern area | TP-4, MW-2, SB-21 | Debris (0 to 4 feet), concrete structure (4 feet), white material (3 feet), pockets of black oil saturated stones (5 feet, TP-4a only), free product (5 feet TP-4a only). | ~8 | 500 | <0.5 | 249 |
| Coal Bin/Shed/Generator House | East of main building, central and northern areas | TP-5, SB-14, SB-15, SB-23, SB-19, SB-18, SB-30, MW-3 | Debris (2-5 feet), coal pieces (2-5 feet), brick structures (3 to 5 feet), slag (2 to 5 feet), white material (2 feet). No NAPL observed above water table. | ~8 | 10.2 | 11.7 | 852 |

Notes:

PID - Photo-ionization detector

TVOCs – Total Volatile organic compounds

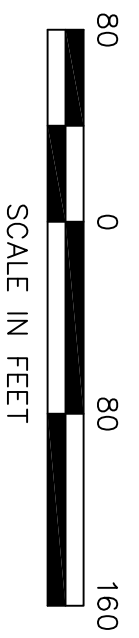
TSVOCs - Total Semi-volatile organic compounds



LEGEND

— AREA FOR VAPOR MITIGATION OPTIONS

- - - APPROXIMATE AREA FOR THERMAL OR CHEMICAL TREATMENT



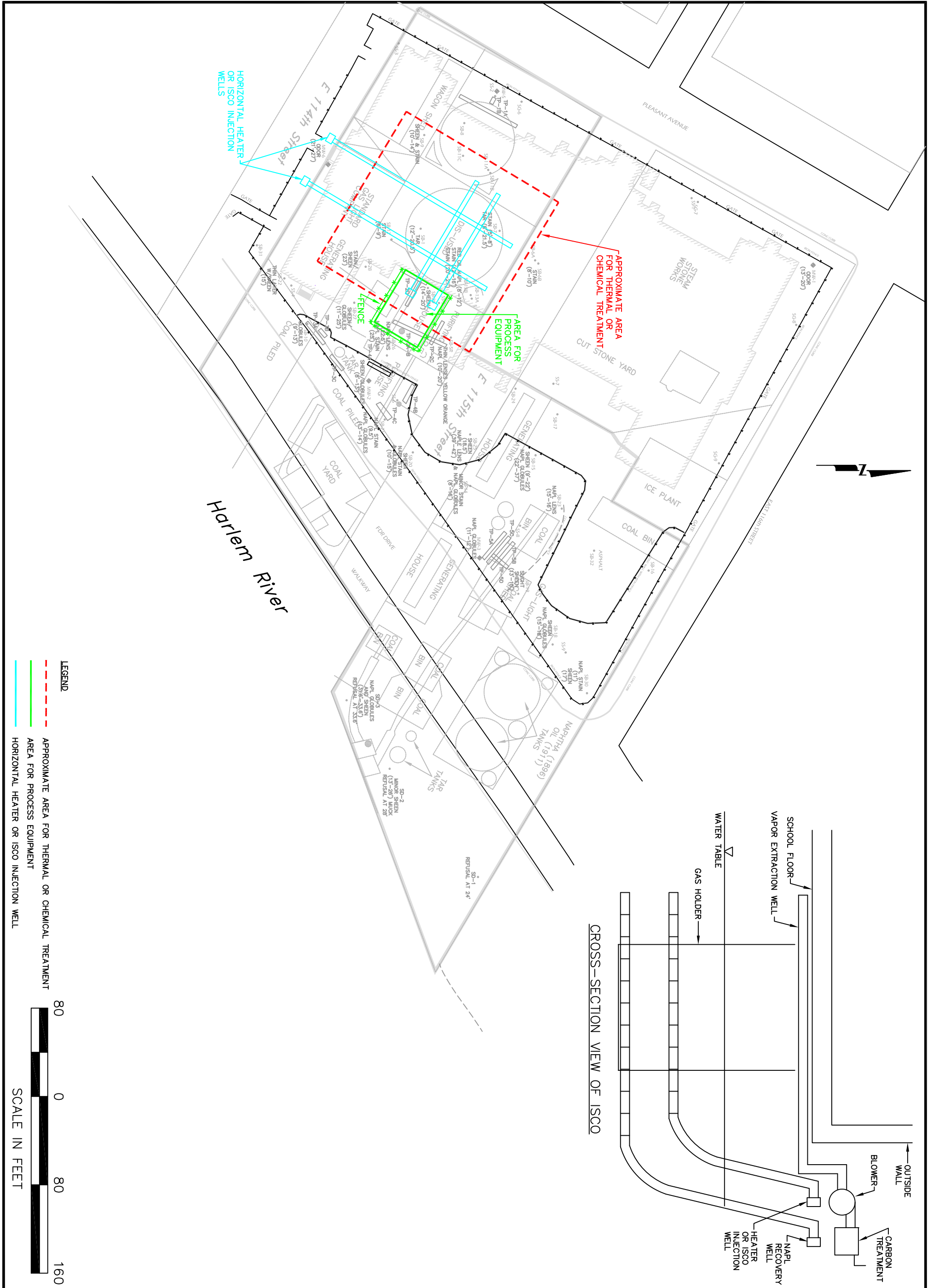
| | |
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| FIGURE NUMBER: | 4-1 |
| SHEET NUMBER: | 1 |

| | | |
|---|-------|-----------------|
| IMPACTED AREAS BENEATH SCHOOL CONSOLIDATED EDISON EAST 115th STREET FORMER MGP NEW YORK, NY | | |
| SCALE: | DATE: | PROJECT NUMBER: |
| 1" = 80' | 3/09 | 01869-115-800 |

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| DESIGNED BY: | REVISIONS | | | |
|--------------|-----------|--------------|-------|-----|
| | NO.: | DESCRIPTION: | DATE: | BY: |
| X | | | | |
| DRAWN BY: | | | | |
| K.P.B. | | | | |
| CHECKED BY: | | | | |
| C.M. | | | | |
| APPROVED BY: | | | | |
| C.M. | | | | |



LEGEND

- - - APPROXIMATE AREA FOR THERMAL OR CHEMICAL TREATMENT
- - - AREA FOR PROCESS EQUIPMENT
- HORIZONTAL HEATER OR ISCO INJECTION WELL



| | | |
|---|-------|-----------------|
| CONCEPTUAL PLAN FOR ENHANCED NAPL REMOVAL CONSOLIDATED EDISON EAST 115th STREET FORMER MGP NEW YORK, NY | | |
| SCALE: | DATE: | PROJECT NUMBER: |
| AS SHOWN | 1/07 | 01869-115-200 |

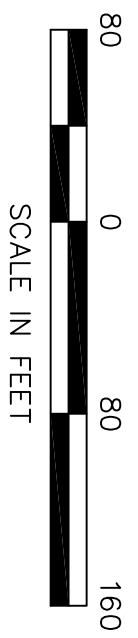
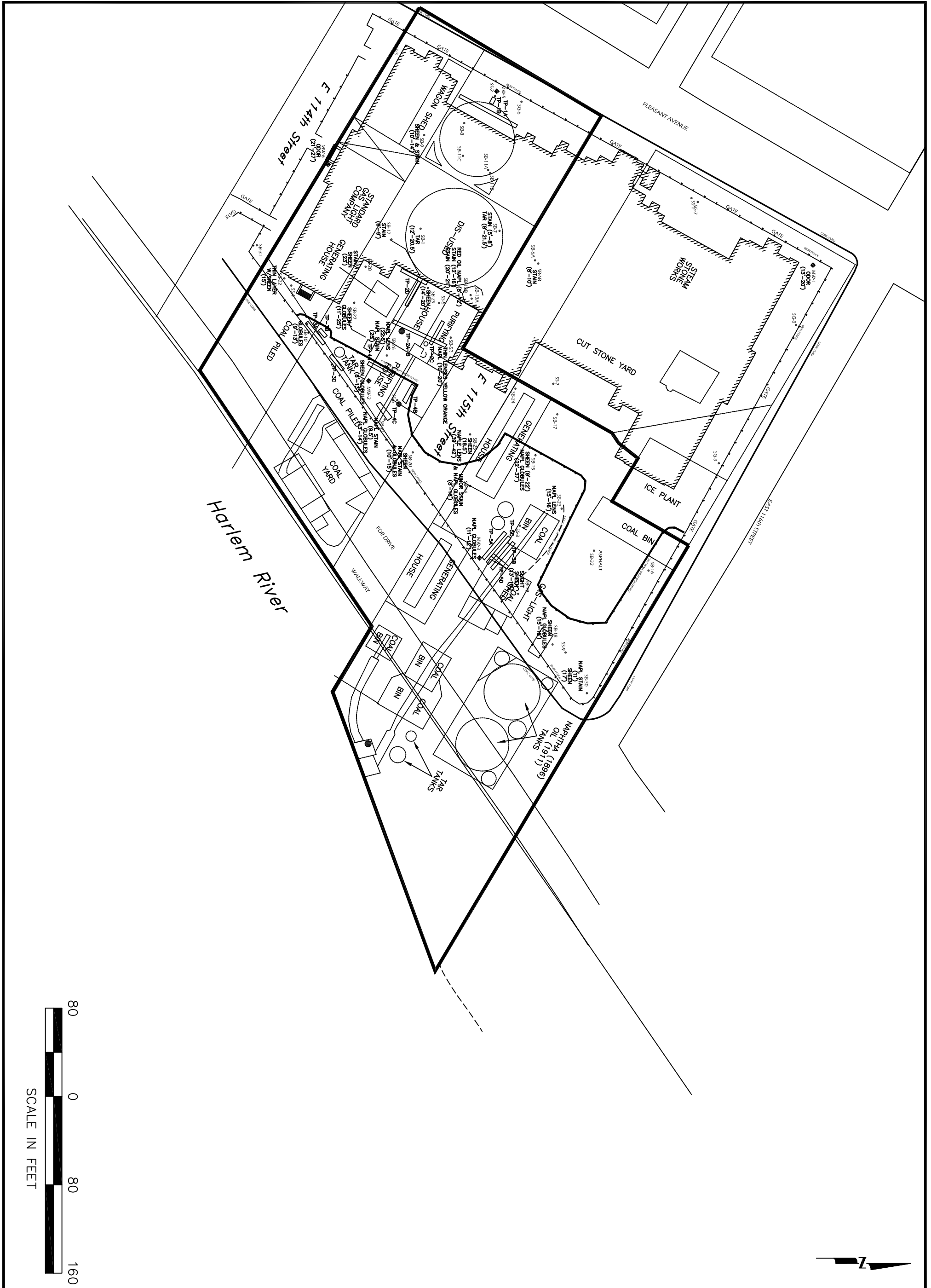
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| C.W.M. | NO.: | DESCRIPTION: | DATE: | BY: |
| DRAWN BY: | | | | |
| K.P.B. | | | | |
| CHECKED BY: | | | | |
| D.S. | | | | |
| APPROVED BY: | | | | |
| D.S. | | | | |

FIGURE NUMBER:
4-2

SHEET NUMBER:
1



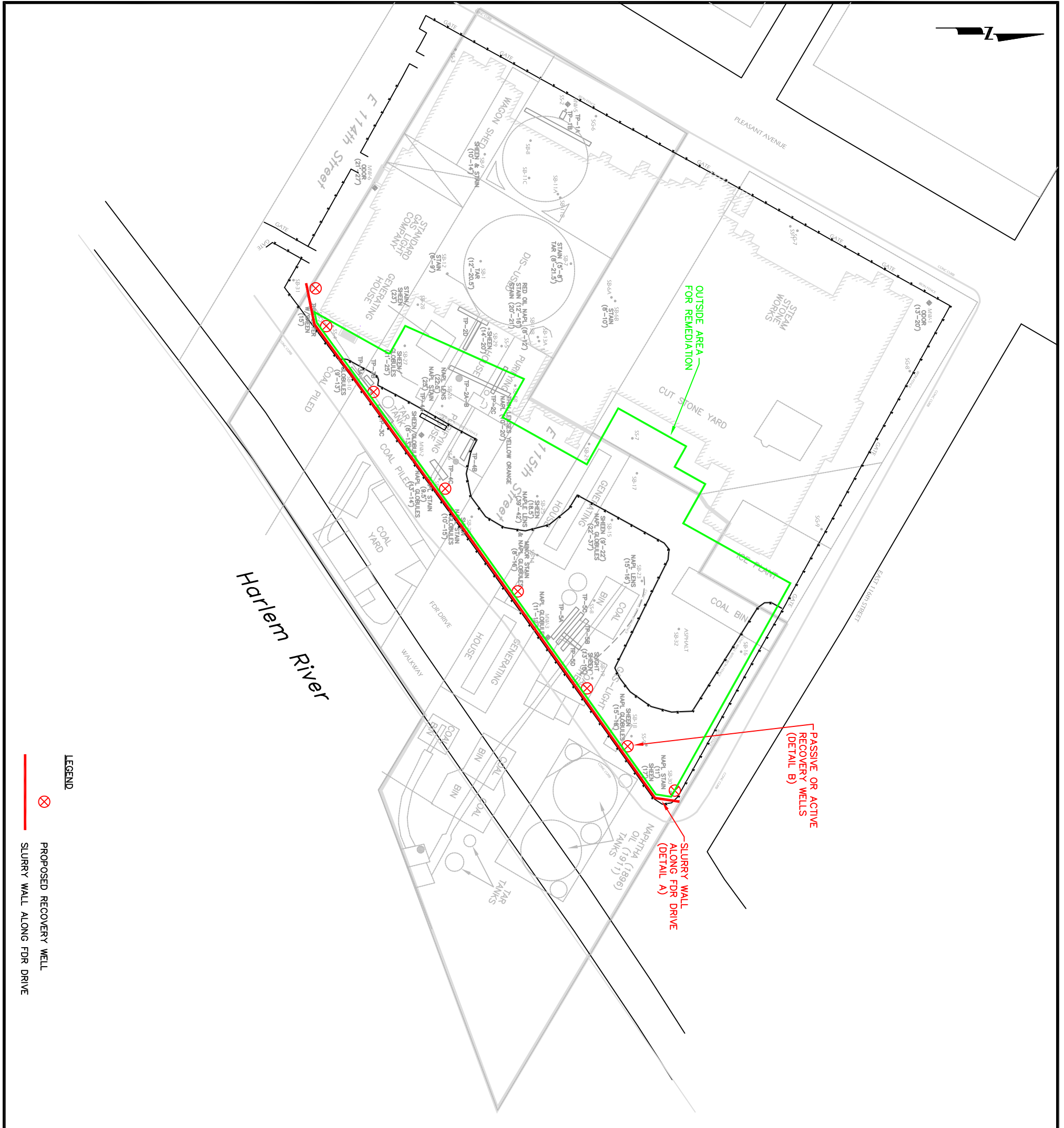
| | |
|----------------|------------|
| FIGURE NUMBER: | 4-3 |
| SHEET NUMBER: | 1 |

| | | |
|--|-------|-----------------|
| SAMPLE LOCATIONS AND FORMER MGP STRUCTURES CONSOLIDATED EDISON EAST 115th STREET FORMER MGP NEW YORK, NY | | |
| SCALE: | DATE: | PROJECT NUMBER: |
| AS SHOWN | 12/05 | 01869-110-200 |

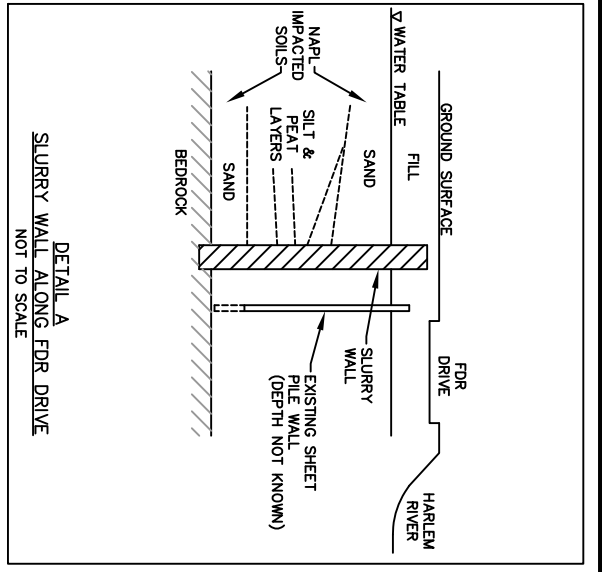
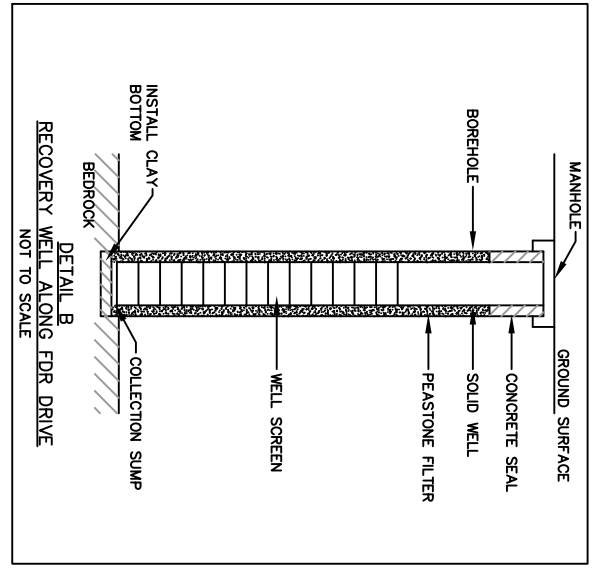
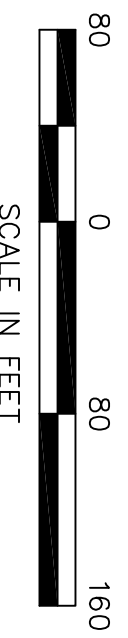
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| | NO.: | DESCRIPTION: | DATE: | BY: |
| C.W.M. | | | | |
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| K.P.B. | | | | |
| CHECKED BY: | | | | |
| D.S. | | | | |
| APPROVED BY: | | | | |
| D.S. | | | | |



