Prepared for:
Consolidated Edison Co. of New York, Inc.
31-01 20th Avenue, Astoria, NY 11105

Remedial Investigation Report
Stuyvesant Town
Former Manufactured Gas Plant Sites

Former East 14th Street Station Site (NYSDEC Site #V00535),
Former East 17th Street Station Site (NYSDEC Site #V00541), and
Former East 19th Street Station Site (NYSDEC Site #V00542)
New York, New York

VCA Index D2—0003-02-08

AECOM, Inc.
October 2009
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Executive Summary

As required under the terms of Voluntary Cleanup Agreement Index N. D2-0003-02-08 (VCA) by and between the New York State Department of Environmental Conservation (NYSDEC) and Consolidated Edison Co. of New York, Inc. (Con Edison), this report presents the results and findings of the remedial investigation (RI) that was performed on Con Edison's behalf by AECOM Environment ([AECOM] formerly ENSR Corporation [ENSR]), for the former manufactured gas plant sites (MGP) of the East 14th Street Station (NYSDEC Site #V00535), East 17th Street Station (NYSDEC Site #V00541), and East 19th Street Station (NYSDEC Site #V00542) sites located in the borough of Manhattan in New York City, New York. Except as otherwise indicated, the RI was conducted in two phases and in conformance with GEI's NYSDEC-approved RI Work Plan dated February 2006 and with AECOM's NYSDEC-approved supplemental RI Work Plan dated May 2008 (ENSR, 2008).

As approved by the NYSDEC, the RI was designed to be an extension of the Site Characterization Study (SCS) that was conducted for the East 14th Street Station, East 17th Street Station, and East 19th Street Station sites during 2004, and it focused primarily on the horizontal and vertical delineation of previously identified MGP-related impacts. RI activities were performed at the site in 2006 by GEI in accordance with the NYSDEC-approved RI Work Plan (GEI 2006). The 2006 RI results were presented in the Draft Remedial Investigation Report for the site (GEI 2006). Based on NYSDEC comments on the Draft RI Report, additional investigation was requested and the Draft RI report was finalized as the Interim Remedial Investigation Report (IRIR) in September 2007. Based on the NYSDEC August 24, 2007 comments, AECOM, on behalf of Con Edison, developed a supplemental RI Work Plan (ENSR 2008) to further investigate the impacts associated with the site.

This document presents the results of the remedial investigation performed for the former East 14th Street, East 17th Street, and East 19th Street holder stations. These sites were located within the footprint of the current Stuyvesant Town residential apartment complex in the Borough of Manhattan in New York City, New York. RI activities included delineation of the MGP-related soil and groundwater impacts within the property boundary of Stuyvesant Town, including immediately adjacent sidewalks up to the curb along surrounding streets. In addition, two borings were completed on the south side of East 14th Street to delineate MGP-related soil impacts south of the former holder station. Previously installed groundwater monitoring wells on the east side of Avenue C were also sampled to determine MGP-related groundwater impacts attributable to the former East 14th Street holder station. Also presented in this report are the data collected from a single boring completed on the First Avenue Loop Road that was installed in accordance with comments from the NYSDEC dated August 24, 2007.

The East 14th Street, East 17th Street, and East 19th Street Station sites are comprised the former grounds of three MGP holder stations that were owned and operated by Con Edison and its corporate predecessors from approximately 1857 until 1945. The East 14th Street Station site occupied the majority of the block between Avenue B and Avenue C and East 14th and East 15th Streets on the western side of Avenue C. The East 17th Street Station site is situated approximately mid-way between Avenues B and C and extends from East 17th Street to East 18th Street. The East 19th Street Station site occupied the least amount of property of the three station sites located at the present-day Stuyvesant Town apartment complex and was located on the south side of East 19th Street between Avenues A and B.

These station sites were decommissioned between 1921 and 1934 when they were sold by Con Edison's predecessors. In 1945, the grounds of the former holder stations were sold to Stuyvesant Town Corporation and the Metropolitan Life Insurance Company (MetLife) for the construction of the Stuyvesant Town housing complex.

The site geology generally consists of four units. These units, from ground surface downward include fill; a layer of organic deposits and/or peat; a layer of glacial lacustrine/glacial outwash deposits; and bedrock. Bedrock, identified as the Ravenswood Granodiorite, is present at varying depths beneath the three former MGP station sites ranging from approximately 40 to 80 feet (ft) below ground surface (bgs) in the area near the former East 14th Street Station to more than 80 ft bgs in the footprint of the former East 17th Street Station. In addition to the Ravenswood Granodiorite underlying the Stuyvesant Town property, the Inwood Marble underlies the area of the former East 19th Street Station and is present at approximately 60 to 80 ft bgs in this area.

A single unconfined, unconsolidated overburden aquifer is present beneath the Stuyvesant Town property and therefore, the three former holder stations. Shallow (approximately 5 to 15 ft bgs), intermediate (approximately 25 to 35 ft bgs), and deep (approximately 50 to 70 ft bgs) zones within the overburden aquifer were evaluated during the investigations. The groundwater flow direction in all of the depth zones is to the east-northeast towards the East River. The vertical gradient is generally downward throughout the site, however it is locally influenced by heterogeneities in the subsurface and exhibits an upward gradient in select monitoring wells pairs.

Based on site observations and analytical data, it appears that surface soils were imported to the site after the MGP operations ceased, possibly for final grading purposes during the construction of the Stuyvesant Town housing complex. The concentrations of compounds detected in the SCS and RI surface soil samples are considered to be attributable to fill material quality, anthropogenic sources, or naturally occurring sources unrelated to former MGP operations.

The fill soils underlying Stuyvesant Town are generally distinct from the lower organic deposits and glacial deposits at the site. The majority of the fill appears to represent imported material brought to the property following the cessation of MGP operations. In general shallow subsurface soils, defined as those soils between 0.1 and 17 ft bgs, did not exhibit MGP-related materials.

A capital improvement project to replace the water and hydrant valves across the Stuyvesant Town apartment complex property was completed prior to beginning Supplemental Remedial Investigation (SRI) work. A total of six soil borings were advanced during the SRI to investigate the potential MGP-related impacts encountered in the water valve excavations near the former East 17th and East 19th Street Stations, as well as to investigate shallow subsurface soil impacts observed at the excavations on the First Avenue Loop Road. The information gathered during the SRI from these borings, including analytical samples and visible and olfactory impacts observed during drilling indicate that significant MGP-related impacts are not present at the valve locations.

Intermediate soils were defined as those soils between 17 ft bgs and native soils with the deep soils being defined as native material. At the former East 14th Street Station site, MGP-related impacts were generally observed between 24 and 28 ft bgs. Petroleum-related impacts, however, were observed to a depth of approximately 35 ft bgs. MGP-related subsurface soil impacts have been horizontally and vertically delineated at the East 14th Street Station site. Subsurface soils at the former East 17th Street Station site exhibited MGP-related impacts between 26 and 29 ft bgs including staining and naphthalene-like odors. At the former East 19th Street Station site, impacts were observed in subsurface soils between 4.6 and 16.6 ft bgs with the highest concentrations of total VOCs and SVOCs generally being present in the more shallow fill material. The single boring advanced along the First Avenue Loop Road was completed at 20 ft bgs within the fill. No odors or visible impacts related to former MGP activities were encountered during drilling at this location.

A bedrock investigation was not performed at the site during the RI, however four borings were extended to bedrock during the various investigations that have taken place on this site. MGP-related impacts were not encountered at the overburden-bedrock interface during any of these investigations.

Non-aqueous phase liquid (NAPL) was noted in some of the monitoring wells at the site. Due to the presence of NAPL in monitoring wells at the site, Con Edison submitted an Interim Remedial Measure Work Plan for NAPL Monitoring and Recovery (ENSR 2008a). This work plan was submitted to NYSDEC in December 2008 and is considered to be part of the draft Interim Site Management Plan (SMP), dated August 15, 2008.