LEGEND
 PROPOSED RECOVERY WELL
 SLURRY WALL ALONG FDR DRIVE



| | |
|----------------|------------|
| FIGURE NUMBER: | 4-4 |
| SHEET NUMBER: | 1 |

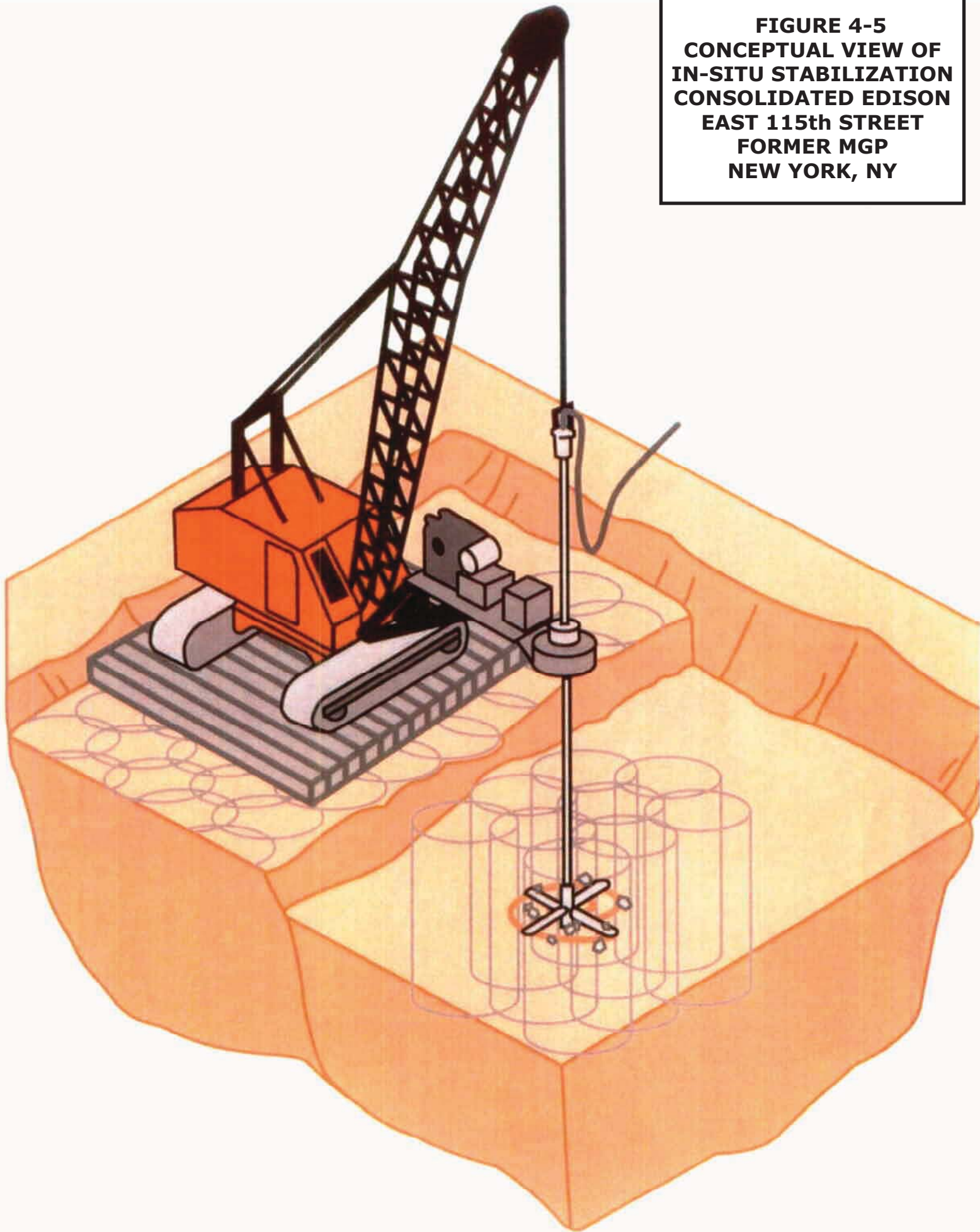
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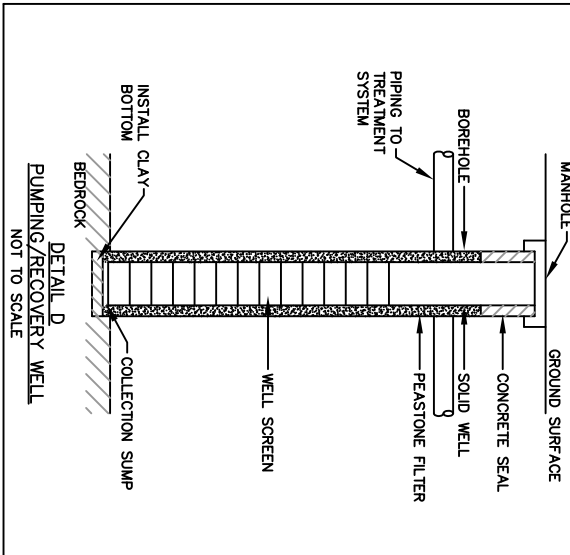
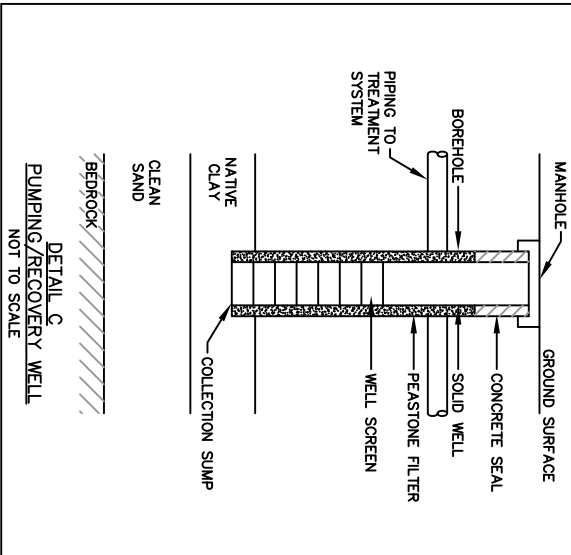
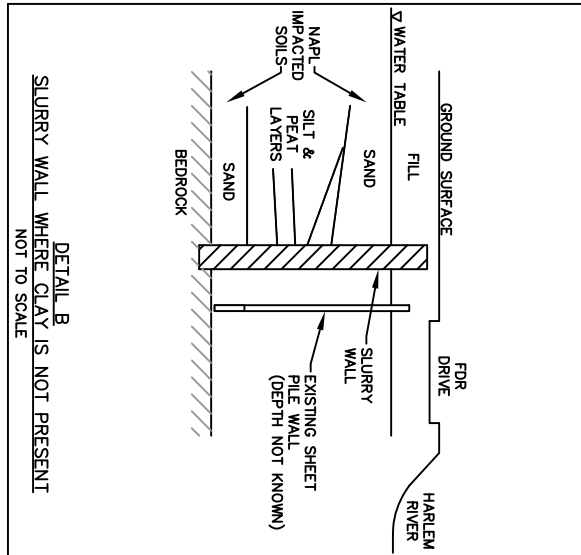
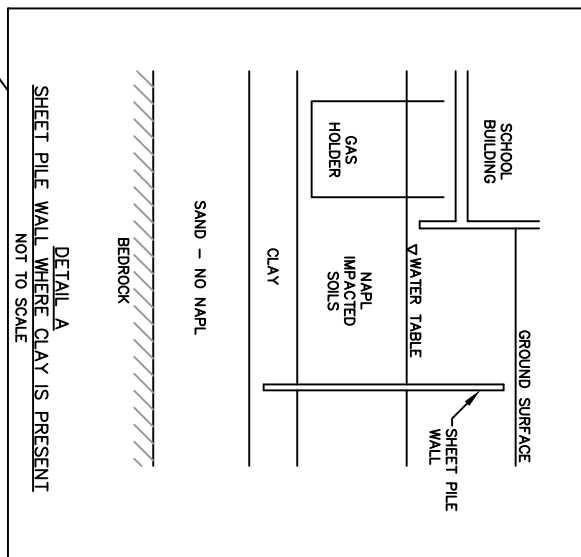
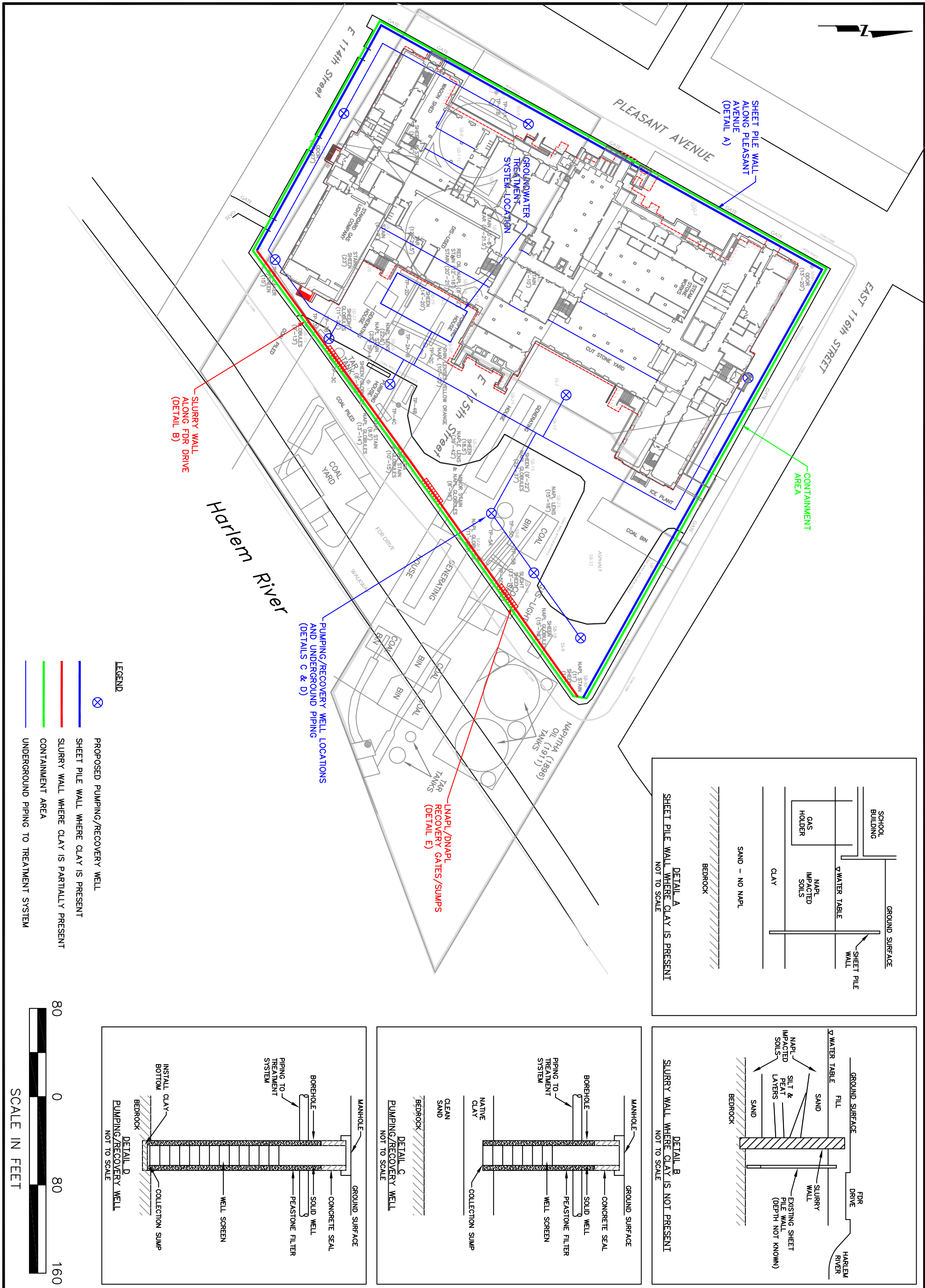
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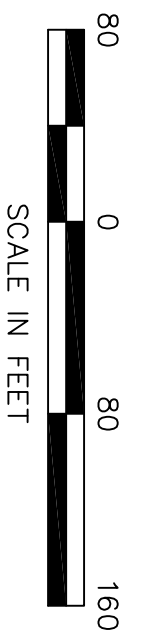
**FIGURE 4-5
CONCEPTUAL VIEW OF
IN-SITU STABILIZATION
CONSOLIDATED EDISON
EAST 115th STREET
FORMER MGP
NEW YORK, NY**





LEGEND

- ⊗ PROPOSED PUMPING/RECOVERY WELL
- SHEET PILE WALL WHERE CLAY IS PRESENT
- SLURRY WALL WHERE CLAY IS PARTIALLY PRESENT
- CONTAINMENT AREA
- UNDERGROUND PIPING TO TREATMENT SYSTEM



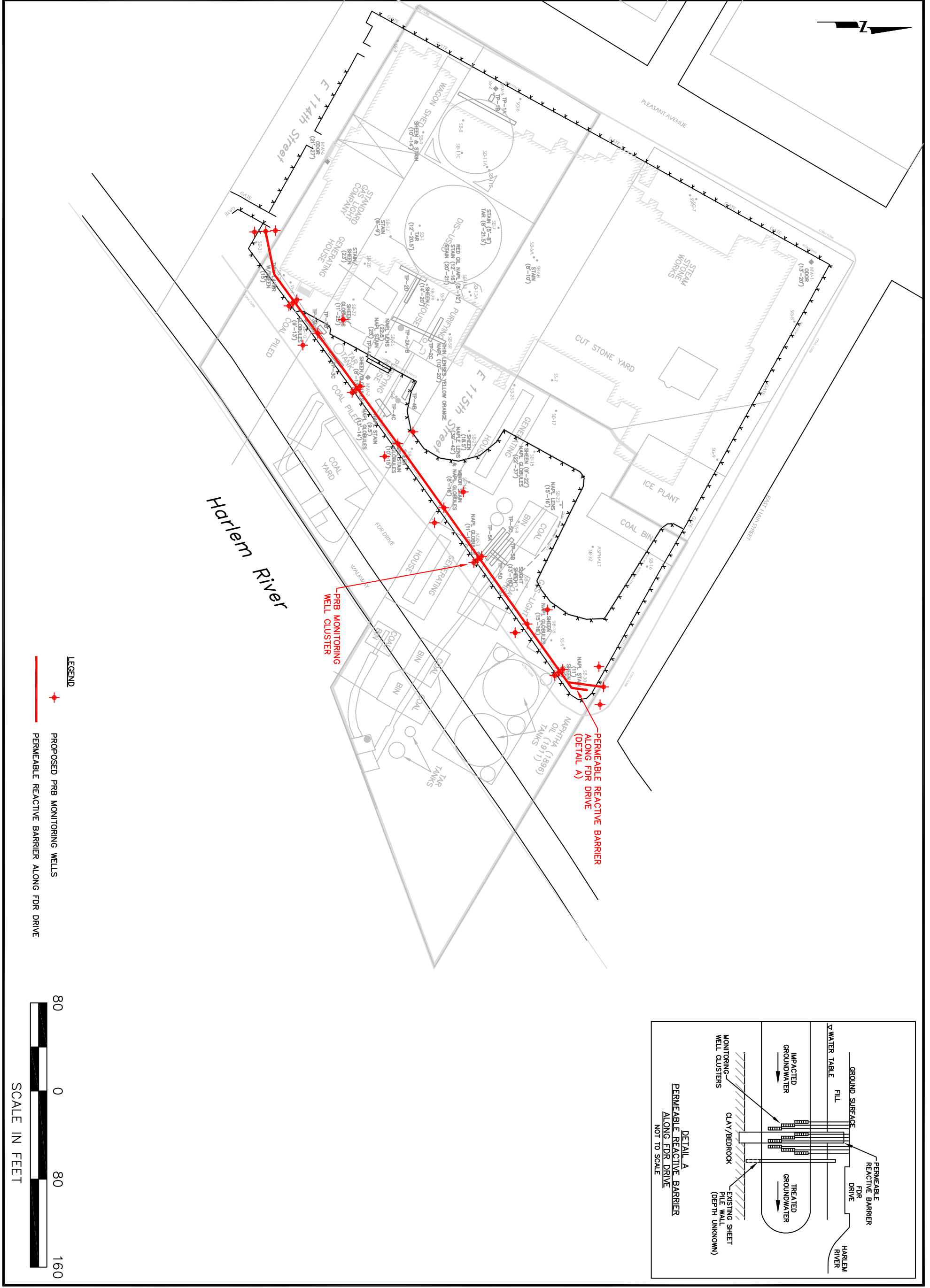
LOCATIONS FOR AND CONCEPTUAL VIEW OF GROUNDWATER 360 DEGREE CONTAINMENT OPTION CONSOLIDATED EDISON EAST 115th STREET FORMER MGP NEW YORK, NY

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 * PROPOSED PRB MONITORING WELLS
 — PERMEABLE REACTIVE BARRIER ALONG FDR DRIVE

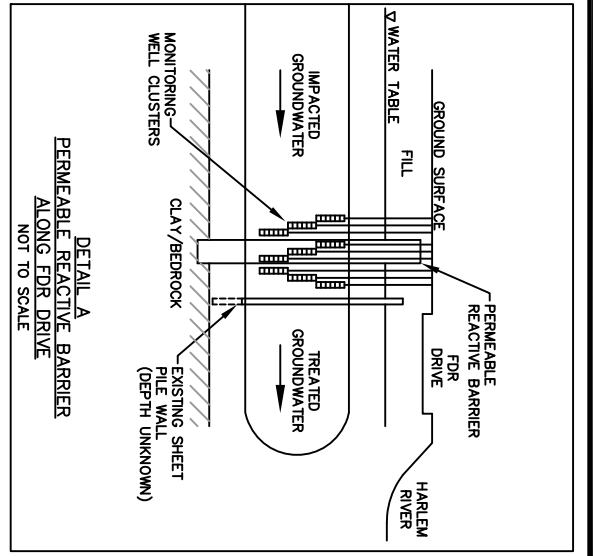
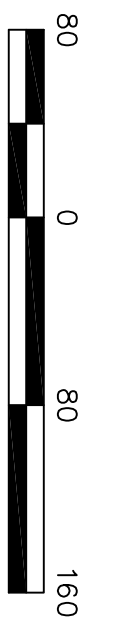


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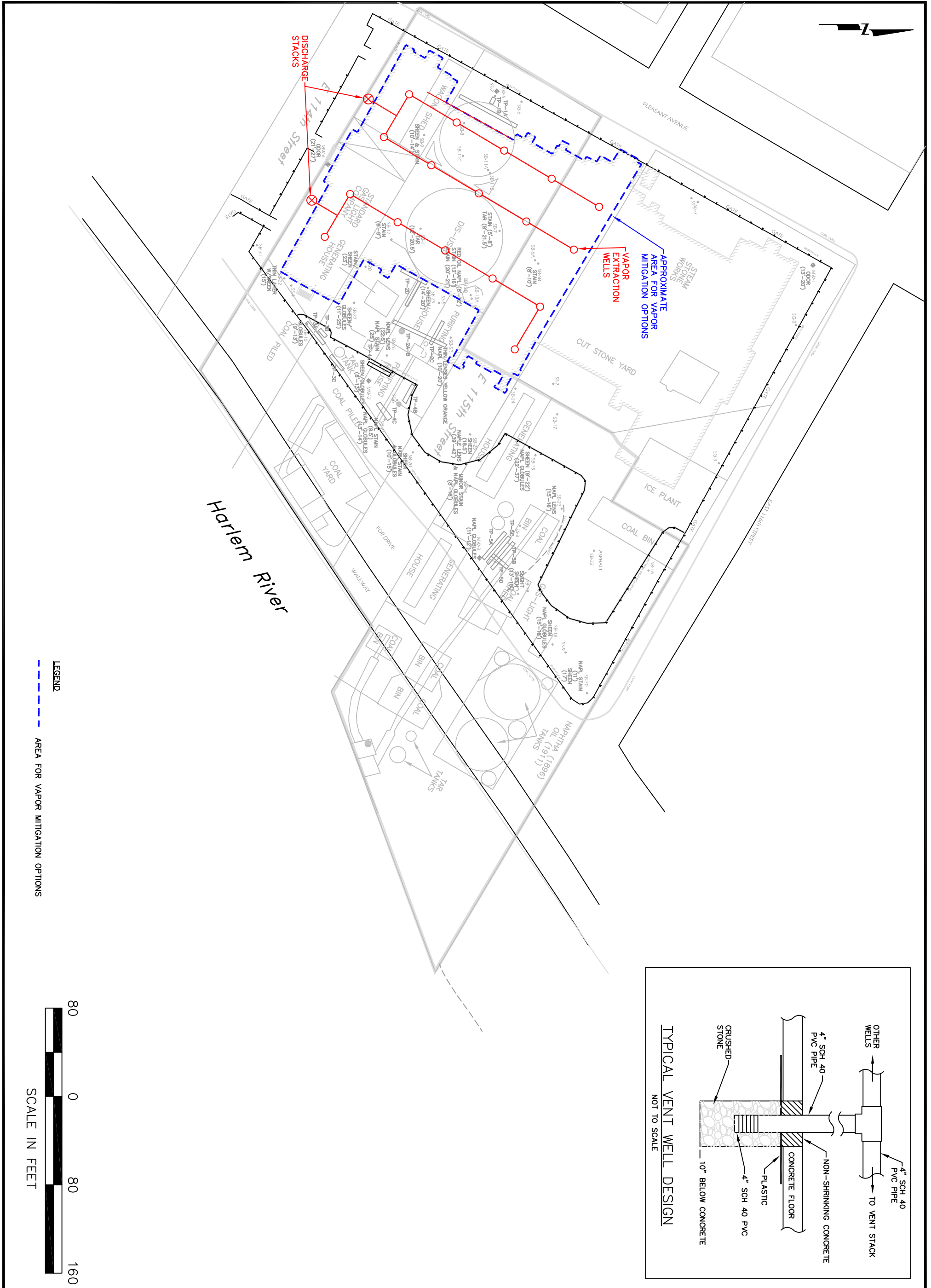
LOCATION FOR PERMEABLE REACTIVE BARRIER
 CONSOLIDATED EDISON
 EAST 115th STREET FORMER MGP
 NEW YORK, NY

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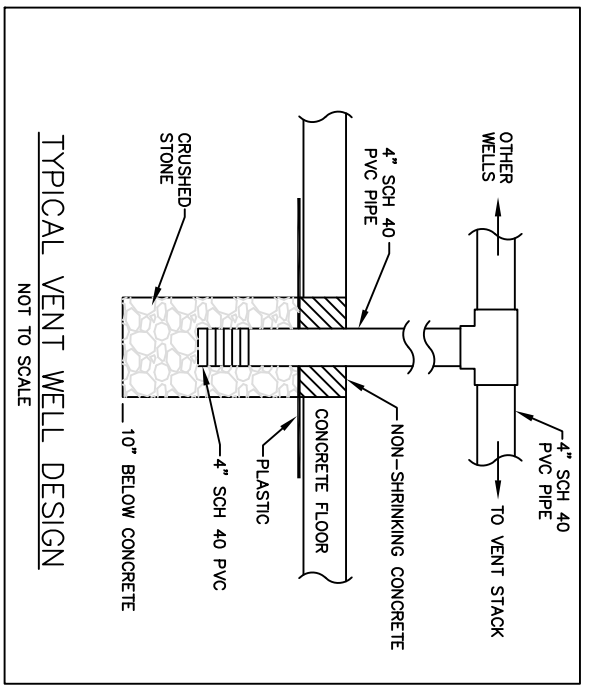
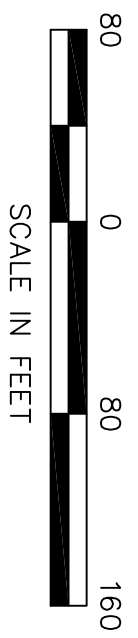
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| APPROVED BY: D.S. | | | | |



LEGEND
 - - - - - AREA FOR VAPOR MITIGATION OPTIONS



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| FIGURE NUMBER: | 4-8 |
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| CONCEPTUAL VENT SYSTEM DESIGN CONSOLIDATED EDISON EAST 115th STREET FORMER MGP NEW YORK, NY | | |
| SCALE: | DATE: | PROJECT NUMBER: |
| AS SHOWN | 12/05 | 01869-110-200 |

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5.0 Comparative Analysis of Remedial Alternatives and Proposed Site Remedy

This section presents comparisons of the alternatives developed in Sections 4.2, 4.3, and 4.4 and concludes with the recommended site remedies.