Groundwater in the shallow, intermediate, and deep unconfined aquifer zones beneath the sites have been impacted by former MGP operations. The greatest MGP-related groundwater impacts were detected in the vicinity of the former gas holders at the East 14th and East 17th Street Station sites. In the area of the former East 19th Street Station site, the general area of shallow and intermediate groundwater impacts has been determined. At the former East 14th and East 17th Street Station sites, the lateral extent of groundwater impacts in the shallow, intermediate, and deep aquifer zones to the east, southeast, and northeast has not been specifically defined based on comparison with groundwater standards. The vertical extent of groundwater impacts has also not been fully defined. However, unless the evaluation of remedial alternatives or the implementation of remedial actions requires that the groundwater be more fully delineated, additional field work for delineation is not proposed at this time. If additional groundwater data are necessary for remedial alternative evaluation or remedial action implementation, they would be collected during a pre-design investigation.

Soil gas and indoor air sampling was performed during the 2006 phase of the RI and during a prior investigation performed by RETEC in 2003. Indoor air sampling was performed in the following buildings: 522 East 20th Street, 16 Stuyvesant Oval, 245 Avenue C, and 615, 625, 629, 635, and 645 East 14th Street. The results from these sampling events indicated that the indoor air quality within the residential buildings of Stuyvesant Town, as measured on each sampling day, was not likely to have been adversely impacted by subsurface intrusion of MGP-related vapors. Based on the results of these sampling events, intrusion of vapors emanating from MGP-related material that may be present at the site was not evident. In addition, air quality within all Stuyvesant Town buildings was investigated in 2007 on behalf of the Owners. These data have not been reviewed by Con Edison or NYSDEC and are not presented in this report. Although indoor air sampling has not indicated that subsurface vapors associated with former MGP residuals affect indoor air quality, Con Edison is performing additional sampling to determine that there has been no significant change of indoor air quality. Con Edison submitted an Interim Remedial Measure Work Plan (IRMWP) for Indoor Air Sampling (ENSR 2008c) to NYSDEC on November 18, 2008. This IRMWP is also considered to be part of the draft SMP, dated August 15, 2008. The first round of indoor air sampling and analysis was performed in February and March 2009.

A qualitative human health exposure assessment (QHHEA) was performed to identify the potential exposure pathways associated with impacted media for residents, day-care attendees, commercial building occupants, parking lot attendants, maintenance workers, utility workers, and site visitors and pedestrians. Maintenance or utility workers who perform subsurface excavation work and/or repairs could possibly be exposed to impacted media and controls are recommended to limit potential exposures in these areas. Additionally, building residents, day-care attendees, occupants, visitors, and workers could potentially be exposed to indoor air impacts if sub-slab construction activities are performed and controls are recommended to limit exposure during these activities. Remedial options for these areas will be evaluated in an alternatives analysis report. Exposure of residents of the Stuyvesant Town apartment complex to MGP residuals is considered to be unlikely.

A Draft Interim Site Management Plan (ENSR 2008d) (SMP) was developed and submitted to NYSDEC on August 15, 2008. The SMP specifically details institutional controls enacted on the Stuyvesant Town property to protect maintenance, utility and landscape workers from soil impacts present below 5 feet. The plan outlines procedures for detecting and managing impacted soil and groundwater if they are encountered. While still draft, property owner personnel, and all others doing subsurface work, are currently operating under and are subject to the procedures in the SMP..

Based on the combined findings of the SCS and RI, the following activities are recommended for the site:

Delineation of subsurface soil and groundwater impacts associated with the former MGP Stations within Stuyvesant Town has been completed to a sufficient degree to evaluate appropriate remedial technologies and begin development and evaluation of remedial alternatives for the impacts identified at the site for inclusion in an alternatives evaluation report. It is recommended that the alternatives analysis for Stuyvesant Town be initiated. If additional delineation data are necessary for remedial alternatives evaluation or remedial action implementation, it is recommended that they be collected during a pre-design investigation. It is recommended that the Site Management Plan, which includes the Interim Remedial Measure Work Plan for NAPL Monitoring and Recovery and the Interim Remedial Measure Work Plan for Indoor Air Monitoring be implemented at the site..

List of Acronyms

AECOM – AECOM Environment
ADT – Aquifer Drilling and Testing, Incorporated
AGS – Advanced Geophysical Services
ASP – NYSDEC Analytical Services Protocol
AWQSGV – NYSDEC Ambient Water Quality Standard Guidance Values
BaP – benzo(a)pyrene equivalents
bgs – below ground surface
BTEX – benzene, toluene, ethylbenzene, xylene
CAMP – Community Air Monitoring Program
C&D – construction and debris material
CEC – Community Environmental Corporation
Chemtech – Chemtech Laboratories
COC – constituent of concern
EDC – Economic Development Corporation
EDD – electronic data deliverables
EH&S – Environmental Health & Safety
EM – electro-magnetic
ENSR – ENSR Corporation (now AECOM)
GEI – GEI Consultants
GPR – ground penetrating radar
HASP – Health and Safety Plan
H&A – Haley & Aldrich
HSA – hollow stem auger
IDW – Investigation-derived Waste
IRMWP – Interim Remedial Measure Work Plan
IRI – Interim Remedial Investigation
IRIR – Interim Remedial Investigation Report
ISMP – Interim Site Management Plan
Langan – Langan Engineering and Environmental Services, P.C.
MetLife – Metropolitan Life Insurance Company
mg/kg – milligram per kilogram
mg/L – milligram per liter
mg/m^3 – milligram per cubic meter
MGP – Manufactured Gas Plant
MPE – Multi-phase Extraction
MSL – Mean Sea Level
MS/MSD – matrix spike/matrix spike duplicate
MTA – Metropolitan Transportation Authority
MTBE – meth-tert-butyl-ether
NAVD88 – North American Vertical Datum 1988
NAD83 – North American Datum 1983
NAEVA – NAEVA Geophysics, Incorporated
NAPL – Nonaqueous Phase Liquid
NCP – National Contingency Plan
NY – New York
NYCDEP – New York City Department of Environmental Protection
NYCRR – New York Code of Rules and Regulations
NYSDEC – New York State Department of Environmental Conservation
NYSDOH – New York State Department of Health
PAH – Polycyclic Aromatic Hydrocarbon

PEC – Paragon Environmental Construction, Incorporated
PVC – polyvinyl chloride
PID – photoionization detector
PPE – personal protection equipment
QAPP – Quality Assurance Project Plan
QA/QC – Quality Assurance/Quality Control
QHHEA – Qualitative Human Health Exposure Assessment
RETEC – The RETEC Group, Incorporated
RI – Remedial Investigation
RIWP – Remedial Investigation Work Plan
ROW – Right-of-Way
RSCO – NYSDEC Recommended Soil Cleanup Objective
SC – Site Characterization
SCR – Site Characterization Report
SCS – Site Characterization Study
SMP – Site Management Plan
SRI – Supplemental Remedial Investigation
SRIWP – Supplemental Remedial Investigation Work Plan
SSBV – Site-Specific Background Value
SVI – soil vapor intrusion
SVOC – Semi-Volatile Organic Compound
TLM – tar-like material
USEPA – United States Environmental Protection Agency
USC – Utility Survey Corporation
USGS – United States Geologic Survey
UST – Underground Storage Tank
ug/m^3 – micrograms per cubic meter
ug/L – microgram per liter
VCA – Voluntary Cleanup Agreement
VOC – Volatile Organic Compound

1.0 Introduction

As required under the terms of Voluntary Cleanup Agreement Index No. D2-0003-02-08 (VCA) by and between the New York State Department of Environmental Conservation (NYSDEC) and Consolidated Edison Company of New York, Inc. (Con Edison), this report presents the results and findings of the supplemental remedial investigation (SRI) that was performed on Con Edison's behalf by by AECOM Environment ([AECOM]. formerly ENSR Corporation [ENSR]), for the East 14th (NYSDEC Site #V00535), East 17th (NYSDEC Site #V00541), and East 19th (NYSDEC Site #V00542) Street Station sites located in the Borough of Manhattan in New York City, New York. In addition, data from the 2006 interim RI (IRI) activities performed on Con Edison's behalf by GEI Consultants, Inc. (GEI) were previously presented in the Interim Remedial Investigation Report dated September 2007 (GEI, 2007a) and are summarized in this report. The 2006 IRI was carried out in accordance with the NYSDEC-approved RI Work Plan (RIWP) entitled *Remedial Investigation Work Plan, Stuyvesant Town Former Manufactured Gas Plant Sites* (GEI, 2006). 2008 RI activities were carried out in accordance with AECOM's Supplemental Remedial Investigation Work Plan (SRIWP), Stuyvesant Town Former Manufactured Gas Plant Sites (ENSR 2008). The SRI was also carried out in general accordance with the most recent and applicable guidelines of the NYSDEC, the United States Environmental Protection Agency (USEPA), as well as the National Contingency Plan (NCP).