5.1 Comparative Analysis of Remedial Alternatives

The comparison of alternatives presented below is divided into the same four categories used in Section 4.

5.1.1 Comparison of Remedial Alternatives for Soil and Groundwater

Table 5-1 provides a summary of the rankings of each alternative for the six criteria evaluated in Section 4.

The two goals for soil and groundwater are containment of NAPL (prevent migration towards Harlem River) and removal of source materials to the extent feasible.

Based on currently available technologies, a Barrier Wall along the FDR Drive is recommended for containment of NAPL. The Barrier Wall is a proven technology that can be implemented without closing the school. Excavation Outside of School Building and 360 Degree Complete Containment Wall were also considered but are not recommended. Both these alternatives received “poor” ratings for implementability and would likely result in the complete or partial shut down of the school for several months or more. Because of the close proximity to the school, installation of a 360 Degree Complete Containment Wall would likely require that classes be cancelled for an extended time. Noise, dust, cutting of utilities, traffic issues, duration of construction (over one year) would be major concerns if a 360 Degree Complete Containment Wall was installed. Excavation Under School Building can not be conducted without removal of the school building.

ISS is another alternative that was considered but not selected. ISS treatment would be disruptive of school activities but could be conducted in outside areas without shutting down the school. ISS would effectively immobilize the NAPL and has the potential for reducing the migration of dissolved phase constituents. Implementation of ISS might significantly change groundwater flow around the Site and could possibly cause the migration of MGP materials to currently unimpacted areas. While ISS appears to be viable, it is not recommended due to uncertainties of its long-term effectiveness.

The options evaluated for NAPL containment along the FDR drive were Recovery Wells with Active Pumping (Recovery Wells), Barrier Wall, and Permeable Reactive Wall. Although the Barrier Wall requires more on-site construction, it is expected to provide superior long-term effectiveness compared to Recovery Wells. NAPL recovery rates depend on the volume and mobility of NAPL present. Very little NAPL has been observed in existing site monitoring wells. Therefore, the effectiveness of recovery wells at removal of NAPL at this site is questionable. The Barrier Wall would provide a more reliable barrier to NAPL migration and, therefore, is preferred over the Recovery Wells.

A significant advantage of the Permeable Reactive Wall over the Barrier Wall is that the PRB does not require active pumping to prevent groundwater mounding. However, for this Site, tidal influence and direct contact of the PRB with MGP NAPL are concerns for the effectiveness of the PRB. Also, the long-term effectiveness of the PRB at treatment of MGP materials has not been fully demonstrated. Based on the current level of development of PRB walls for MGP materials, use of a PRB wall is not recommended. The combination of a Barrier Wall for the deeper zones where NAPL is present and shallow PRB walls for treatment of groundwater flowing over the Barrier Wall is a possible area for evaluation during the remedial design phase.

Comparison of Alternatives to Remove Sources of Contamination to the Extent Feasible (source removal)

Enhanced (via ITT or Chemical Treatment) NAPL recovery using horizontal wells to remove source material from underneath the school building was evaluated in detail and is not recommended. Results of that evaluation are provided in the Pilot Study Work Plan (Appendix A). Neither ITT nor Chemical Treatment is expected to be capable of removing a significant amount of the NAPL present beneath the building. Horizontal drilling and effective NAPL removal are technically challenging under the current Site conditions.

Excavation of MGP material underneath the building was also evaluated but is not recommended. Excavation entails several years of construction work in an urban area. Excavation would require demolition of a three-story building and displacement of over 1,500 students for up to several years.

Based on the short-term risk, the need to close the school and serious implementability issues associated with both Enhanced NAPL Recovery and Excavation, neither alternative is recommended at this time.

While removal or treatment of source materials underneath the school building does not appear to be feasible with the current site use, if at some point in the future site use changes, options for addressing source materials underneath the building could be re-evaluated.

5.1.2 Comparison of Alternatives for Impacted Vapors Beneath the School Building

Table 5-2 provides a summary of the rankings of each alternative to address impacted vapors for the six criteria evaluated in Section 4.

Because No Action provides no mechanism to prevent future construction or other work that might lead to vapor intrusion into on-site building, No Action is not an acceptable alternative.

Monitoring alone received a ranking of “poor” for Long-term Effectiveness and Reduction in Toxicity Mobility or Volume. Therefore, monitoring is not adequate as a stand-alone alternative. The other alternatives received rankings of “fair” and “good” for the five criteria with no single alternative being markedly better than another.

Maintaining acceptable air quality in the school building is essential. None of the individual alternatives appears to be adequate as a stand-alone technology. While a significant source of vapors remains beneath the building, implementation of complementary alternatives is recommended. Based on indoor sampling results to date, the existing floor is an adequate vapor barrier. No additions or improvements to the floor are recommended at this time. Institutional controls to assure that the floor is not damaged are recommended. Monitoring to confirm that indoor air quality continues to be acceptable is also recommended.

Passive Venting may help mitigate potential vapor intrusion, but, compared to Active Venting, it is more difficult to confirm the effectiveness of passive venting. Passive Venting presents only minimal advantages over active venting in term of disruption to the school and cost. Therefore, Passive Venting is not recommended.

Under current conditions, Active Venting does not appear to be necessary. However, Active Venting would provide an added level of assurance that sub-slab vapors would not enter the building. Installation of an Active Venting system is recommended. The Active Venting system would include implementing an operation and maintenance plan. After the Active Venting system has been installed and demonstrates effective depressurization of the sub-slab area, indoor air monitoring may be discontinued.

Institutional Controls are required to assure that activities that may cause a future impact to indoor air are prevented from occurring. Institutional Controls would include development and implementation of an operation and maintenance plan (O&M Plan) to assure that the system operates properly.

Active Venting, Monitoring, and Institutional Controls are recommended for impacted vapors beneath the school.

5.1.3 Comparison of Alternatives for Sediments

Table 5-3 provides a summary of the ratings for the sediment alternatives.

The No Action alternative provides no mechanism to prevent future activities, such as navigational dredging, that may expose buried impacted sediments. Therefore, No Action is not considered to be an acceptable alternative.

Dredging is the only alternative that would remove MGP impacted sediments from the river. However, as discussed earlier, implementation of this alternative presents significant short-term risks to humans and ecological receptors and would curtail use of the river. Because the MGP impacted sediments are currently isolated from potential human and ecological receptors, the benefit to dredging appears to be minimal.

Institutional Controls would establish a mechanism to control activities such as navigational dredging that might lead to human or ecological exposure to buried sediments.

Monitored Natural Recovery would involve periodic characterization of the sediments necessary to monitor and evaluate the natural recovery process of the sediments. As discussed earlier, because physical site activity required for this alternative is limited to sediment sampling, there would be no additional risks to the surrounding community, workers or the environment during implementation. However, because degradation of MGP materials in buried sediments is expected to be a very slow process and may not be significant in the thirty year timeframe NYSDEC is assessing, combining Monitored Natural Recovery with Institutional Controls would provide both the necessary monitoring and appropriate control measures to assure that the impacted sediments remain isolated.

Monitored Natural Recovery and Institutional Controls is the recommended alternative for sediments.

5.1.4 Preferred Remedy

The recommended remedy (see Figure 5-1) includes the following:

1. Install a barrier wall along the FDR drive to contain NAPL. This is a proven and effective technology and can be implemented without closing the school.
2. Limited excavation in areas outside of the school building to remove NAPL and MGP structures above the water table is also recommended. A general area in the southeast portion of the site (at Test Pits 3 and 4a) has been identified for such excavation. This area will be further defined by test borings or test pits as part of the remedial design or remedy implementation. The area will be extended as dictated by the pre-design investigation. In addition, any NAPL-impacted soils encountered during installation of the barrier wall would be excavated and removed off-site (limited excavation).
3. Conduct active venting and monitoring for indoor air. This remedial approach provides additional insurance that sub-slab vapors would not enter the building and that indoor air goals are met. After an active venting system has been installed and demonstrates effective depressurization of the sub-slab area, indoor air monitoring may be discontinued.
4. Implement monitored natural recovery for sediments. Under current conditions, impacted sediments appear to be isolated and do not pose a risk to human or ecological receptors. This alternative would

provide confirmation that the impacted sediments remain isolated and would prevent or control activities that might expose impacted sediments.

5. Establish Institutional Controls. These controls, among other things, assume implementation of a Site Management Plan (SMP). The SMP would include provisions to assure the safety of any future excavation activity and that all components of the site remedy are not damaged and continue to function properly. Additional details on the SMP are discussed below. Also, the institutional controls will provide for additional remedial activities if permitted by a change in site use.

A Site Management Plan (SMP) will be developed as part of the site remedy. The SMP will include provisions to control any future development or maintenance activities requiring subsurface excavation or the extraction of groundwater at the site. These provisions, among other things, will include health and safety guidelines requiring that construction workers involved in this work have appropriate Occupational Safety and Health (OSHA) training as required in 29 CFR 1910.120 (Hazardous Waste Operation and Emergency Response) and that appropriate worker and community air monitoring be conducted. The SMP will include a soil management plan to govern future excavation activities at the site. The SMP will include a monitoring plan for groundwater, sediment, and indoor air (in the initial year of SSDS operation). An operation and maintenance plan for the engineering controls will also be part of the SMP to ensure that they are functioning properly and have not been damaged so as to compromise its effectiveness. The SMP will also contain provisions for annual inspections of the site's engineering and institutional controls by a New York professional engineer or other designated environmental professional followed by filing annual certifications with the NYSDEC.

**Table 5-1
Comparison of Alternatives for Soil and Groundwater
East 115th Street Former MGP
Consolidated Edison, New York, New York**

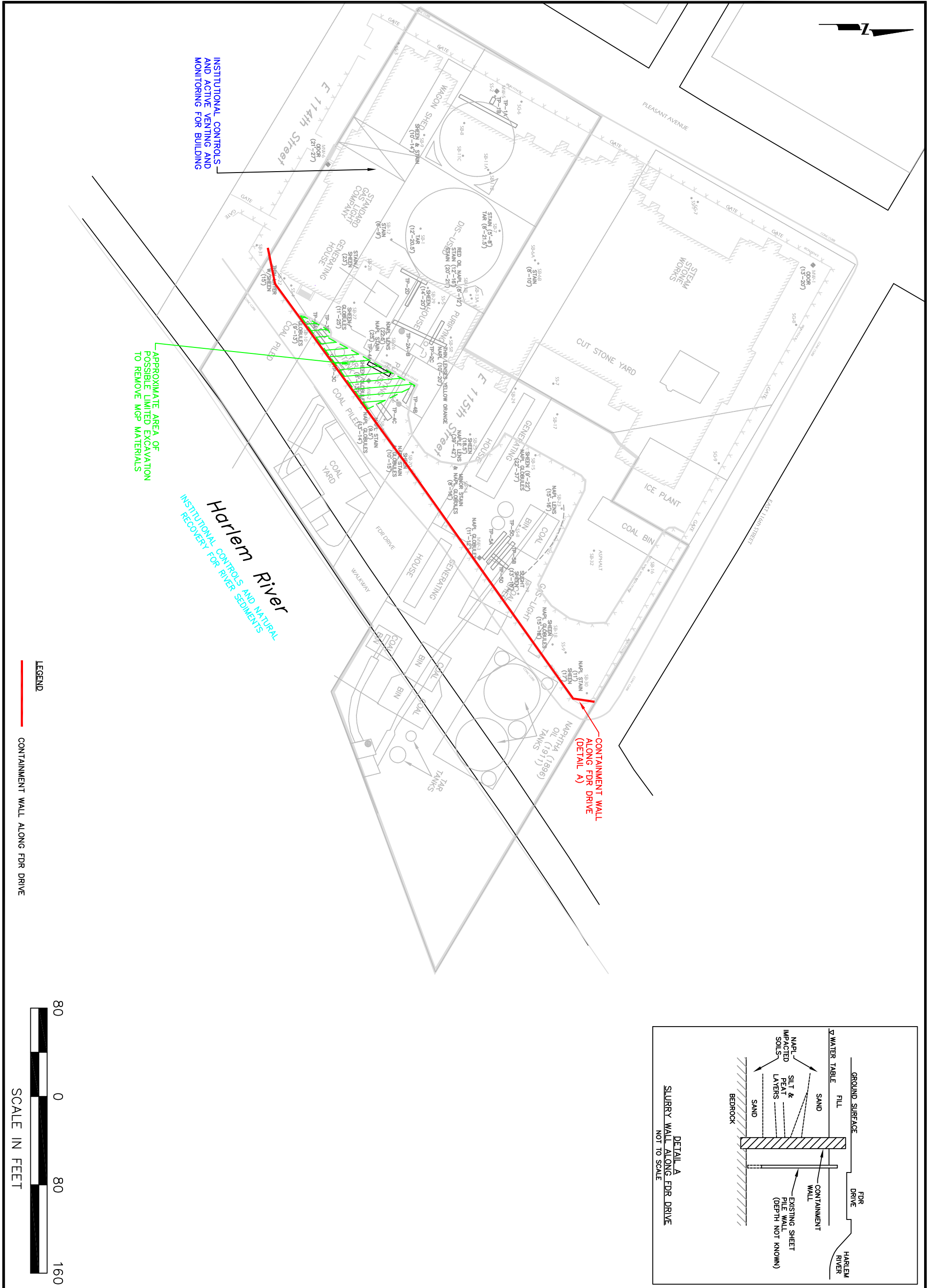
| Alternative | Overall Protection of Public Health | Compliance with Standards | Long-Term Effectiveness | Reduction in Toxicity, Mobility or Volume | Short-term Effectiveness | Implementability |
|--------------------------------------|--|----------------------------------|--------------------------------|--|---------------------------------|-------------------------|
| No Action | Unacceptable | Poor | Poor | Poor | Good | Good |
| In-Situ Thermal Treatment | Fair | Fair | Fair | Good | Poor | Poor |
| In-Situ Chemical Oxidation | Fair | Fair | Fair | Fair | Fair | Poor |
| Excavation Under Building | Good | Good | Good | Good | Poor | Unacceptable |
| Excavation Outside Building | Good | Good | Good | Good | Poor | Fair |
| In-Situ Stabilization | Good | Fair | Fair | Good | Fair | Poor |
| Cut-off Wall by FDR Drive | Good | Fair | Good | Fair | Fair | Good |
| Recovery Wells | Good | Fair | Fair | Fair | Good | Good |
| 360 Degree Complete Containment Wall | Good | Fair | Good | Fair | Poor | Poor |
| Permeable Reactive Barrier (PRB) | Good | Good | Fair | Fair | Fair | Fair |

**Table 5-2
 Comparison of Alternatives for Impacted Vapors underneath the Building
 East 115th Street Former MGP
 Consolidated Edison, New York, New York**

| Alternative | Overall Protection of Public Health | Compliance with Standards | Long-Term Effectiveness | Reduction in Toxicity, Mobility or Volume | Short-term Effectiveness | Implementability |
|--------------------|--|----------------------------------|--------------------------------|--|---------------------------------|-------------------------|
| No Action | Unacceptable | Poor | Poor | Poor | Good | Good |
| Monitoring | Fair | Fair | Poor | Poor | Good | Good |
| Passive Venting | Good | Fair | Good | Fair | Good | Poor |
| Active Venting | Good | Good | Fair | Fair | Good | Good |
| Vapor Barriers | Good | Fair | Good | Fair | Good | Good |

**Table 5-3
 Comparison of Alternatives for Impacted Sediments
 East 115th Street Former MGP
 Consolidated Edison, New York, New York**

| Alternative | Overall Protection of Public Health | Compliance with Standards | Long-Term Effectiveness | Reduction in Toxicity, Mobility or Volume | Short-term Effectiveness | Implementability |
|---|--|----------------------------------|--------------------------------|--|---------------------------------|-------------------------|
| No Action | Poor | Poor | Poor | Poor | Good | Good |
| Institutional Controls | Fair | Poor | Fair | Poor | Good | Good |
| Monitored Natural Attenuation with Institutional Controls | Good | Fair | Fair | Fair to Poor | Good | Good |
| Dredging | Fair | Good | Good | Good | Poor to Unacceptable | Poor |



LEGEND
 ——— CONTAINMENT WALL ALONG FDR DRIVE

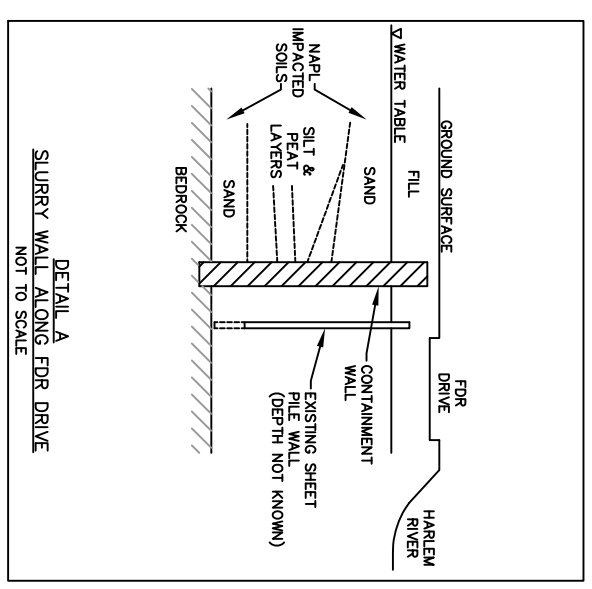


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LOCATIONS FOR REMEDIAL OPTIONS
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 EAST 115th STREET FORMER MGP
 NEW YORK, NY

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| CHECKED BY: C. W. M. | | | | |
| APPROVED BY: D. S. | | | | |

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Appendix A

Pilot Study Work Plan Former East 115th Street Station Manufactured Gas Plant (MGP) NYSDEC VCA Site No. V00540-2

Appendix A

Pilot Study Work Plan

Former East 115th Street Station

Manufactured Gas Plant (MGP)

NYSDEC VCA Site No. V00540-2

Prepared for:
Consolidated Edison Company of New York, Inc.
New York, NY



Pilot Study Work Plan

Former East 115th Street Station

Manufactured Gas Plant (MGP)

NYSDEC VCA Site No. V00540-2

ENSR Corporation
December 2007
Document No.: 01869-115-400

Prepared for:
Consolidated Edison Company of New York, Inc.
New York, NY

Pilot Study Work Plan
Former East 115th Street Station
Manufactured Gas Plant (MGP)
NYSDEC VCA Site No. V00540-2



Prepared By



Reviewed By

ENSR Corporation
November 2007
Document No.: 01869-115-400

Contents

| | |
|---|------------|
| 1.0 Introduction | 1-1 |
| 1.1 Background | 1-1 |
| 1.2 Description of pilot test area..... | 1-1 |
| 2.0 Treatment objectives and goals of pilot study | 2-1 |
| 3.0 Installation of subslab depressurization system | 3-1 |
| 4.0 Installation of horizontal treatment/recovery wells..... | 4-1 |
| 4.1 Site access | 4-2 |
| 4.2 Permit requirements | 4-2 |
| 4.3 Water level monitoring | 4-2 |
| 4.4 Establishment of site work zone | 4-3 |
| 4.5 Underground utility clearance | 4-3 |
| 4.6 Tree removal | 4-3 |
| 4.7 Community air monitoring | 4-3 |
| 4.8 Test pit excavation | 4-4 |
| 4.9 Vertical monitoring well installation..... | 4-5 |
| 4.10 Pilot borehole advancement | 4-5 |
| 4.11 Horizontal well installation and development | 4-7 |
| 4.12 Installation of angled monitoring points | 4-8 |
| 4.13 Installation of sumps..... | 4-8 |
| 4.14 Investigation derived waste..... | 4-9 |
| 5.0 Monitoring for tar recovery prior to enhanced recovery tests | 5-1 |
| 6.0 Enhanced recovery by thermal processes | 6-1 |
| 6.1 Theory of thermal recovery process | 6-1 |
| 6.2 Equipment and installation procedures | 6-1 |
| 6.3 Site support requirements (space and utilities) | 6-2 |
| 6.4 Application procedures..... | 6-2 |
| 6.5 In-process testing and monitoring..... | 6-2 |
| 6.6 Monitoring tar recovery | 6-3 |

7.0 Enhanced recovery by *in situ* chemical treatment..... 7-1

7.1 Theory behind *in situ* chemical recovery process 7-1

7.2 Equipment and installation procedure 7-2

7.3 Site support requirements (space, utilities) 7-2

7.4 Application procedures..... 7-2

7.5 In-process monitoring and testing..... 7-3

8.0 Health and safety plan..... 8-1

9.0 Conceptual Schedule 9-1

List of Appendices

Appendix A Site Health and Safety Plan (HASPs)

Appendix B Preliminary Structural Evaluation

List of Tables

Table 9-1 Conceptual Pilot Study Schedule 9-2

List of Figures

Figure 1-1 Site Location Map 1-3

Figure 1-2 Site Plan – Current and Historic Site Features 1-4

Figure 1-3 Cross Section A-A' 1-5

Figure 1-4 Cross Section B-B' 1-6

Figure 3-1 Proposed Vent System Design 3-3

Figure 4-1 Pilot Test Activities 4-10

Figure 4-2 Proposed Horizontal Well Installation Details 4-11

1.0 Introduction

On behalf of Consolidated Edison Company of New York (Con Edison), ENSR has prepared this Pilot Study Workplan for the East 115th Street Station Former Manufactured Gas Plant (MGP) Site (the Site) in New York, New York. Options for remediation of the Site were developed and evaluated in the draft Remedial Action Selection Report (RASR, ENSR January 2007). The challenges of remediating coal tar now located beneath the Manhattan Center for Science and Mathematics (the school) are discussed in the RASR, which concludes that recovery of coal tar located beneath the building using horizontal wells is the most viable approach and should be further tested. Testing of methods to enhance recovery of coal tar such as in-situ heating and use of chemical oxidants is also recommended. This pilot study workplan describes the installation of horizontal wells beneath the building and the testing of methods to improve the recovery of coal tar. Results of the pilot study will be used to develop recommendations for the full-scale treatment.