GEI performed IRI activities on the site in 2006 in accordance with the NYSDEC-approved RI Work Plan (GEI 2006). The 2006 results were presented by GEI in the Interim Remedial Investigation Report, Stuyvesant Town Former Manufactured Gas Plant (MGP) Sites, dated September 2007. Based on the August 24, 2007 NYSDEC comments on the Draft Remedial Investigation Report (GEI, 2007a) and subsequent addendum, Valve Replacement Project Observation Summary Report for the Stuyvesant Town MGP Sites (GEI, 2007b), additional investigation was required at all three former MGP stations and the Draft RI report was finalized by GEI as the Interim Remedial Investigation Report, Stuyvesant Town Former MGP Sites and dated September 2007. Based on the NYSDEC August 24, 2007 comments, AECOM developed a SRI Work Plan (ENSR 2008d) as an extension of the IRI to further investigate the impacts associated with the three former MGP holder stations.

This report presents the results of the remedial investigation activities performed on the East 14th, East 17th, and East 19th Street Station sites, as well as further investigation of the subsurface on the First Avenue Loop Road associated with impacts found during the water valve replacement activities conducted in 2006 and 2007 as part of a capital-improvement plan to the property. The East 14th, East 17th, and East 19th Street Stations were located in what is presently the Stuyvesant Town apartment complex in the Borough of Manhattan in New York City, New York. The areas of concern associated with these station sites include MGP-related soil and groundwater impacts within the property boundary of Stuyvesant Town, including immediately adjacent sidewalks up to the curb of surrounding streets.

This RI Report incorporates the findings of other phases of environmental investigation work performed at the sites. MGP Research Reports were completed by Langan Engineering & Environmental Services, P.C. (Langan) in 2002 and 2003 for the former station sites. An evaluation of indoor air and soil gas sampling was performed in the residential apartment buildings at Stuyvesant Town in 2002 by The RETEC Group, Inc. (RETEC). The Site Characterization Study (SCS) was conducted by Haley & Aldrich, Inc. (H&A) during 2004, the findings of which were reported in the Site Characterization Report (SCR) dated October 2004 and revised in April 2005. GEI completed an IRI in 2007 and reported its findings in the Interim Remedial Investigation Report, Stuyvesant Town Former MGP Sites, dated September 2007. In addition, this report includes observations made during a large-scale capital improvement project to replace the water and hydrant valves servicing Stuyvesant Town during 2006 and 2007. During this project, 58 underground water and hydrant valves were replaced across the property. GEI and AECOM both served as third-party oversight on behalf of Con Edison at various parts of the water valve replacement project.

1.1 Remedial Investigation Purposes and Objectives

The purpose of this SRI was to gather sufficient information and assess whether remedial actions are necessary at the former MGP station sites and, if such actions are necessary, to support analysis of remedial alternatives and selection of a remedy. The scope of this RI was developed to supplement previous investigation findings including those of the IRI conducted by GEI as well as the SCS conducted by H&A.

The goals of the SRI were to:

1) Further delineate the extent of MGP staining and brown product-like globules observed during the valve excavation activities.

2) Further delineate the extent of MGP impacts noted in subsurface soils at the former East 17th Street Station and East 14th Street Station.

3) Further develop the dataset necessary to allow preparation of an Alternative Analysis Report to evaluate and select possible remedial alternatives for site clean-up.

The purpose and objectives described above for the SRI are consistent with the NYSDEC's comprehensive site characterization and remedial investigation goals as described in the NYSDEC Draft DER-10 Technical Guidelines for Site Investigation and Remediation (December 2002).

1.2 Scope of Work

The scope of work for this SRI was defined by the NYSDEC-approved RI Work Plan (GEI, 2006) and the NYSDEC-approved SRI Work Plan (ENSR, 2008d). The SRI included the following tasks:

- Underground utility clearance
- Community air monitoring
- Soil boring advancement and subsurface soil sample collection and analysis
- Groundwater level and nonaqueous phase liquid (NAPL) thickness measurements
- Groundwater sampling and analysis
- Surveying of new sampling locations
- Management of investigation-derived waste (IDW)

All activities were performed in accordance with the methods specified in the Supplemental Remedial Investigation Work Plan (SRIWP) (ENSR, 2008d), including the site-specific Quality Assurance Project Plan (QAPP) included in Appendix A of the 2008 ENSR SRIWP and the site-specific Health and Safety Plan (HASP) included in Appendix B of the 2008 ENSR SRIWP.

1.3 Report Organization

The remainder of this RI report is organized into the sections and appendices listed below.

- Section 2 provides a description of the East 14th, East 17th, and East 19th Street former MGP Station sites and surrounding properties, a summary of information regarding site ownership and operational history, and a summary of previous investigations.

- Section 3 provides a description of field investigation activities and sample analyses performed during the RI.

- Section 4 provides a discussion of the site geology and hydrogeology.

- Section 5 provides a discussion of the observations regarding the extent of observed MGP residuals, and a summary of the analytical results for environmental media sampled during the SC and RI.

- Section 6 presents a qualitative evaluation of the risk associated with the MGP constituents for the site.

- Section 7 presents a summary and conclusions of the RI.

- Section 8 presents recommendations for future activities at the site.

- Section 9 presents references cited.

Tables and figures are included in the sections immediately following the text of this report.

Appendices to this report include the following:

- Appendix A – Historic site maps

- Appendix B – Boring and well construction logs

- Appendix C – GEI Valve Replacement Project Summary Report

- Appendix D – Groundwater sampling forms

- Appendix E – GEI Aquifer Conductivity Data

- Appendix F – Investigation-derived waste management

- Appendix G –Summary Tables and Data Usability Reports

- Appendix H – Background statistical analysis

2.0 Site Location, Description, and Setting

The former MGP station sites located at East 14th, East 17th, and East 19th Streets, are located within the present-day residential campus of Stuyvesant Town. Stuyvesant Town occupies Block 972 Lot 1 in the Borough of Manhattan within the City, County, and State of New York and is located in the Lower East Side section of Manhattan (Langan, 2003). It is bounded by and extends from East 14th Street north to East 20th Street and from First Avenue east to Avenue C. Figure 2-1 illustrates the site location on a portion of the Brooklyn, New York quadrangle topographic map.

Stuyvesant Town apartment complex extends from First Avenue to Avenue C and from East 14th Street to East 20th Street and includes 35 high-rise buildings, playgrounds, sport courts, and underground parking garages across a 61-acre area. Figure 2-2 shows the current site layout and the former MGP structures. The East 14th Street Station was located on a 2-acre area at the corner of East 14th Street and Avenue C. The station was used for gas storage and gas purification from circa 1857 to sometime between 1903 and 1920. The land was subsequently used for storage by Con Edison. The East 17th Street Station was located on a 1.5-acre area off the current Avenue C Loop Road. The station was used for gas storage from between 1860 and 1867 to between 1920 and 1924. Following decommissioning, the land was used for cinder storage and then bought by the Reconstruction Garage, Inc. in 1943. The East 19th Street Station was located on a 0.3-acre area off the current East 20th Street Loop Road. The station stored gas starting between 1863 and 1868 until between 1920 and 1921 when it was replaced by an auto/truck garage and then sold to Improvement Garage, Inc. in 1943. Stuyvesant Town Corporation acquired the land of all three stations in 1944 for the development of the Stuyvesant Town apartment complex.

The former East 14th Street Works site existed on several city blocks, mostly on the east side of Avenue C, and is designated as Tax Block 988, Lot 1, a portion of Block 990, Lot 1, and a portion of Block 972, Lot 1 on the tax map of the City of New York, New York (Langan, 2003). Only a portion of the former East 14th Street Works is located on the land presently occupied by the Stuyvesant Town apartment complex and is referred to as the East 14th Street Station. The former East 17th Street Station site existed on what was formerly Tax Block 985, but is currently designated as Tax Block 972. In addition, the former East 19th Street Station site existed on what was formerly Tax Block 976, but is currently designated as part of Tax Block 972 (Langan, 2002b).