1.1 Background

The Site is located at 116th Street and Pleasant Avenue, New York, NY, as shown in Figure 1-1, and is identified by the New York City Tax Map as Block 1713, Lot 1. Part of the former MGP property included what are now the FDR Drive and the Harlem River. Research indicates that the subject property was situated adjacent to a ferry station which is now occupied in part by the Harlem River. It is possible that the property once included a pier that is no longer present. The location of the former MGP property and its extent were determined through review of Sanborn Insurance Maps. Figure 1-2 provides a plan of the Site, which depicts current site features and boundaries.

The Site is currently used as the Manhattan Center for Science and Mathematic High School and the Isaac Newton Junior High School for Science and Math. Over 1500 students (Inside School.org Dec 2007) and the associated teachers and administrative staff routinely occupy the school. The Site is bounded to the north and west by residential and commercial properties. Thomas Jefferson Park is located adjacent to and south of the Site. FDR Drive and the Harlem River abut the Site to the east. The focus area for this pilot study is a larger former gas holder that is now located primarily beneath the school cafeteria.

1.2 Description of pilot test area

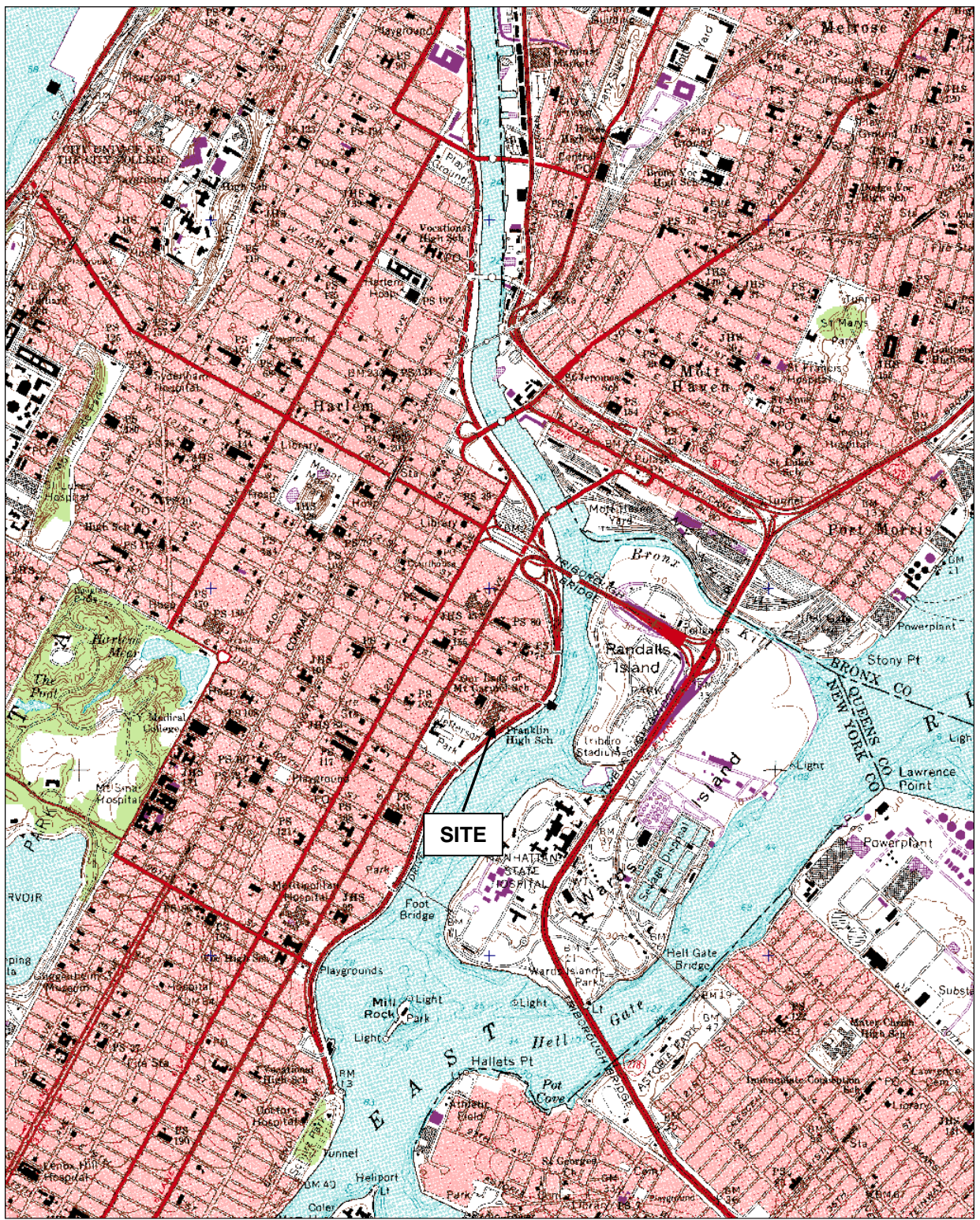
Physical features of the larger gas holder and nearby media include the following:

- The larger gas holder appears to be located completely under the school building. The eastern portion of the gas holder is close to the outer wall of the building.
- Diameter of the gas holder is estimated to be 90 feet.
- From the basement floor to the apparent bottom of the gas holder is 20 feet. From the basement floor to ground surface is another 6 feet.
- The design of the larger gas holder is not known with certainty, but based on borings conducted within the holder and test pitting around the adjacent smaller gas holder, the holder walls are believed to be brick and the holder bottom is concrete.
- The total volume of material in the larger gas holder is 4,700 cubic yards and consists of debris (bricks, wood, and concrete). The first 5 or 6 feet of soil below the basement floor does not appear to be impacted.
- Based on examination of soil cores, non-aqueous phase liquids (NAPL) is believed to be present within the main gas holder from approximately 14 to 20 feet below the basement floor. The amount of

NAPL in and around the gas holder cannot be estimated with certainty, but it is likely that thousands of gallons of NAPL are present (based on the observed thickness of NAPL and size of the holder).

Groundwater is present at approximately 5 to 6 feet beneath the basement floor. Due to the presence of NAPL, groundwater beneath the building is expected to be impacted with Volatile Organic Compounds (VOCs) and Semi Volatile Organic Compounds (SVOCs). Soils below the water table consist of sand with silt and clay lenses to a depth of 25 feet below the basement floor. The clay unit may serve as an aquitard. Bedrock is present at approximately 40 feet below the basement floor. Cross sections showing soil types are provided in Figures 1-3 and 1-4.

Use of the school building includes summer school sessions and the only time when the school does not host students is a two week period in August. According to the school design drawings (Foundation Plan, Benjamin Franklin HS Manhattan, May 13, 1940) the building rests on 240 piling clusters. Piling clusters consist of one to six individual pilings. Pilings were first driven as hollow steel tubes to bedrock and then cleaned-out and filled with concrete. Estimated quantities in the design drawings indicate that the depth to bedrock estimated in 1940 is similar to that observed in the Supplemental Remedial Investigation (RI). Piling clusters are present every 14 to 28 feet along the outside walls and inside the footprint of the building. At least 4 pile clusters are present within the footprint of the main gas holder. It is not known if these piles pierce the gas holder floor. The basement floor is 8 to 12 inches in thickness with steel rod reinforcements.

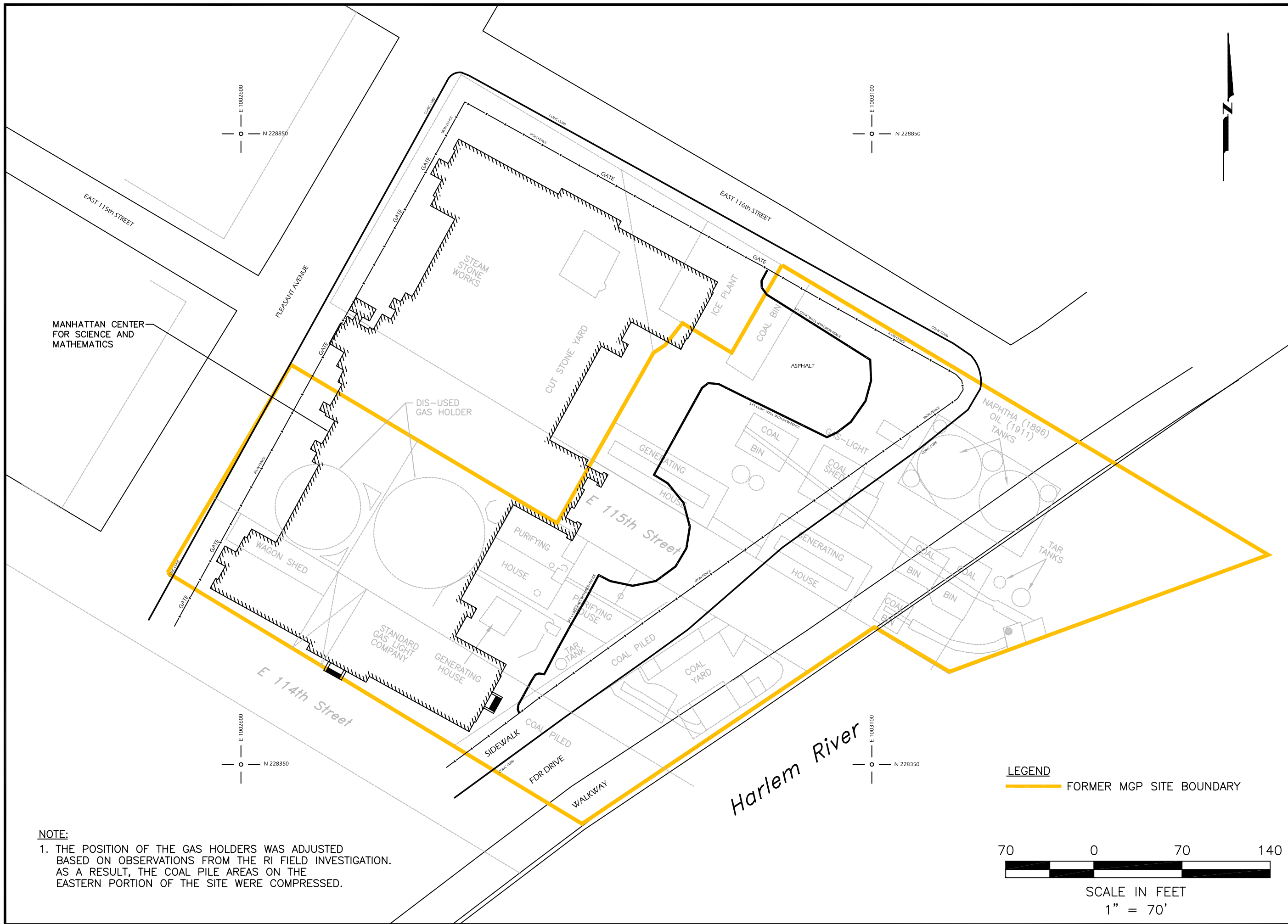


3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS 742 ft Scale: 1 : 25,000 Detail: 13-0 Datum: WGS84

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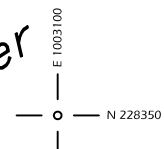
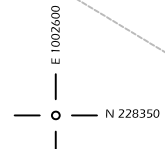
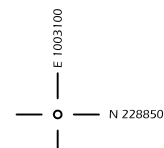
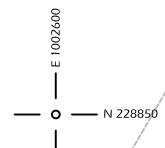
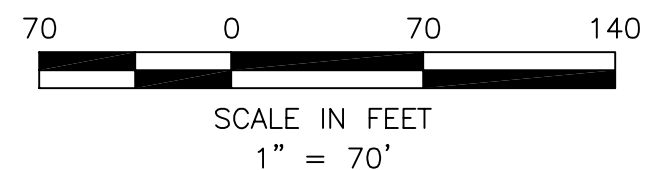
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|---|---|--------------------------|--|
| ENSR AECOM 2 TECHNOLOGY PARK DRIVE WESTFORD, MA 01886 PHONE: (978) 589-3000 FAX: (9778) 589-3282 WEB: HTTP://WWW.ENSR.COM | SITE LOCATION MAP EAST 115th STREET STATION FORMER MGP SITE NEW YORK, NEW YORK | | FIGURE NUMBER 1-1 |
| | DRAWN BY: KAG | DATE: 11/02/07 | PROJECT NUMBER: 01869-115 |

J:\ndi\Service\Project Files\ConEd 1869\115th Street\PilotTest Activities\Figure 1-2 Current and Historic Features.dwg



NOTE:
 1. THE POSITION OF THE GAS HOLDERS WAS ADJUSTED BASED ON OBSERVATIONS FROM THE RI FIELD INVESTIGATION. AS A RESULT, THE COAL PILE AREAS ON THE EASTERN PORTION OF THE SITE WERE COMPRESSED.

LEGEND
 FORMER MGP SITE BOUNDARY



| DESIGNED BY: | | REVISIONS | |
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| NO.: | DESCRIPTION: | NO.: | DESCRIPTION: |
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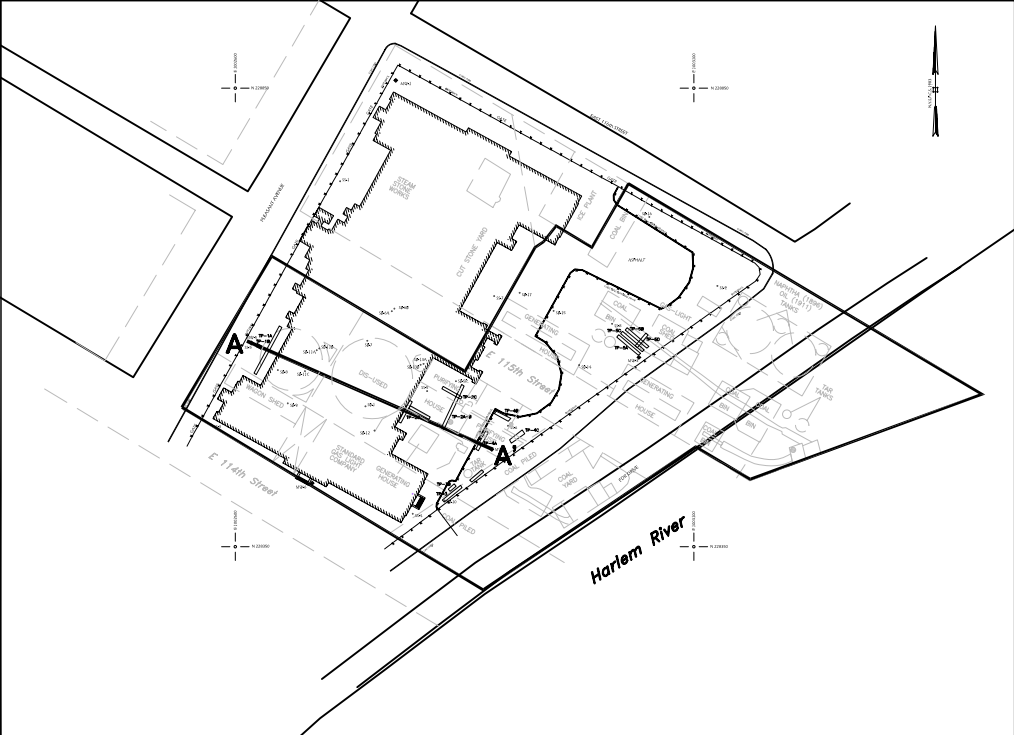
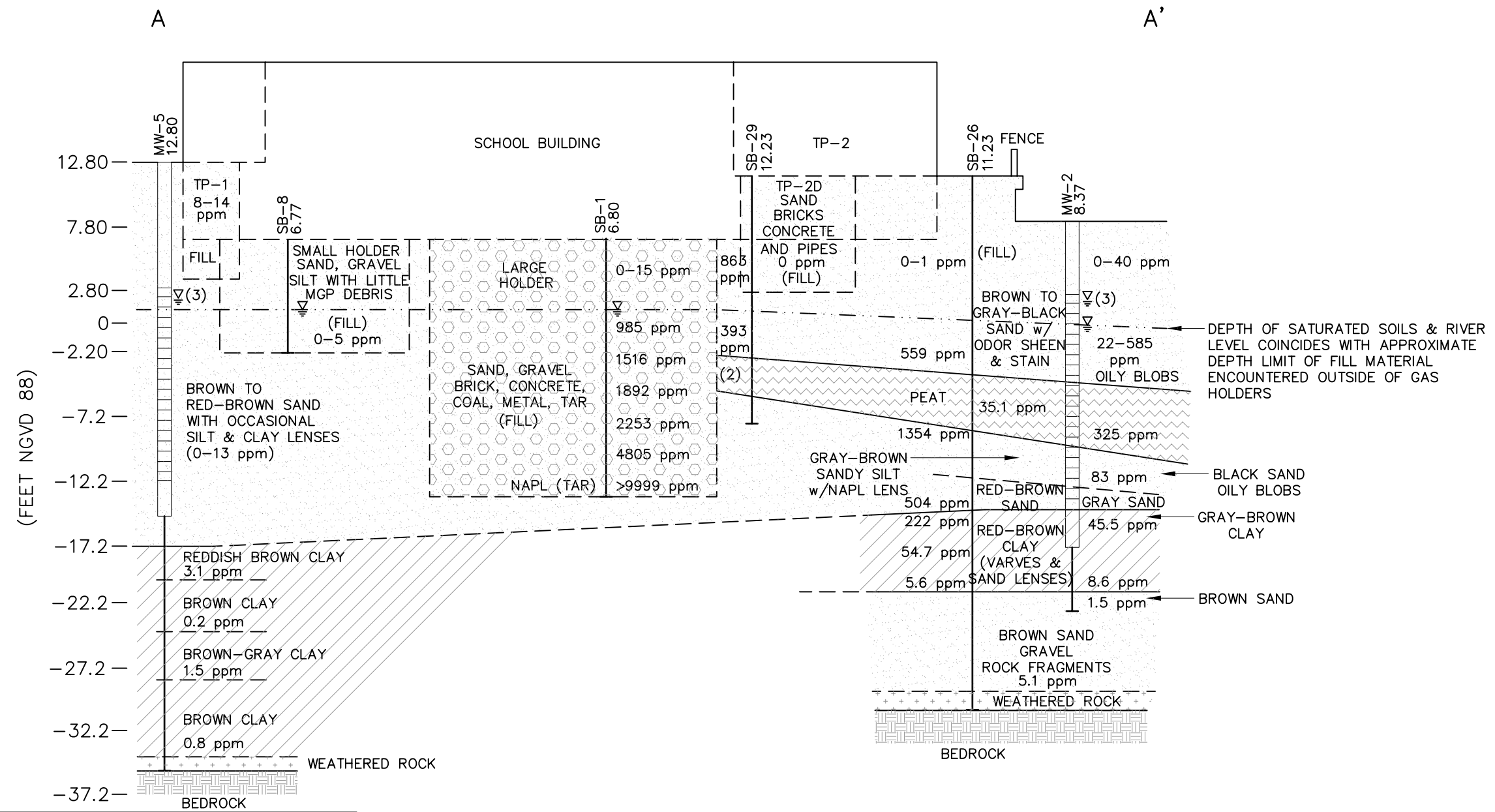
CURRENT AND HISTORIC FEATURES
 CONSOLIDATED EDISON
 EAST 115TH STREET FORMER MGP
 NEW YORK, NY

SCALE: 1" = 70' DATE: 11/07 PROJECT NUMBER: 01869-115-400

FIGURE NUMBER:
1-2

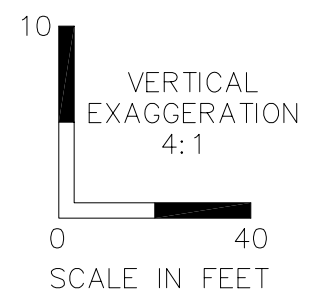
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J:\Inl_Service\Project Files\ConEd 1869\115th Street\PilotTest Activities\Figure 1-3 Cross Section A-A'.dwg



NOTES:

1. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
2. ELEVATION OF PEAT LAYER APPROXIMATED FROM SB-12. NO RECOVERY AT SB-29 - UNABLE TO CONFIRM PRESENCE OF PEAT AT THIS LOCATION.
3. WATER TABLE ELEVATION ON 8/28/03.



| DESIGNED BY: | NO.: | DESCRIPTION: | DATE: | BY: |
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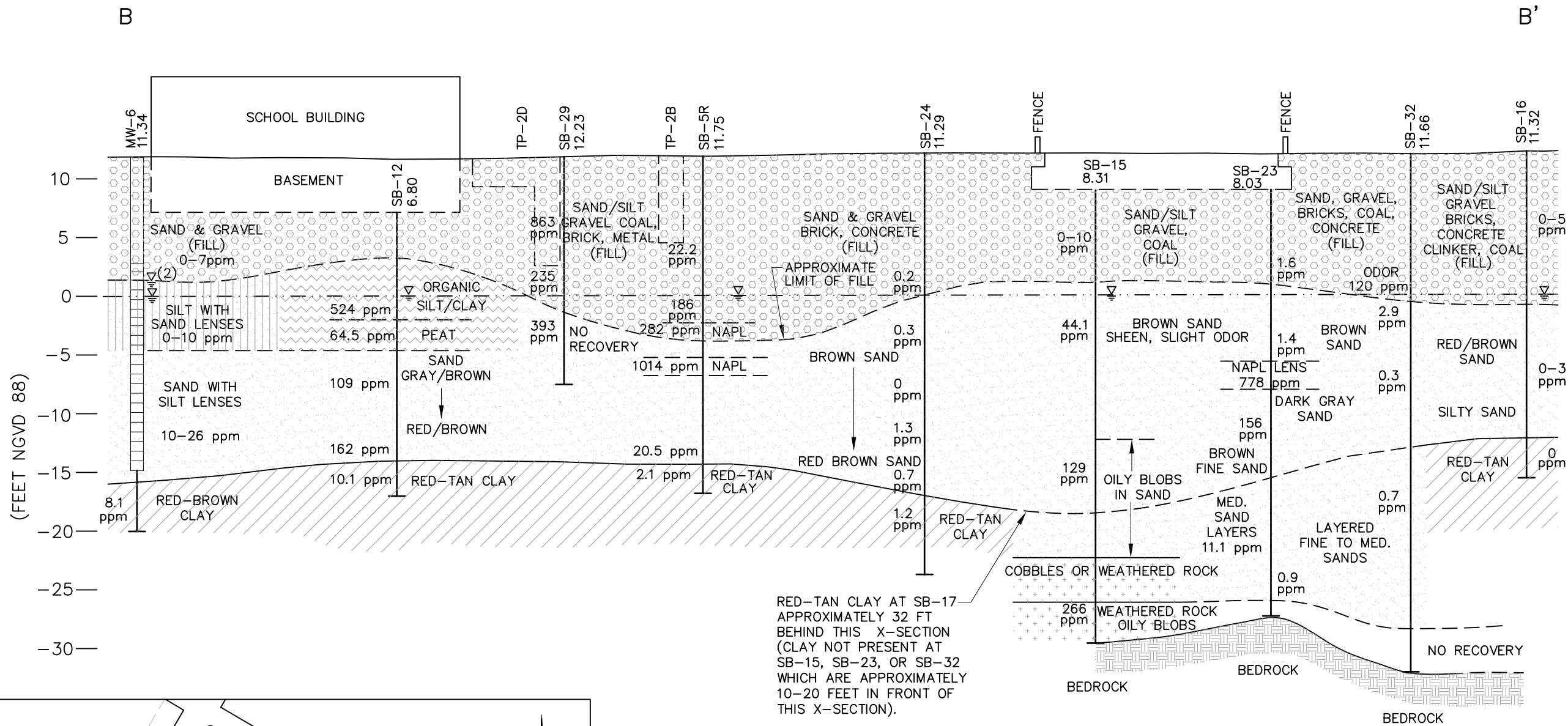
CROSS SECTION A-A'
CONSOLIDATED EDISON
EAST 115TH STREET FORMER MGP
NEW YORK, NY

SCALE: AS SHOWN DATE: 11/07 PROJECT NUMBER: 01869-115-400

FIGURE NUMBER:
1-3

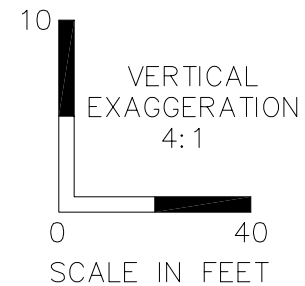
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NOTES:

1. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
2. WATER TABLE ELEVATION ON 8/28/03.



| NO. | DESCRIPTION | DATE | BY |
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DESIGNED BY: **J.E.B.**
 DRAWN BY: **J.E.B.**
 CHECKED BY: **S.O.**
 APPROVED BY: **D.S.**

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CROSS SECTION B-B'
CONSOLIDATED EDISON
EAST 115TH STREET FORMER MGP
NEW YORK, NY

SCALE: **AS SHOWN** DATE: **11/07** PROJECT NUMBER: **01869-115-400**

FIGURE NUMBER:
1-4

SHEET NUMBER:
1

2.0 Treatment objectives and goals of pilot study

Three levels of treatment for coal tar located beneath the school building were evaluated in the RASR. The highest level of treatment, complete removal of tar, was determined to be infeasible. Complete removal of tar would require demolishing the school or installation of several hundred vertical treatment wells. In either case, complete removal of the tar would require the school to be closed for several years and is not a viable option.

The next level of treatment, removal of volatile organic compounds (VOCs), may be at least partially accomplished while the school is still in use. The pilot study design includes monitoring to determine whether the concentration of lighter hydrocarbons is reduced during treatment.

The final level of treatment, coal tar removal to the extent practical, is the primary treatment objective. The objective is to remove as much coal tar as practical without creating an unsafe condition or disrupting use of the building.

To assure that the remediation work does not create an unsafe condition or disrupt use of the building, the following conditions apply to the pilot study and ultimately to the full-scale remediation:

- A subslab depressurization system will be installed in the basement prior to the start of drilling and testing of treatment technologies. The subslab depressurization system will assure that any vapor that may be released during the pilot study will be prevented from entering the building.
- No injection, extraction, or heating wells will be installed through the floor of the school building. No treatment solutions or extracted liquids will be handled within the school building. Horizontal extraction/injection/heating wells will be installed from outside the building. Removal and handling of coal tar will occur outside. All treatment solutions and extracted liquids will be handled outside.
- A secure area will be established outside for access to the horizontal wells and management of any treatment solutions or extracted liquids.
- All work will be closely coordinated with the Department of Education. In general, access to the inside of the building will be limited to evenings, weekends, and the August recess.

The volume of coal tar removed will be measured to determine the relative success of the various methods of coal tar removal. Although several feet of coal tar was observed during installation of vertical soil borings, it is not known how mobile the material is and how much of it can be removed.

Goals of the pilot study are:

- Confirm the feasibility of installing horizontal wells with minimal disruption of school activities.
- Confirm the feasibility of the horizontal drilling method to install deep enough wells into the gas holder beneath the building to allow for sufficient evaluation of the feasibility of coal tar removal with and without treatment.
- Determine the rate of coal tar removal from horizontal wells without any treatment to enhance recovery.
- Test the effectiveness of thermal treatment to enhance coal tar removal.
- Test the effectiveness of in-situ chemical treatment (cosolvent/surfactant flushing and oxidation) to enhance coal tar removal.
- Determine if any LNAPL is generated during treatment. If so, remove the LNAPL.
- Provide the basis for final selection of the method(s) to be used for removal of coal tar.

- Provide process information for the design of a full-scale treatment system.

Specific plans to achieve the above goals are presented in Sections 3 to 7. The work is divided in four phases. First, installation of the subslab venting system is discussed in Section 3. Second, installation of wells to support the various NAPL recovery tests is discussed in Section 4. Testing of passive recovery of NAPL is discussed in Section 5. Testing of thermal treatment and testing of chemical treatment to enhance NAPL removal are discussed in Section 6 and 7 respectively.

3.0 Installation of subslab depressurization system

Installation of an active subslab depressurization system (venting system) is proposed as part of the overall remedy for the Site. Installation of the venting system is proposed as the first step in the pilot study in order to prevent migration of vapors into the building during the drilling of horizontal wells and during treatment to enhance removal of coal tar.

The venting system will consist of shallow wells installed in the basement floor, piping, and a vent blower. A layout of the venting system and the vent well design are shown in Figure 3-1. A key design parameter is spacing between the vent wells. To determine the optimal spacing, an initial pilot vent test will be conducted. Based on the findings of the pilot vent test, the final well spacing will be determined.

The initial pilot study will consist of installing one vent well and several small diameter monitoring points. The vent well will consist of a 2-inch diameter screened well point installed through a 6-inch diameter cored hole. Using a concrete core machine, the 6-inch core will be completed through the approximate 8-inch thick concrete slab. Approximately 1 to 2 feet of native soil will be removed from beneath the slab using hand tools. The 1-foot long 10-slot screen section of schedule 40 PVC will then be installed within the bore hole with a sand or pea stone filter pack. A 1-foot section of PVC riser will be connected to the screen section and the annular space between the borehole and PVC riser will be sealed with bentonite and concrete. The vent well will be secured within a flush mounted roadbox equipped with a rubber gasket.

The temporary monitoring points will consist of 3/8-inch aluminum soil gas sampling probes manually driven through a 5/8-inch diameter hole drilled through the concrete floor. The temporary probes will penetrate about one foot into the native soil beneath the slab. The points will be sealed in place during the testing with grout. Monitoring points will be spaced approximately 10, 20, and 30 feet from the pilot test vent well as shown in Figure 3-1. Using a portable blower, pressure and flow tests will be conducted by drawing air from the vent wells and measuring the pressure response at the monitoring points. Extracted air will be vented to the outside. Pressure drop at the monitoring points will be monitored. After testing, the temporary probes will be removed and the holes sealed with concrete.

Equipment used in the sub vent testing will consist of a 3 horsepower (HP) Gast Regenerative blower (or similar) equipped with the appropriate valves to allow for controlling the vacuum and flow applied to the formation. A photo ionization detector (PID), a hotwire anemometer, and digital anemometers, will be used to measure VOCs, vapor flow rates, and vacuums and pressures, respectively. Various 2-inch PVC fittings, and hoses will be used to connect the blower to the sub slab ventilation points. The blower will be vented to the outside.

Step tests will be conducted by varying the applied vacuum and the flow rate. The radius of influence for the vent well will be determined at one or more flow rates over a one hour period. A pressure drop on 0.01 inches of water or more in a monitoring point would be indicative of that point being within the radius of influence. The venting pilot test will take 4 to 8 hours to complete. Findings of the vent test will be used to determine the spacing of vent wells and design of the vent blower.

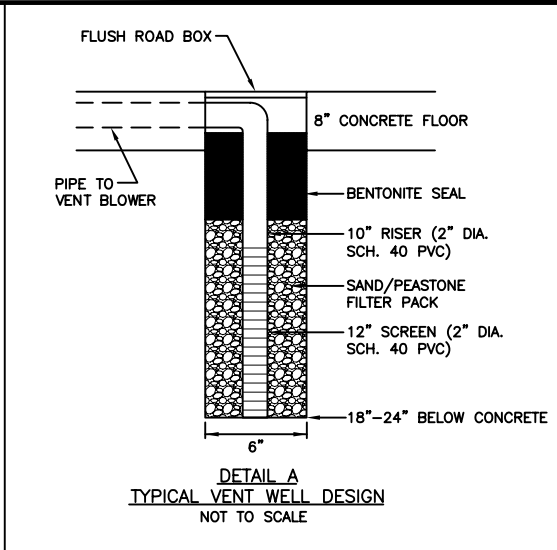
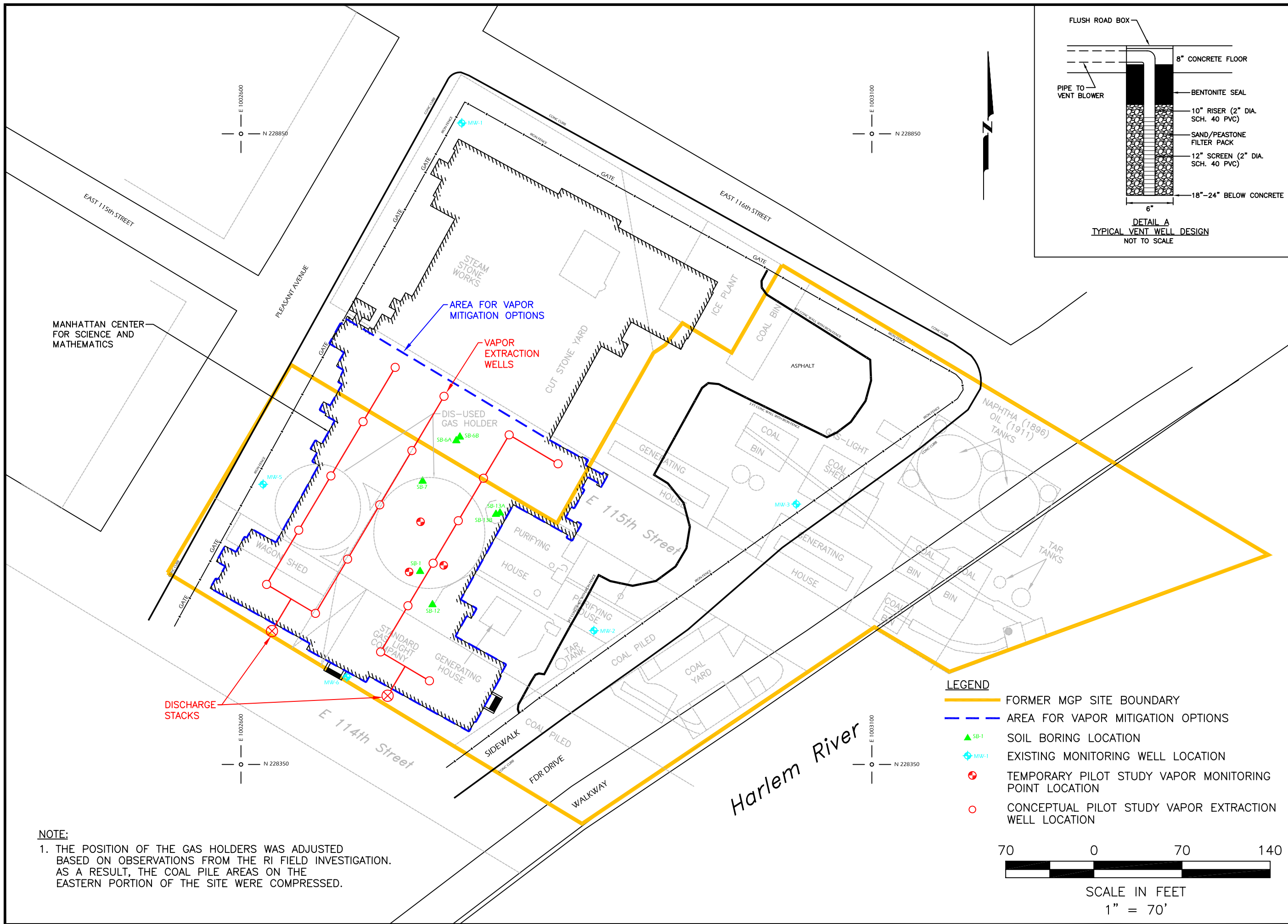
Installation of the venting system will be conducted as follows:

- ConEd will coordinate the working hours with the Department of Education (DOE). Work will be conducted only when students are not using the areas.
- Work will likely be conducted at night or on weekends. All work areas will be cleaned and covered at the end of every working shift.

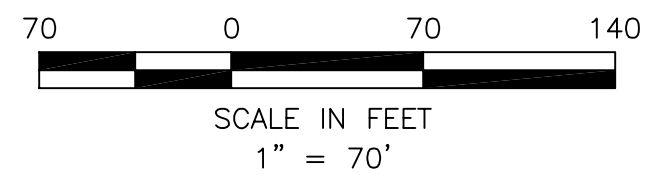
- In cases where asbestos tiles are present, the tiles will first be removed by a certified asbestos remediation contractor.
- Proposed locations of the vent wells will be discussed with DOE. Ideally vent wells will be located close to walls and/or in areas of low traffic.
- Vent wells and associated piping will be installed in a manner to avoid creating trip hazards. Where necessary, trenches will be installed in the concrete floor for piping. Trenches will be covered with concrete and tile.
- To the extent practical, piping runs will be hidden inside walls or hanging ceilings.
- The vent blower will be located in a utility closet or in the boiler room. A licensed electrician will make the necessary electrical connections.
- Vent line will be installed from the vent blower to the outside. The discharge point will be at least ten feet from any window and three feet above the ceiling.
- At this time it is not anticipated that off-gas treatment will be required for the venting system. Discharge monitoring will be conducted during the first month of operation and during the coal tar removal tests to confirm that off-gas treatment is unnecessary.

Including installation of test wells, the venting pilot test will require one to two days to complete. Installation of a full venting system will require approximately one week. At start-up of the system flow rates and vacuum measurements will be taken. Also, the level of volatile organic compounds in the discharge will be tested using a PID. The venting system will be inspected monthly to assure proper operation and to measure VOC levels. The vent wells and all piping will be sealed. A power outage or other event that causes the vent blower to stop running will not result in leakage of vapors into the building from the vent system.

J:\Ind_Service\Project Files\1869\115th Street\PilotTest Activities\Figure 3-1 Proposed Vent System Design Pilot Study Locations.dwg



- LEGEND**
- FORMER MGP SITE BOUNDARY
 - - - AREA FOR VAPOR MITIGATION OPTIONS
 - ▲ SB-1 SOIL BORING LOCATION
 - ◆ MW-1 EXISTING MONITORING WELL LOCATION
 - TEMPORARY PILOT STUDY VAPOR MONITORING POINT LOCATION
 - CONCEPTUAL PILOT STUDY VAPOR EXTRACTION WELL LOCATION



NOTE:
 1. THE POSITION OF THE GAS HOLDERS WAS ADJUSTED BASED ON OBSERVATIONS FROM THE RI FIELD INVESTIGATION. AS A RESULT, THE COAL PILE AREAS ON THE EASTERN PORTION OF THE SITE WERE COMPRESSED.

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PROPOSED VENT SYSTEM DESIGN
 PILOT STUDY LOCATIONS
 CONSOLIDATED EDISON
 EAST 115TH STREET FORMER MGP
 NEW YORK, NY

SCALE: 1" = 70'
 DATE: 11/07
 PROJECT NUMBER: 01869-115-400

FIGURE NUMBER:
3-1

SHEET NUMBER:
 1

4.0 Installation of horizontal treatment/recovery wells

As discussed previously, use of vertical injection/heater/extraction wells within the school building is not viable. Therefore, the use of horizontal wells is planned. The advantage of horizontal wells is that all of the drilling can be conducted outside with minimal disruption of school activities. Use of horizontal wells also allows all handling of heating equipment, chemical reagents, and extracted tar to occur outside.