The Stuyvesant Town residential campus encompasses approximately 61 acres and contains residential high-rise apartment buildings, playgrounds and courts, a fitness center, and private underground parking garages. Four loop roads onto the property are accessible from 20th Street, 14th Street, Avenue C, and First Avenue, and a service road with additional parking is located along the northern, western, and southern boundaries of the complex. Currently, the majority of the property is designated a R7-2: Moderate to High-Density Residential District, according to Zoning Map 12C of the New York City Planning Commission (GEI, 2007a). A bank, laundry service, and a number of retail stores are also located on the perimeter of the property and are designated as commercial segments (C1: Light Commercial). In addition, the management office for both the Peter Cooper Village and Stuyvesant Town apartment complexes is located at 317 Avenue C, and a day care center (Manhattan Kids Club II), is located at 629 East 14th Street, on the south side of the complex (GEI, 2007a). The Stuyvesant Town property was sold to an affiliate of Tishman Speyer Properties, L.P. and Blackrock Realty Advisors, Inc. by Metropolitan Tower Insurance Company, an affiliate of the Metropolitan Life Insurance Company (MetLife), in 2006.

Current surrounding land uses consist of residential, commercial, and institutional. North of the site, on the north side of East 20th Street, is the Peter Cooper Village apartment complex and a restaurant on the northeast corner of the First Avenue and East 20th Street intersection. First Avenue consists of several

northbound traffic lanes with an access road which includes parking and sidewalks along the east side. Commercial establishments such as delis, a grocery store, restaurants, etc., are located along the west side of First Avenue across from the site. In addition, there are a number of retail stores and restaurants on the east side of First Avenue adjacent to the site. John Murphy Park, an off-site playground, is located approximately ¼ mile southeast of the site, and two schools, PS 34 at 730 East 12th Street and Saint Emeric's Church and School at 740 East 13th Street are located approximately ½ mile south of the site (Langan, 2002). In addition, a public esplanade (Stuyvesant Cove Park) to the east of the site is located between the site and the East River, across Avenue C (Langan, 2002a and 2002b).

The section of Avenue C and the elevated FDR Drive between East 20th Street and Avenue C are situated east of the grounds of the former MGP stations. Parking areas are located beneath the FDR and a waterfront park, Stuyvesant Cove Park, is located further east between the parking areas and the East River. The park property is owned by the City of New York and managed by the New York City Economic Development Corporation (EDC). The Community Environmental Corporation (CEC) leases the property from EDC and manages and operates Stuyvesant Cove Park. The park consists of landscaped areas, bike and walking paths, benches and tables. An Environmental Education Building (Solar One) is located in the northern portion of Stuyvesant Cove Park.

A gasoline station is located north of Stuyvesant Cove Park, northeast of the site. Previous releases of petroleum products have been documented from a former service station facility with several underground storage tanks (USTs) at this location. Two multi-phase extraction (MPE) systems were installed within Stuyvesant Cove Park between East 18th Street and East 23rd Street to address this contamination and have been decommissioned.

Con Edison facilities are located east of Stuyvesant Town between East 18th and East 14th Streets and Avenue C and the FDR Drive. These facilities include the East River Generating Station, various substations, an administration building, ball fields, and parking areas.

2.1 Site History

2.1.1 Pre-Manufactured Gas Plant

The 18-block area developed as Stuyvesant Town in the 1940s was formerly part of the East River and associated marsh lands well into the 1800s, as can be seen on the historic survey maps and plates available in Appendix A. There were a number of small creeks and streams feeding the East River that ran through the area during the colonial period, during which the area appears to be mainly farms and orchards (GEI, 2007a). With the increasing population and growing demands of New York City, the area gave way to more industrial planning and development in the early 1800s and as a result, the area east of First Avenue between East 13th and East 26th Streets required filling and reworking to extend the shoreline to its present location and elevate the grade of the land. There were some tenements on the reclaimed land before the development of the former MGP station sites as gas storage and/or gas plant facilities (GEI, 2007a). As stated above, the historic maps are included as Appendix A to this report.