The following is a summary of the basic installation parameters for the horizontal wells.

- Prior to commencement of the horizontal well installation, excavation to remove debris and structures associated with the former MGP immediately east of the school is required in order to visually confirm the construction of the building footer and alignment of the pilings, and to facilitate installation of the horizontal wells and the outside vertical monitoring wells mentioned below.
- Two vertical 4-inch diameter monitoring/extraction wells will be installed outside the school adjacent to the gas holder prior to installation of the horizontal wells. These vertical wells will be used to determine if NAPL is migrating out of holder during drilling or treatment. These wells will also be used to recover NAPL, if present. .
- Possible horizontal well alignments are limited by the position of the support pilings for the building.
- Stainless steel screen and riser material will be required.
- Maximum possible stainless steel well diameter is 6 inches.
- Traditional slotted screen or wire wrap screen can not be used. Specially designed vertical slots or drilled holds will be used.
- Drilling of the deep wells must start at least 105 feet east of the building. The length of the drill rig and the distance to the fence along the FDR Drive will dictate where the rig can setup and thus the orientation of the wells.
- A pilot borehole will be advanced with mud rotary drilling and the screen and riser will then be pushed into place. Maximum borehole diameter is 12 inches (5-inch pilot hole reamed to 12 inches).
- Well development via water jetting and/or vacuum extraction is required to remove the drilling mud. Alternatively, a biodegradable grout will be used.
- The driller can also push a 1 to 3-inch diameter steel pipe into the borehole alongside the well. This could be used for various purposes such as installation of heating elements, chemical injection, monitoring, and/or well redevelopment.
- At this time, one horizontal well at the base of the holder at 24 feet bgs and one at the water table at 13 feet bgs are planned.
- After the horizontal wells are installed, installation of sumps and access manways approximately 10 feet from the building are planned. These sumps will facilitate monitoring activity as well as tar removal.

A detailed discussion of the proposed process to install the horizontal extraction/treatment wells including the above parameters is presented in the following sections. A preliminary analysis of potential structural impacts to the building has been conducted and is provided as Appendix B. Review of the drilling and treatment plans by a New York State structural engineer will be conducted.

4.1 Site access

To this point, the RI field activities have been conducted solely during the two weeks in August when the school does not host students. If limited to this same time constraint, execution of the pilot test activities would take several years to complete. Therefore, it will be necessary to conduct work on the school grounds while school is in session. All work will be closely coordinated with the DOE and pre-planning discussions will be required in order to establish the conditions governing the work (i.e., site access, tasks to be performed, work hours, exclusion zones, noise levels, etc.). It is assumed that access to the inside of the building will be limited to times when students are not present within the basement (i.e., evenings, weekends, vacations, and the August recess).

Access to the basement of the school will be required by ENSR and subcontractor personnel during installation of the subslab venting system and during drilling of the pilot boreholes for the horizontal wells. Indoor activities related to the installation of the subslab venting system were previously presented in Section 3. Indoor activities during drilling will be limited to tracking the location and depth of the drill head beneath the basement floor. While this work is not intrusive, it will likely be done in the evenings or weekend when the cafeteria is not in use.

4.2 Permit requirements

Approval from the Department of Education will be required in advance of this project.

Permits are not required for the installation of the horizontal wells.

The need for construction and utility relocation permits is not anticipated.

The need for transportation permits for mobilizing large equipment to the Site is not anticipated.

Local ordinances may limit noise levels and work hours.

Based on the available space onsite to the east of the school building, it is not anticipated that the proximity of the entry point for the deep horizontal wells to the FDR Drive will require notification to, or approval by, the highway authority as no disruption of the sheet pile wall or potential impacts to the construction of the FDR Drive are anticipated. A visual barrier may be desirable.

It is assumed that all investigation derived waste liquids and soil will be transported offsite for disposal at a Con Edison-approved disposal facility. As such, an Underground Injection Control permit or discharge permit will not be required.

4.3 Water level monitoring

Additional groundwater elevation data will be obtained prior to the start of drilling. This information will be required to determine the optimal target depth of the shallow horizontal well beneath the building. Five rounds of water level measurements have been obtained from onsite monitoring wells between mid-August and early September (in 2003 and in 2004). As such, potential seasonal fluctuations in the water table beneath the site are unknown. Three rounds of site wide water level measurements from the five existing monitoring wells are proposed for January 2008, February 2008, and March 2008 as part of the pre-design process.

In addition, the tidal influence on the water table beneath the Site is not known. Continuous electronic water level measurements from onsite monitoring wells MW-2 and MW-5 is proposed for a 48 to 72 hour period in order to evaluate the tidal influence on water table elevations. In the event that LNAPL and/or non-aqueous phase liquids (DNAPL) are present within well MW-2, water levels will be monitored in MW-3 instead.

4.4 Establishment of site work zone

Prior to commencement of subsurface activities, the Site work zone will be established. In order to separate work activity from students and school personnel, fencing will be used to enclose two separate work areas onsite as shown in Figure 4-1: the approximate 60 x 70 foot southernmost courtyard immediately east of the school building, and an approximate 40 x 40 foot area in the grass near FDR Drive. All equipment and supplies will be staged within the secure fenced work areas. Additional space for vehicle parking may be required. Visual blinds will be installed if necessary.

It is anticipated that a temporary locking gate will need to be installed in the fence to provide separate access to the work area to and from E. 116th Street. A sidewalk permit may be required from the NYC Department of Transportation (NYCDOT). In order to install the gate, the black wrought iron fence along E. 116th Street will need to be cut. The potential for lead based paint on the fence is not known. Therefore, similar to the previous work completed onsite in 2003, a subcontractor will be hired to cut through the fence using the appropriate lead based paint mitigation procedures. The same contractor will be hired to restore the fence upon completion of work.

4.5 Underground utility clearance

A mark-out of underground utilities in the proposed drilling locations and excavation areas will be requested for the site from the One Call Center for the New York City-Long Island Area (1-800-272-4480) at least 72 hours prior to the initiation of drilling or excavation activities. Intrusive field work will not begin until the required utility clearances have been performed. Because public utility clearance organizations typically do not mark-out underground utility lines that are located on private property, an M-scope survey will be conducted by Con Edison and/or a private utility survey contractor, in the vicinity of each proposed drilling location to identify any buried utilities at the school property. Based on the utility clearance information obtained by ENSR during the RI, a number of locations at the Site are already known to be clear of utilities. This information will be reviewed and augmented during the utility clearance process. In addition, some or all of the following steps may be taken in an attempt to identify on-site private utilities:

- Obtain any available as-built drawings for the areas being investigated from the property owner;
- Visually review each drilling location with the property owner or knowledgeable site representative;
- Hire a private line- locating firm to determine the location of utility lines that are present at the property;
- Hand or vacuum excavate in the proposed drilling locations to a depth of at least five feet below grade surface to confirm the absence of the utility lines.

4.6 Tree removal

At this time, it is not anticipated that any existing trees will need to be removed as part of the well installation activities. If it is determined that tree removal is necessary based on physical limitations that could dictate the placement of the horizontal wells (i.e., piling alignment, distance of the entry point(s) from the school, utility locations, test pit excavations, etc.), approval will be obtained in advance from the DOE.

4.7 Community air monitoring

Air monitoring will be conducted during test pit excavation activities to provide protection for site workers, the building occupants, and the downwind community. The air monitoring activities will include community air monitoring, which is described below, and worker air monitoring which will be conducted during all of the investigation activities as described in the community air monitoring requirements from the NYSDOH Generic Community Air Monitoring Plan (CAMP).

Community air monitoring during test pit excavation activities is intended to provide a measure of protection for the downwind community (i.e., off-site receptors and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels provided in the CAMP require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Community air monitoring is not intended for use in establishing action levels for worker respiratory protection. Issues relating to worker health and safety are evaluated in the site Health and Safety Plan (provided as Appendix A).

VOCs will be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis during excavation of test pits and demolition of contaminated or potentially contaminated structures. Periodic monitoring for VOCs is allowed using a photoionization detector for non-intrusive activities (e.g., surface soil sampling, groundwater sampling, remedial monitoring, etc.). Upwind concentrations will be measured at the start of each workday and every two hours thereafter to establish background conditions. The air monitoring will be performed using organic vapor meters equipped with a photionization detector. Equipment will be calibrated, at a minimum, at the start of each workday for the contaminant(s) of interest or for an appropriate surrogate. The equipment will be capable of calculating 15-minute running average concentrations, which will be compared to the levels provided in the CAMP. All readings will be recorded and available for NYSDEC and/or NYSDOH personnel to review.

Particulate concentrations will be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The monitoring will be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes for comparison to the airborne particulate action levels provided in the CAMP. In addition, fugitive dust migration will be visually assessed during all work activities. All readings will be recorded in a bound field notebook and or field worksheet. Other constituents will be monitored in accordance with the site CAMP.

Given that the generation of fugitive dust and/or vapors from the installation of the horizontal wells and the vertical monitoring wells will be minimal, continual community air monitoring will not be performed during these activities. Air monitoring of the worker breathing zones will be monitored within the work zone per the site HASP.

4.8 Test pit excavation

A large amount of debris (bricks, concrete, and piping) as well as intact brick and concrete foundation structures associated with the former gas purifier house are present in the subsurface immediately east of the school adjacent to the gas holder. The presence of the debris will likely jeopardize the integrity of the boreholes and the intact concrete structures present impenetrable obstacles for the angled drill head. As such, excavation is planned at the location shown on Figure 4-1 in order to remove the debris and to the extent practical, demolish the intact foundation structures (walls and floors) to clear the path for the horizontal boreholes.

Based on the proposed entry point for the deep horizontal wells, the anticipated size of the excavation is 70 feet x 25 feet to an anticipated depth of 10 to 12 feet. An estimated volume of 750 to 1,250 cubic yards of material will be excavated in stages. The material may be temporarily stockpiled on plastic sheeting adjacent to the hole for re-use or will be direct loaded for transport and offsite disposal. Excavation will likely be completed using a track mounted excavator. A jackhammer attachment for the excavator will be required to break up the concrete walls and floors to facilitate removal. If intact concrete structures are present beneath the water table, localized dewatering may be required in order to remove the structures. Soil will need to be characterized prior to removal in order to determine an applicable disposal method.

The presence of asbestos-containing pipe wrap material in the subsurface was confirmed in a test pit in this area. Therefore, all necessary approvals will be obtained and appropriate asbestos abatement procedures will

be followed during test pit excavation as part of the pilot study. At a minimum, dust suppression measures in the form of a water spray will be implemented as needed during test pit excavation. When the pipe containing the wrap is encountered, it will be soaked with water, excavated, and separately containerized for disposal in accordance with applicable regulations.

Once the debris and structures have been removed, soil will be excavated to expose and visually confirm the depth of the building footer and the alignment of the structural pilings. Markings will be installed at grade to identify the piling alignment once the excavation is backfilled. If possible, the wall of the gas holder will be exposed above the water table in order to confirm the location, construction, and condition of the wall. If feasible, portions of the gas holder wall may be removed at this stage in order to facilitate drilling of angled monitoring points into the holder, since penetration of the wall will be difficult with angled drilling methods.

Additional excavations to the east may be required in order to identify and/or remove debris and intact walls and/or floors associated with other former MGP structures still present in the subsurface. The need for these additional excavations will be determined based on the calculated entry points for the horizontal wells.

Upon completion of these activities, clean backfill will be brought in to backfill the excavation in lifts. Each lift will be compacted using an attachment to the excavator arm. Low permeability silt or clay backfill will be required in order to avoid the potential for subsidence and/or sink hole hazards that could arise if drilling fluids permeate a porous backfill material. If not visibly impacted with MGP residuals (oils or tar) or large debris (bricks or cinder blocks) some of the excavated debris may be used as backfill providing that it is cohesive enough to not adversely impact the drilling operations.

The excavation and backfilling work will require approximately one week to complete. Although the excavation area will be cordoned off, it is anticipated that normal school activities can go on during the work. Some excavation work may be conducted on weekend to minimize noise impacts to the school operations.

4.9 Vertical monitoring well installation

Once the horizontal extraction/treatment wells are installed, the potential exists for tar to leak from the large gas holder through the borehole around the well casing. To reduce the potential for tar leakage, the driller will inject a grout seal around the well pipe outside the wall of the gas holder prior to development of the horizontal wells.

In addition, installation of two vertical monitoring wells is planned immediately east of the school building and downgradient of the gas holder as shown in Figure 4-1. The vertical wells will be installed to the clay layer between 25 and 30 feet below surface grade and constructed of 4-inch diameter Schedule 40 PVC (Figure 4-1). It is anticipated that the well(s) will include a 10-foot screen interval set just above the clay and a two-foot sump set into the clay. This well construction should provide the ability to monitor for the presence of coal tar, if any, leaking from the gas holder and the ability to actively recover tar, if detected in the well, in order to prevent further migration.

Installation of the vertical monitoring wells will be completed after completion of the test pit excavation and in advance of the horizontal well installation, to the extent practical, depending on the alignment of the horizontal wells and the proposed installation procedures for the sumps as discussed in Section 4.13.

4.10 Pilot borehole advancement

Prior to commencement of horizontal drilling, preparatory activities will include the excavation of a 4x4x4 foot hole at the entry point. The likely drill rig to be used is a Ditch Witch 2720, or similar. Support equipment includes a vacuum trailer (approximately 1,000 gallon capacity), a box truck for storage of supplies, and two to four lined roll off boxes (40-yard capacity). An onsite water supply will be required for the drilling operations. It

is assumed that the driller will obtain a hydrant permit to obtain water. It is anticipated that the drilling and well installation and development operations will require a minimum of 6,000 to 8,000 gallons of water.

In order to achieve the desired depth of 24 feet for the deep wells, the required entry point is calculated to be approximately 105 feet east of the school. This distance is dictated by the bend angle of the stainless steel well material. This will require that the drill rig and support equipment be staged in the grass close to the fence along the FDR Drive. A schematic diagram of the HDD boreholes is provided in Figure 4-2. It is anticipated that the shallow well will be installed in line with and above the deep well. The calculated entry point for the shallow well is approximately 40 feet east of the school building, which is based on a target depth of 12 feet beneath the building.

A pilot borehole must be advanced to allow for the installation of a horizontal well. Each borehole will be drilled "blind" meaning that there will not be an exit hole on the west side of the building. Use of an exit hole would facilitate well installation by allowing the well to be pulled into place instead of being driven through a blind borehole. However, it is not feasible to utilize an exit hole at the Site due to the limited space on the west side of the school as well as the presence of the small gas holder beneath the school building west of the large holder.

A 5-inch diameter pilot borehole will be advanced with wet rotary drilling methods. Mud will be used as the drilling fluid to maintain the borehole and to return the tailings to the entry point. It is anticipated that the mud will consist of a bentonite-polymer blend. The blend will be adjusted during drilling based on the progress of the borehole. Once the borehole is complete and the well installed, a deflocculant will be injected to break down the mud to facilitate removal during development.

Several drill bits are available for this application. A drill bit capable of penetrating the holder wall and debris both outside and within the holder will be required. The applicable drill bit will be determined during the planning stages. One limitation of the horizontal drilling method, similar to conventional drilling methods, is that steel structures, such as the building pilings or potential steel structures and debris within the holder, cannot be penetrated.

The target end point for the boreholes is to reach as far into the holder as possible in order to confirm the feasibility for future full scale treatment system installation. Ideally, the horizontal boreholes will be able to reach the western interior wall of the holder, a maximum distance of 80 to 90 feet beneath the building. However, if impenetrable obstacles or other limitations are encountered, the end point will be modified during drilling. The minimum acceptable penetration depth into the gas holder is 40 feet to make evaluation of the treatment options viable. A maximum of three attempts will be made to install a well 40 feet into the holder.

During advancement, the drill head depth and location will be monitored by electronic tracking equipment, which also provides accurate information necessary for making steering adjustments. Access to the basement of the school will be required in order to track the progress of the drill head.

Once the drill head has penetrated the holder wall beneath the building, the borehole will be sloped upward at an approximate one to two percent slope. This slope will allow tar to drain towards the eastern wall of the holder to facilitate monitoring and enhance the extraction and collection of tar in the deep well sump outside the building.

Once the drill head reaches the end point, the drill pipe will be removed from the borehole and the borehole will be back reamed to enlarge the diameter. The maximum possible final diameter of each borehole is 12 inches.

Based on the nature of the fill material, the volume of tailings to be generated from each borehole is difficult to estimate as the material may be lost into the pore space and/or voids within the fill. It is estimated that approximately 2,000 gallons of fluid (90% liquid and 10% soil/mud) will be generated during advancement of

the pilot boreholes. A portable vacuum system will be used to collect the drilling fluids and transfer them to lined water tight roll off boxes for temporary storage onsite.

4.11 Horizontal well installation and development

Once the blind borehole is complete and the drill pipe removed, the well screen and riser will be inserted into the borehole and pushed or driven to the completion depth. The debris present in the subsurface may pose a challenge when trying to drive the wells through the boreholes. Use of stainless steel material, as opposed to PVC, HDPE, or FiberglasTM, is required to avoid damaging the well while pushing or driving it into the borehole. Stainless steel material is also required to allow pilot testing of the heating and chemical injection options.

Well construction details are depicted in Figure 4-2. The intent is to screen the entire length of the horizontal wells within the gas holder. Screen length will be adjusted based on the actual distance of penetration into the holder and will range from 30 to 80 feet in length. The remainder of the well will be solid riser from the holder wall to the surface entry point. Traditional slotted screen or wire wrap screen will not withstand being driven into the borehole. Therefore, vertical slots or drilled holes will be required. The screens will be specially designed and machined for this application with appropriate slot size and configuration. The screens will be manufactured in sections, the lengths of which may be varied to allow maximum flexibility for adjusting screen length depending on depth of penetration into the holder.

Installation of a filter pack is not possible with a horizontal well. As such, the selection of the slot size will be critical to avoid entrainment of fines into the wells.

In order to pilot test the in-situ heating treatment alternative, two additional well points will be required. Ideally, 2 to 3-inch diameter solid (non-slotted) carbon steel points will be installed to be used as heater wells along side the deep extraction well. There are three possible options for installation of the heater well pipes, with the third option being the most suitable for the pilot study applications:

- 1) within the same borehole as the 6-inch extraction well, in which case the pipes will be in contact with the 6-inch extraction well;
- 2) in separate boreholes advanced approximately 2 feet on each side of the 6-inch extraction well; whereby the potential for deflecting into the neighboring borehole of the 6-inch extraction well exists if large debris or structures are encountered; or
- 3) in separate boreholes located approximately 1-foot below and to the side of the 6-inch extraction well; whereby the potential to deflect into the borehole of the 6-inch extraction well is reduced, although the possibility for deflection in other directions still exists.

After installation, the wells must be developed. Development is typically achieved by using water jetting techniques to flush and remove drilling mud and tailings through the borehole annulus to the entry point where it is then collected with a portable vacuum system. If the well is drilled through porous fill material, which is the case here, minus the area to be excavated and backfilled, the mud and tailings can be lost into the fill material. Therefore, the water jetting method may flush tar from the holder up the borehole and into the subsurface outside the holder. In order to reduce this potential, the potential for development via vacuum extraction through the well will be evaluated. Aside from the limitation of the vacuum lift from a depth of 24 feet, the effectiveness of the vacuum extraction method will be further limited by the need to lift a tar/water mixture. Given that the extraction well is 6 inches in diameter, water jetting and vacuum extraction may be performed concurrently to achieve removal of mud and tailings with a reduced potential for jetting tar out of the holder.

To reduce the potential for tar to leak or be jetted out of the holder, a grout seal may be placed outside the holder wall prior to development. Grout would be injected through tremie pipe inserted through the borehole

annulus in an attempt to seal the gas holder wall around the well pipe. The placement of this grout seal would not be exact and no guarantee can be made that it will be completely successful. The grout would need from a minimum of 24 hours and up to 72 hours to set. The timing of the grout injection would be dependant on the development method selected.

During development, a deflocculant will be injected to break down the mud to facilitate removal. The potential for residual drilling mud to smear the borehole or clog the screen interval is not considered significant.

It is estimated that 2,000 gallons of development water and mud will be generated from each horizontal well. A portable vacuum system will be used to collect fluid during development. The collected fluids and mud will be contained within lined water tight roll off boxes for temporary storage onsite.

A secure manway will be installed flush with the ground at the entry point of each deep horizontal well and heater well to allow access for pilot testing activities. In addition, the deep well will be fitted with sumps and vertical pipes adjacent to the building as described in Section 4.13 and as shown in Figure 4-2. The shallow well will be truncated just outside the school building within a sump as described in Section 4.13 and as shown in Figure 4-2. Because of the noise of this operation, work may have to be conducted during weekends or evenings.

4.12 Installation of angled monitoring points

Once the installation of the horizontal wells including the shallow and deep sumps adjacent to the building is complete, two angled monitoring points will be installed as shown in Figure 4-2. The purpose of these angled points will be to monitor temperature within the holder.

Direct drilling through the holder wall would be difficult as the drill head would glance off the holder wall. In order for these points to be installed through the holder wall, holes will need to be pre-cut in the holder wall during the test pit excavation work, which may or may not be feasible depending on the depth to water, the actual location of the holder wall, and the depth at which the points need to penetrate the wall.

If installation is feasible, it is anticipated that these monitoring points will be constructed of 2-inch diameter stainless steel, with a 10 foot screen section and finished with a flush mounted road box at grade. If installation of the angled wells is not possible, the shallow horizontal wells will be used for monitoring temperature in the holder.

4.13 Installation of sumps

Following completion of the horizontal wells beneath the building, sumps will be installed at a distance of approximately 10 feet from the building. Location of the horizontal wells will be accurately determined by the driller. The sumps will be installed approximately 10 feet east of the school building. The excavation firm will likely use a trench box to advance the excavation to the location of the horizontal well. The shallow horizontal well will be approximately 11 to 13 feet below ground surface. The shallow well is slightly below the water table and installation of the sump will require limited dewatering. Water will be pumped to a storage tank and later sent to an off-site treatment facility. For the shallow horizontal well, the pipe will be cut through and a valve installed. The valve will be designed so that it can be actuated from the ground surface. The sump structure will be grouted where the pipe comes in and sealed to be water tight. A gasketed and locking manhole cover will be installed.

The deep sump installation will be similar to the shallow sump. A trench box or timberbox will be used to advance the excavation to the target depth of 27 feet below ground. Excavation dewatering will be required. A no-leak saddle will be installed over the horizontal pipe. A valve and 4 inch riser pipe will be installed to allow inspection and pumping of NAPL and water from the deep horizontal well.

4.14 Investigation derived waste

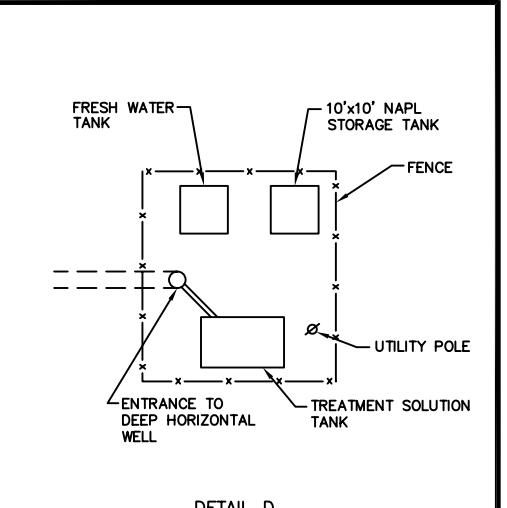
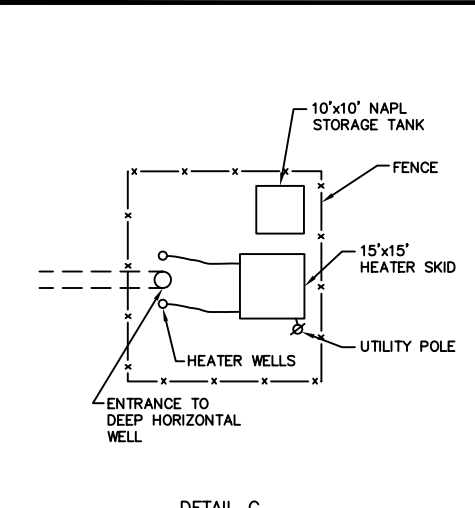
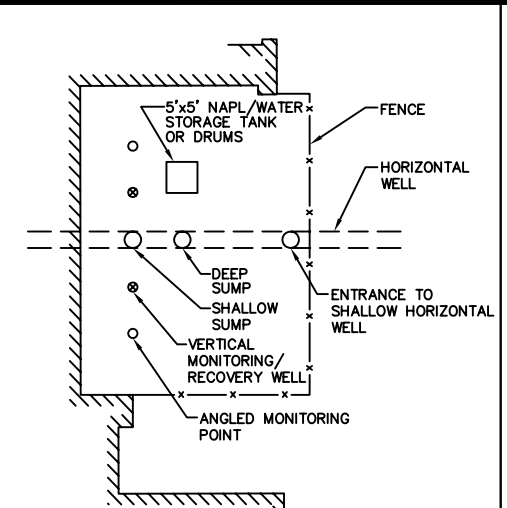
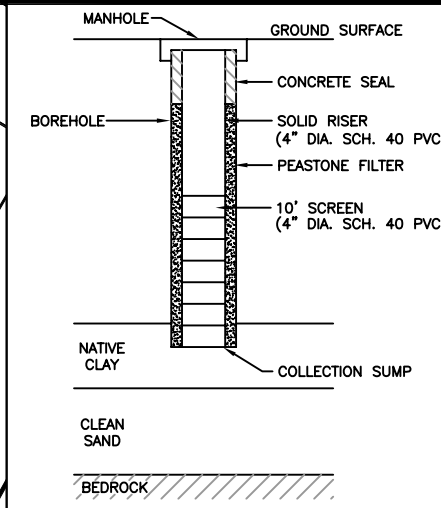
It is anticipated that waste materials will be generated during the field program. These materials include:

- Drill tailings (soil and mud);
- Drilling fluids and well development water; and
- Used personal protective equipment (PPE).

Drill tailings and drilling fluids will be contained within lined water tight roll off boxes (40 yard capacity) onsite. It is anticipated that the fluids would be removed via vacuum truck and the remaining soupy mud and tailings mixture solidified prior to transport and disposal. Used PPE will be contained within Department of Transportation (DOT) approved 55-gallon drums. All IDW will be temporarily stored onsite prior to disposal at a licensed Con Edison-approved disposal facility.

Composite samples of the soil/mud IDW will be collected and analyzed for some or all of the following: TCLP VOCs (Toxicity Characteristic Constituents), TCLP SVOC (Toxicity Characteristic Constituents), TCLP Metals (Toxicity Characteristic Constituents), TPH, PCBs and reactivity. A representative sample of the IDW fluids will be collected and analyzed for the same parameters, in addition to corrosivity. It is noted that only the compounds, chemicals, etc. that have a toxicity criteria under the Resource Conservation and Recovery Act (RCRA) will be reported for the waste characterization samples.

The volume of drill tailings (soil and mud) is difficult to estimate and could range between 10 and 80 yards. It is estimated that approximately 6,000 gallons of IDW fluids with an estimated 10 to 30% solids will be generated during the field program.

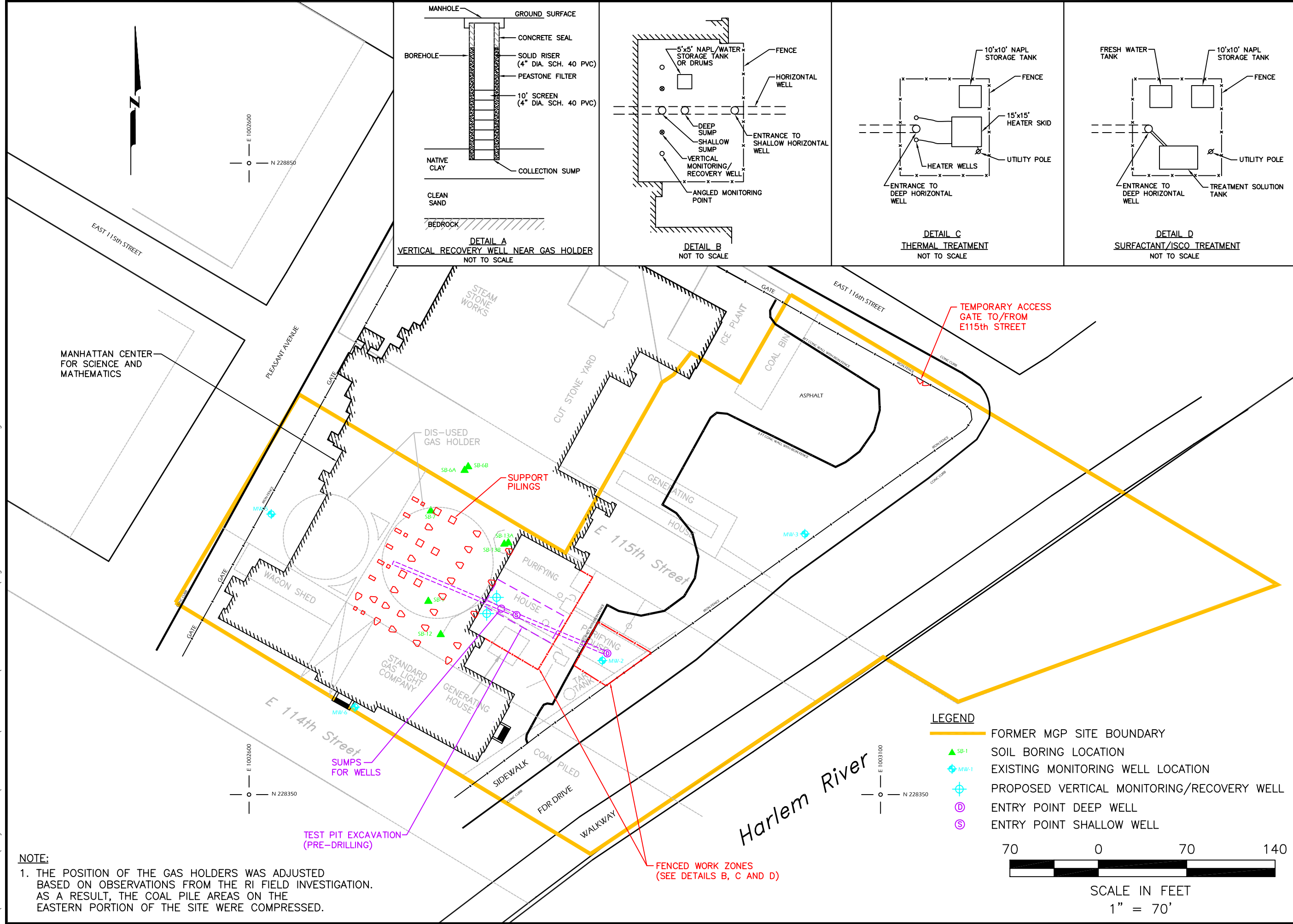


DETAIL A
VERTICAL RECOVERY WELL NEAR GAS HOLDER
NOT TO SCALE

DETAIL B
THERMAL TREATMENT
NOT TO SCALE

DETAIL C
THERMAL TREATMENT
NOT TO SCALE

DETAIL D
SURFACTANT/ISCO TREATMENT
NOT TO SCALE



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NOTE:
1. THE POSITION OF THE GAS HOLDERS WAS ADJUSTED BASED ON OBSERVATIONS FROM THE RI FIELD INVESTIGATION. AS A RESULT, THE COAL PILE AREAS ON THE EASTERN PORTION OF THE SITE WERE COMPRESSED.

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| CHECKED BY: | S.O. | | | |
| APPROVED BY: | D.S. | | | |

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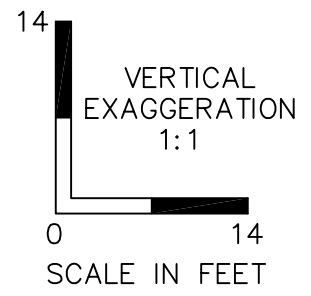
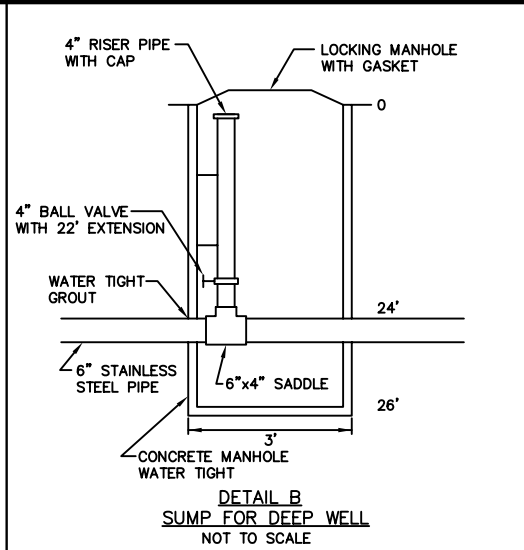
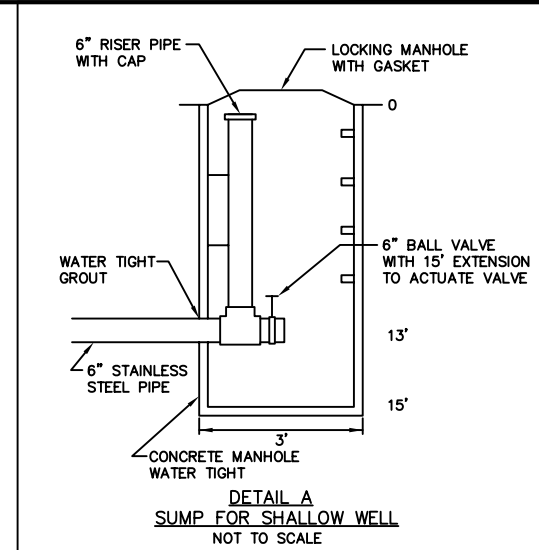
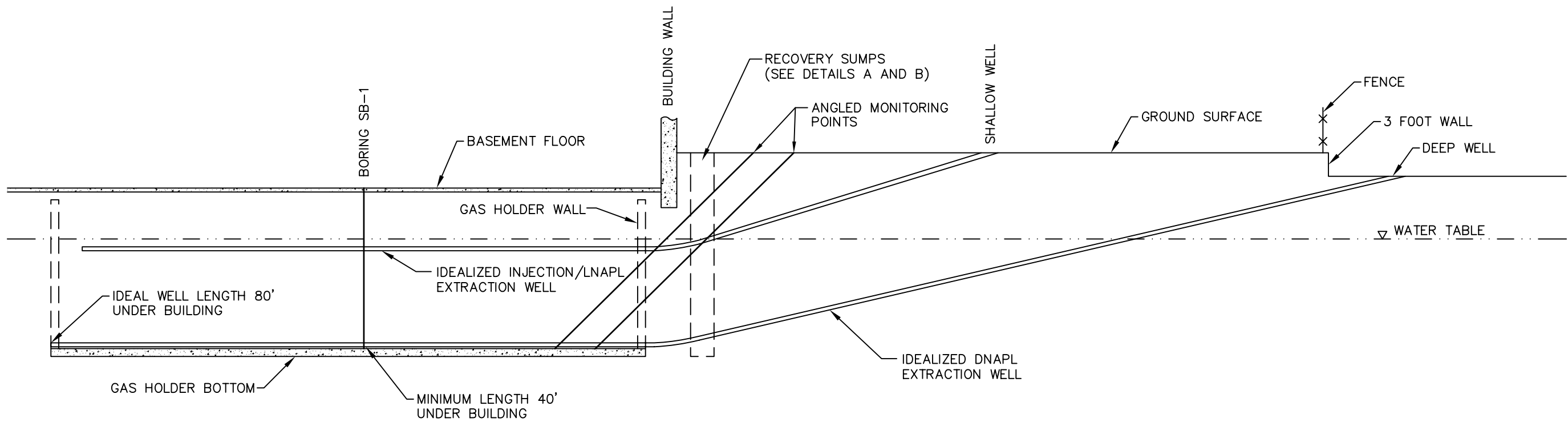
PILOT STUDY ACTIVITIES
CONSOLIDATED EDISON
FORMER MGP
EAST 115TH STREET FORMER MGP
NEW YORK, NY

SCALE: 1" = 70'
DATE: 11/07
PROJECT NUMBER: 01869-115-400

FIGURE NUMBER:
4-1

SHEET NUMBER:
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PROPOSED HORIZONTAL WELL
 INSTALLATION DETAILS
 CONSOLIDATED EDISON
 FORMER MGP
 EAST 115TH STREET
 NEW YORK, NY

SCALE: AS SHOWN DATE: 11/07 PROJECT NUMBER: 01869-125-400

FIGURE NUMBER:
4-2

SHEET NUMBER:
 1

5.0 Monitoring for tar recovery prior to enhanced recovery tests

After the horizontal wells and the new vertical wells are installed and developed, monitoring for the accumulation of LNAPL and DNAPL will be conducted. Measurements will be made monthly for the three months prior to the start of enhanced NAPL removal testing. This data will provide a baseline when assessing the effectiveness of enhanced NAPL recovery methods.

Inspection for LNAPL in a horizontal well presents some challenges. The horizontal well will be installed slightly below the water table. A sump will be used to drain the shallow horizontal well and to inspect for LNAPL. The sump design is shown in Figure 4-1. The sump includes a 6" inch riser pipe, a ball valve that can be actuated from the ground surface, and a two foot deep sump for collection of water and LNAPL. The procedure for testing for LNAPL will be as follows:

- Use an interface probe to check for LNAPL and water level in riser pipe.
- Open valve and observe filling of sump. In theory, draining of the horizontal well will draw the water table down slightly and pull LNAPL into the horizontal well. Conduct visual observation for LNAPL as the sump fills.
- Allow sump to reach equilibrium and inspect for LNAPL. Measure thickness of LNAPL, if present.
- Close the valve. Pump the sump dry. Store water in 55 gallon drums (2) and dispose of at off-site treatment facility.

LNAPL measurements will be made once per month in the shallow horizontal well and the new vertical wells.

Inspection for DNAPL in the deep horizontal well will be conducted by pumping liquid from the low point in the well and observing the effluent for DNAPL. A submersible pump will be installed inside the deep horizontal well at a point just inside the gas holder. A piston pump specially designed for pumping viscous tar will be utilized (Blackhawk Anchor 101 pump or similar). The piston pump will be set for a low flow rate (0.05 gallons per minute or less). Extracted liquid will be discharge to 55 gallon drums. Pumping will be conducted over a 24 hour period. A float control switch will be interlocked with pump operation. Liquids in the 55 gallon drums will be inspected for DNAPL. If a large amount of DNAPL is being extracted (20% or more of the drum volume) installation of a larger tank and continuous extraction will be conducted.

The deep horizontal well design also includes a sump and riser pipe (see Figure 4-1). The riser pipe will allow monthly inspection for DNAPL. However, extraction of liquids directly from the bottom of the gas holder using the submersible pump is expected to provide more reliable data.

6.0 Enhanced recovery by thermal processes

6.1 Theory of thermal recovery process

The coal tar present at the base of the holder is at a temperature of approximately 50°F. At this temperature the tar typically has a high viscosity. At higher temperatures the viscosity decreases. Based on bench studies conducted by ENSR on similar tars, at temperatures of 160°F the tar will become similar to a light motor oil and can be readily pumped. Based on bench studies by TerraTherm, a 10 to 20 fold reduction in viscosity can be expected going from 50 to 160°F. Thus, the proposed approach is to apply heat to the coal tar in the holder and thereby increase recovery of the coal tar. Heating will facilitate removal of oil already within the horizontal well. As the heating propagates away from the heater well coal tar absorbed to the soil and debris will become more mobile and more readily flow towards the extraction well. The proposed approach is to install heater wells adjacent to the extraction well. Coal tar in and around the extraction wells will be heated and extracted. The rate of NAPL extraction during heating will be measured and compared to baseline measurements of NAPL extraction (see Section 5).

It is possible that heating will generate LNAPL. This possibility will be tested in a bench test to be conducted with coal tar from the site. Also, the shallow well will be tested for LNAPL as heating proceeds. As the tar, soil and groundwater are heated, an increase in volatiles compounds and pressure below the building floor are possible. The subslab vent system will be operated thorough out the heating tests to capture volatile compound and to depressurize below the floor. The subslab vent system will also be used as a monitoring point to determine if heating is having any affect on the generation of volatiles compounds. Testing of air inside the building will also be conducted to assure the heating has no affect on indoor air.

One of the firms offering thermal treatment services is TerraTherm. TerraTherm has experience with in-situ thermal treatment to remove coal tar residuals from a gas holder. ENSR worked with TerraTherm to develop the pilot study procedures discussed in sections 6.2 to 6.6. The overall schedule for work is provided in Section 9.

6.2 Equipment and installation procedures

The plan for thermal treatment and monitoring is shown in Figures 4-1 and 4-2. Wells to support the thermal treatment test will consist of the following:

- One six inch stainless steel horizontal recovery well will be located at the bottom of the holder.
- Two horizontal heater wells will be located at the bottom of the holder. The heater wells will be 1 to 2 feet on either side of the recovery well. The heater wells will be 2 to 3 inch diameter carbon steel.
- Angle drilling will be used to install, to the extent feasible, two 2-inch diameter wells for temperature monitoring. These wells will be constructed of stainless steel.
- One six inch stainless steel horizontal recovery well will be located at approximately 13 feet below ground surface near the top of the water table. This well will be used for temperature monitoring and to monitor for LNAPL. However, propagation of heating from the bottom of the holder to this elevation and generation LNAPL during the pilot study appear to be unlikely.
- As discussed previously, the subslab venting system will be in operation during the heating. The subslab venting system will be monitored for an increase in VOCs during heating.

For the purposes of the pilot study, the heater wells will penetrate about 20 to 30 feet into the holder. This will provide ample heating area to determine the feasibility and effectiveness of the process. Heater elements, thermocouples, and controls will be installed into the two heater wells. Generally standard equipment used by

TerraTherm will be used. This includes 250 watt per linear foot heating elements with controls to allow operation at variable setpoints. Thermocouples will also be installed in the extraction wells and in the temperature monitoring wells. The submersible pump will remain in place and operating during the heating pilot test.

6.3 Site support requirements (space and utilities)

There will be two above ground work areas. First an approximately 40 by 40 foot area will be needed in the grassy area near the FDR drive. This is the entry point for the heater wells and the extraction wells. The area will be fenced in. A skid to power the heater elements, heater controls and monitoring equipment will be located here. Also, the controls and storage tank for the tar recovery system will be located in this area. The heater skid will require 440 volt, three phase electrical power. Sanitary facilities and potable water will also be needed to support the pilot test.

The second area will be in the courtyard just east of the school building. An approximately 20 by 20 foot fenced in area will be needed in this area. Access to the vertical recovery wells, angled thermal couple wells, and sumps for the horizontal wells will be in this area. Electrical service, a 110 volt service is needed for the control panel. Above ground storage of extracted groundwater and coal tar will also be present in this area.

6.4 Application procedures

As discussed in Section 5, baseline measurements of coal tar recovery prior to heating will be collected over a three month period before the heating pilot test. Also, baseline measurements of vapor in the subslab vent system will be made prior to the start of the heating tests.

Coal tar recovered during the baseline testing, if any, will be used for bench testing prior to the start of on-site heating tests. A small scale simulation of the heating process will be created in the laboratory. Heat will be applied to coal tar in a column covered with sand and water. Changes in tar viscosity, generation of LNAPL and generation of gases will be evaluated in the laboratory study. Data from the laboratory study will be used to determine test parameters for the on-site pilot study. If generation of gases or other potential safety issues arise during the laboratory testing, on-site testing of thermal treatment may be cancelled.

Prior to the start of heating during the on-site pilot study all instruments will be checked for proper operation and baseline temperature measurements will be made. A megger check will be made to ensure that there are no short circuits on the heaters. All electrical and ground connections will be inspected and verified. Controller programming will also be verified.

Heating will start by slowly increasing the heat in the two heater wells. Changes in temperature in the extraction well and nearby monitoring wells will be closely monitored. Testing at relatively lower heater power and higher temperatures will be tested. Maximum temperatures in the heater wells are 500-800°F. The maximum target temperature in the extraction well is 160°F.

During the first 10 hours the equipment will be continuously monitored by on-site personnel. TerraTherm operations staff will be on-site for the first two weeks to monitor operations and train ENSR staff (see schedule in Section 9).

6.5 In-process testing and monitoring

Monitoring will include the following

- Temperature rise in heater/extraction well, shallow vertical well, and the two angled temperature monitoring wells.

- VOC levels in subslab vent system – ENSR will use a PID, daily for one week then once a week.
- VOC levels inside building – PID readings daily during heating.
- The outside vertical monitoring wells/NAPL recovery wells will be inspected weekly for the presence of NAPL. NAPL will be removed during each inspection, if present.
- The shallow horizontal well will be inspected weekly for presence of LNAPL.

6.6 Monitoring tar recovery

The submersible pump will be operated continuously during the heating pilot test. The flow rate will be set to 1 gallon per minute or less. The rate of NAPL recovery and water recovery will be measured at least once per week. The color and apparent viscosity of the extracted liquids will be noted each week.

7.0 Enhanced recovery by *in situ* chemical treatment

7.1 Theory behind *in situ* chemical recovery process

In-situ chemical treatment enhanced removal of MGP coal tar or to destroy coal tar in place is an emerging technology. There are three basic mechanisms that chemical treatment may employ. These include direct oxidation and destruction of the organic compounds, increasing solubility of compounds to facilitate extraction, and enhancing biological remediation. Some chemical treatment processes also generate heat which can act to desorb tar from the soil and reduce the viscosity of the tar. Ideally, a chemical treatment would be designed to take advantage of a combination of the treatment mechanisms listed above.

The basic principal for this pilot study will be to inject chemical reagents and to continue DNAPL and LNAPL measurements and extraction. While increased NAPL recovery would be one measure of success, a means to determine if coal tar is being destroyed in place will also have to be developed. Some in-situ chemical treatments are very aggressive (exothermic) and create significant heat and steam generation. Use of a highly exothermic process is not compatible with site conditions. The selected chemical treatment process will be readily controlled and safe for application under the school while it is in use.

There are other technical challenges. Uniform delivery of reagent will be difficult. Use of vertical injection wells is incompatible with use of the school, only horizontal wells will be used. The soils are heterogeneous and filled with debris. Also, getting a reagent to penetrate the tar may be difficult. Reagent formulations that include surfactants and oxidants specifically designed to dissolve/degrade coal tar will be tested.

The Surfactant-Enhanced In-Situ Chemical Oxidation (S-ISCO™) process developed by VeruTEK appears to be best suited to the site conditions and the goals of the 115th Street project. The patent-pending S-ISCO™ technology uses biodegradable, food-grade surfactants (VeruSOL™). VeruSOL is a mixture of citrus-based co-solvents and plant oil-based surfactants. The co-solvent/surfactants are designed to solubilize immiscible organic compounds into groundwater. With the organic compounds now more soluble, they can be more readily extracted. Conversely, the solubilized organic compounds would be amenable to in-situ destruction. An oxidant such as persulfate would be injected either at the same time as the surfactant or as part of a separate injection after the surfactant injection to destroy the organic compounds in place.

In the case of the 115th Street project, the pilot study will be conducted in two phases. In the first phase only the co-solvents/surfactants (VeruSOL) will be injected via the deep extraction well. After a period of one to three days following injection of the co-solvents/surfactants, the extraction pump will be reactivated and the resulting liquids examined. Ideally, the recovered liquids will be an emulsion high in MGP constituents. Extraction would continue until the extracted fluid returns to the same consistency as before injection. Laboratory testing of organic compounds in the extracted emulsion will be used to determine the mass of MGP materials removed in the co-solvent/surfactant test phase.

In the second phase of testing, the co-solvent/surfactant injection would be repeated. A mild oxidant will also be injected in this test. A dilute persulfate solution is a likely oxidant for this test. This dilute oxidant formulation will not create the strongly exothermic reactions often associated with other oxidant formulations. Before injecting the oxidants at the site, a bench-top test using the extracted emulsion from the first phase of testing will be conducted. The purpose of this testing is to select the optimal oxidant and dose. In addition to measuring destruction of MGP materials, heat and gas generation will be measured in the bench top testing. On-site injection of oxidants will proceed after a safe and effective oxidant has been developed from the bench testing. The effectiveness of the oxidant will be determined by measuring VOCs and SVOCs before and after oxidant addition. A removal efficiency of at least 75% is needed for the laboratory testing to be considered a success.

If the laboratory testing indicates that oxidant addition is safe and effective, on-site pilot testing will be conducted. Effectiveness of the second phase of chemical treatment will be determined by sampling the angled monitoring wells inside the gas holder and the vertical recovery wells located just outside the holder. If the oxidant treatment is effective, the NAPL thickness (if any) present in the angled wells and possibly the outside recovery wells will be reduced. The concentrations of dissolved phase constituents in all wells before, during and after oxidant inject will be measured. Significant increases in mobile NAPL (as evidenced by accumulation in wells) or dissolved phase constituents would indicate that the chemical treatment process is working but needs to be supplemented with an active (pumping) NAPL and groundwater recovery system. No change from baseline measurements in the wells from treatment would indicate that the process is ineffective.

7.2 Equipment and installation procedure

The same wells installed for the thermal testing will be used for the chemical treatment testing. The wells and their purpose are as follows:

- The six inch stainless steel deep horizontal well will be used as the injection and recovery well for the chemical treatment tests.
- The two 2-inch angled wells will be used as monitoring points. Monitoring will include water levels during injection, presence of treatment reagents, chemical parameters indicative of treatment, measuring NAPL thickness, and collection of samples for laboratory analysis.
- The six- inch stainless steel shallow horizontal well will be used as a monitoring well for LNAPL. This well will be equipped with an extraction pump during the injection testing. In the unlikely event the water table or temperature rises too quickly, the pump will be activated. This well may also serve as an injection point in later tests.
- Vertical NAPL recovery wells installed outside will serve as monitoring points. These wells may also be used as active recovery wells.

Surface equipment will be located within the 40 by 40 foot fenced area on the lawn adjacent to the FDR drive. Equipment will include above ground tanks for potable water, treatment chemicals, mixing equipment, controls, and monitoring equipment. All tanks will be clearly marked and MSDS sheets will be on hand at all times. Additional precautions associated with storage and handling of treatment chemicals will be discussed in the health and safety plan. It is anticipated that treatment liquids will be applied by gravity flow alone (no pumping). Application will likely include a stinger pipe (a HDPE pipe installed within the injection well to the desired location for injection). As with the thermal treatment testing, only the first 20 to 30 feet of area within the gas holder will be treated in the pilot study. If the horizontal drilling is successful in reaching the full 76 foot target length under the building, an inflatable packer will be used to isolate the 30 to 76 foot screen interval.

7.3 Site support requirements (space, utilities)

The injection system will require an area of approximately 50 ft by 60 ft for set-up. Figure 4-1 shows an approximate layout of the S-ISCO injection system. The system includes 12' x 30' injection trailer, one 18,000 gallon Baker tank for water storage or continuous water supply connection two 1,100 gallon poly-tanks for VeruSOL™ and activator storage, and either one 4,500 gallon tanker truck or 3,650 gallon poly-tank for sodium persulfate storage. VeruTEK will require connection to the city water supply, as well as electrical connection to run system.

7.4 Application procedures

The injection process will be continuously manned and closely monitored. During the injection process the injected flow rates and concentrations will be changed such that the S-ISCO chemicals have maximum contact with the contaminants. Both process and performance monitoring will be conducted during the operation of the

injection system ensuring the proper amount of S-ISCO chemicals are being injected, as well as reaching the targeted areas.

In the first phase of testing, only the co-solvent/surfactant will be injected. The target injection volume in this first test is 6,000 gallons (a 30 by 10 by 10 foot area around the injection well, assume 30% aquifer porosity). The maximum allowable injection rate is 3 gallons per minute. Inject will likely be conducted over three 12 hour period (a total of three days). The actual injection volume and rate of injection will vary depending on aquifer conditions and in process monitoring results. Two to three days following injection, the extraction well in the deep horizontal well will be activated. The extraction rate will be approximately 2 gallons per minute. Extracted fluids will be visually inspected (approximately every 100 gallons) and sampled for laboratory analysis (every 1,000 gallons). It is anticipated that 6,000 to 10,000 gallons of liquid will be extracted. Extraction may be terminated earlier if the appearance of the liquid returns to baseline conditions earlier. A sample of the emulsified liquid will be collected for use in bench top testing.

The formulation and volume of oxidant to be injected in the second phase of testing will be determine based on bench testing of liquids recovered from the first phase of testing. In the bench top testing various formulations and doses of oxidants will be tested. Of the many potential oxidants available for use, Fenton's formulations are expected to be too exothermic (generating gas and heat) and will not be tested. Permanganate, due to its high mobility and purple color also has been eliminated from consideration. Other oxidants include persulfate and percarbonate formulations. The tendency for persulfate regents to attack clay is a concern because the clay unit below the holder may be acting to prevent downward migration of coal tar. However, the concentration of reagent is expected to be too low to have this affect.

To test effectiveness of reagents in the bench test, total volatile organics and total semivolatile organics in the tar emulsion will be tested before and after treatment. A removal efficiency of at least 75% is necessary in the bench testing to be considered a success. Changes in the composition of organic compounds (high molecular weight compounds verses lower molecular weight compounds, etc) will also be noted. The bench testing will also include measuring temperature changes and evolution of gasses. Treated samples will be examined for the generation of precipitates. Also, dissolved metals before and after testing will be measured. The bench top test results will be closely reviewed to assure that a safe and effective reagent is selected. If safety and effectiveness has not been demonstrated in the bench scale, on-site inject will not be conducted.

Injection of the oxidant/co-solvent/surfactant solution will also be by gravity and at a rate not to exceed 2 gallons per minute. The volume of oxidant will be determined based on the bench top studies. The volume of oxidant is expected to be less than 6,000 gallons. Oxidant is expected to be injected over a 3 day period. The operation will be continuously manned. It is anticipated that the injections will occur starting on a Friday and continuing during a weekend. Injections will occur during daytime hours, monitoring will be done continuously including evening hours.

7.5 In-process monitoring and testing

Monitoring during injection tests will include:

- Continuous monitoring of water levels within the injection wells will be conducted to assure reagents do not rise to the ground surface.
- Injection flow rate and total volume injected will be tested.
- Continuous monitoring of water levels within the two angled wells, the shallow horizontal extraction well and outside vertical extraction wells will be conducted. Given the fact that the water table is 6 feet below the school floor, injection will be slowed down or terminated if a rise in the water table of more that 2 feet is detected.

- During oxidant injection, the temperature in the angled wells will be monitored (injection will be discontinued if the temperature rises by 20°F)
- VOC levels in the sub-slab venting system will be monitored during injection and daily for three days after injection.

As discussed previously, extraction of fluids will be conducted after the co-solvent/surfactant injection. Visual observations will be made every 100 gallons and water will be sent for laboratory analyses every 1,000 gallons. Laboratory analyses will include total volatile organics and total semi-volatile organics. Water and NAPL from the shallow horizontal well, angled wells, and outside vertical wells will be visually inspected during and for three days after the injection/extraction testing.

8.0 Health and safety plan

Site specific health and safety plans (HASPs) for each of the stages of the proposed work will be prepared. The plans will comply with the Occupational Safety and Health Agency (OSHA) Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120). The HASPs will include personnel contact information and responsibilities, summaries of proposed work, hazard assessments, air monitoring requirements, requirements for personnel protective clothing, site control requirements, decontamination procedures, medical surveillance and training requirements, and emergency response requirements.

Detailed HASPs will be prepared by ENSR and the subcontractors for each stage of work. Separate HASPs are expected to include;

- Drilling activities (vapor wells within the building and horizontal and vertical wells outside the building)
- Excavation, soil stockpiling and disposal
- Passive recovery of LNAPL and DNAPL
- Testing of In-Situ Heating
- Testing of In-Situ Chemical Treatment

HASPs will be prepared by health and safety specialists and reviewed by the project manager. In addition to OSHA requirements, ConEd and ENSR safety policy and procedures will be followed.

9.0 Conceptual Schedule

The conceptual schedule for pilot study activities is provided as Table 8-1. The actual schedule will depend on input from all stakeholders. To the extent practical work will be conducted during school breaks, weekends, and evenings.

Table 9-1 Conceptual Pilot Study Schedule

| Activity | Date | Notes |
|---|------------------------------|---|
| Pilot Study Work Plan to NYSDEC | December 2007 | |
| NYSDEC Approval of Pilot Study Work Plan | February 2008 | |
| Obtain any necessary permits – Drilling, Underground injection Control, Construction | March 2008 | |
| Drill Vertical Wells for Sub-slab Vent System | March 2008 | Two days to complete, cafeteria can not occupied during drilling. Wells could be installed at night. Can be schedule to coincide with school break. |
| Complete Piping Runs for Sub-slab Vent System | March 2008 | Three days to complete, cafeteria can not be occupied during work. Could be completed over a weekend or during school break. |
| Install blower and activate Sub-slab vent system | March 2008 | One day. Could be conducted while school is occupied. |
| Excavate Outside to Locate Building Support Pilings. Includes removal of MGP structures and backfilling | April 2008 | Five days. Could be conducted while school is occupied but may be a noise distraction, will work weekends/evening or school breaks to extent practical. |
| Install Vertical wells outside | April 2008 | Three days to complete. |
| Horizontal Drilling 2 wells each 200 feet long, one well 25 feet deep and one 12 feet deep. | April –May 2008 | Two wells in two weeks. Set-up and outside drilling can occur while cafeteria occupied. When drilling under building, cafeteria should not be occupied. Drilling can be conducted nights and over weekends. |
| Install Sumps | May 2008 | One week. Work can be conducted while school is occupied but may be a noise distraction. |
| Monitor Tar Recovery Without Enhanced Recovery | June – August 2008 | All outside work, no impact on school activities. |
| Conduct Bench Top Studies of Heating and Solvent Extraction | June – August 2008 | |
| Set-up for Heating or Reagent Injection | Early August 2008 | One week |
| Initial Heating or Reagent Injection | Summer Recess August 2008 | Two weeks, cafeteria must not be occupied during initial two weeks |
| Continue Heating/Injection and Monitoring | September – November 2008 | Three months. All outside work (except testing vent system) no impact to school activities. |
| Report on Pilot Studies | December 2008 | |
| Additional Studies (if recommended) | To be determined | |
| Revised Remedial Action Selection Report to NYSDEC | February 2009* | * assumes no further pilot testing necessary |

Appendix A

Site Health and Safety Plan (HASPs)

To Be Provided Prior to the Start of Field Activities

Appendix B

Preliminary Structural Evaluation

ENSR plans to install two horizontal wells to recover water and non-aqueous phase liquid (NAPL) from a former gas holder foundation. The gas holder is located beneath the Manhattan Center for Science and Mathematics' (MCSM) basement at East 116th Street, New York, New York. A preliminary evaluation of possible structural damage to the Center caused by the drilling or pumping is provided below. This includes: a summary of existing conditions; a description of potential structural impacts, and a list of measures to control structural impacts.

Existing Conditions

The MCSM's building foundation includes 240 pile clusters and a reinforced concrete slab (Foundation Plan, Benjamin Franklin HS Manhattan, May 13, 1940). The pile clusters contain one to six concrete filled steel pipe piles covered with a reinforced concrete pile caps. The design drawings indicate that the piles extend to bedrock approximately 40 feet below ground surface. It is not clear from existing documentation if the piles are end bearing, friction, or a combination of both. The slab is at basement level (approximately four feet below ground surface) and includes eight to 12 inches of concrete with ½-inch diameter steel reinforcement 24-inches on center both ways.

The gas holder is approximately 90 feet in diameter and the holder bottom is approximately 20 feet below the basement floor slab. The exact configuration of the gas holder structure is unknown, but soil borings and test pits indicate that it consists of brick walls with a concrete bottom. The exact number of pile clusters present within the footprint the gas holder has not been determined. It is not known if these piles are found on the holder bottom or if they extend through the gas holder bottom to bedrock.

Two boring installed inside the holder indicate that it is filled with sand, gravel and debris. Water was encountered approximately six feet below the basement floor slab. The water level was consistent with the groundwater level observed at other location of the Site. NAPL was observed in the bottom of the gas holder.

The two wells will be installed with horizontal drilling techniques and will be six-inches in diameter. Water and NAPL will be pumped from the horizontal wells and may lower the water table beneath the building. Soils beneath the building may also be heated to enhance NAPL recovery.

Possible Structural Impacts

Possible structural impacts to the Center building caused by installation of the recovery wells, lowering of the groundwater table, or heating of the soils include:

- Damage to a pile cluster from direct contact during horizontal drilling
- Drilling vibrations causing cracks in the interior or exterior building wall or slabs
- Ground subsidence induced by lowering the water table will cause the basement floor slab to settle
- Ground subsidence induced by lowering the water table will cause a pile or pile cap to settle and
- Pressure increases due to heating will cause cracks in the basement slab

Control Measures

A structural engineer registered in the State of New York should be retained to evaluate possible structural impacts in detail. Other measures to control structural impacts include:

- Review existing design documentation to determine the number of piles inside the holder limits and determine where these piles are founded
- Use existing design documentation, observed column spacing, survey, and test pits along the building exterior to establish the pile alignments across the holder

- Have the structural engineer inspect and document structural conditions prior to conducting the work
- Have the structural engineer establish the range of acceptable vibrations for the building
- Conduct vibration monitoring in the building basement during drilling as recommended by the structural engineer
- Have the structural engineer establish an acceptable range of water table drawdown.
- Monitor water levels inside and outside the holder during pumping
- Install strain gauges at pile caps and monitor settlement during pumping as directed by the structural engineer.