2.1.2 Manufactured Gas Plant

Detailed historic information was previously compiled and presented in three reports entitled *MGP Research Report, East 14th Street Works* prepared by Langan in January 2003, *MGP Research Report, Volume I of III, East 17th Street Station* prepared by Langan in September 2002, and *MGP Research Report, Volume I of III, East 19th Street Station* prepared by Langan in August 2002. The historical information provided herein was derived from the Interim Remedial Investigation Report (GEI, 2007a) which referenced those reports as well as the Site Characterization Report prepared by Haley & Aldrich in 2005. Figure 2-2 illustrates the former MGP structures associated with the East 14th, East 17th, and East 19th Street Stations.

The East 14th, East 17th, and East 19th Street Stations, located within present-day Stuyvesant Town, were operable between the mid-1800s and early 1900s and were owned and operated by Con Edison's predecessor companies including the Consolidated Gas Company of New York, the New York Steam Company, the Standard Gas Company, and the Manhattan Gas Light Company. A summary of each station's site history is provided below.

The East 14th Street Station was part of the larger facility called the East 14th Street Works, which was operated by Consolidated Gas Company. The majority of that larger facility was located on the eastern side of Avenue C between East 14th and East 16th Streets. The East 14th Street Station site occupied the majority of the block between Avenue B and Avenue C and East 14th and East 15th Streets on the western side of Avenue C and operated as a gas storage and purification facility from circa 1857 to some time in between 1903 and 1920. Historic Sanborn® maps show six gas holders (approximately 350,000 cubic feet capacity each), one meter house, and one purifying house on the station site prior to the 1920s. The 1920 Sanborn® map and aerial photographs taken in the 1920s, however, confirm the absence of the holders prior to demolition of the purifying house. Demolition occurred some time between 1924 and 1934.

Operations as a gas storage facility began at the East 17th Street Station between 1860 and 1867. Two gas holders, with a capacity of approximately 270,000 cubic feet each, were located on the western portion of the site while the eastern portion of the site was used for pipe and material storage, as well as office space. Situated approximately mid-way between Avenues B and C, stretching from East 17th Street north to East 18th Street, the station was in operation until some time between 1921 and 1924 when the station was decommissioned with removal of the holders. Based on historic Sanborn® maps, the area was then used as a cinder yard until the property was sold to Reconstruction Garage, Inc., in 1943. The Stuyvesant Town Corporation subsequently acquired the property in 1944.

The East 19th Street Station reportedly began operations between 1863 and 1868 as a holder site. This station occupied the least amount of property of the three station sites on the present-day Stuyvesant Town property, and was located on the south side of East 19th Street between Avenues A and B. Based on the historic maps of the area, a single gas holder (approximately 500,000 cubic feet capacity) and a small unidentified structure occupied the site. The station was replaced by an auto/truck garage between 1920 and 1921 and was sold to Improvement Garage, Inc., in 1943. The Stuyvesant Town Corporation subsequently acquired the property in 1944 for the construction of the Stuyvesant Town apartment complex.

2.1.3 Post-Manufactured Gas Plant

A number of residential, commercial, and industrial properties occupied the area that is now the Stuyvesant Town residential campus. Through private sale and eminent domain, along with the New York City Housing Authority, MetLife acquired the properties within the 18-block footprint of Stuyvesant Town during the early to mid-1940s to begin construction of the post-war housing. Approximately + 3,100 families and + 500 commercial and industrial facilities were razed as part of the project including the existing apartments and tenements within the project boundaries, as well as machine shops, ice plants, auto garages, iron works and foundry yards, brick works, coal yards, lumber and construction storage yards, livery stables, house-ware storage facilities, churches, and private and public schools. Any remaining aboveground structures initially related to the East 14th, East 17th, and East 19th Street holder stations would have been razed along with surrounding structures prior to the construction of the Stuyvesant Town apartment complex. Historical maps showing the area prior to construction of the Stuyvesant Town apartment complex are available in Appendix A.

Approximately four acres in total were at one point occupied by the three holder stations, though they were located on non-contiguous parcels as illustrated in Figure 2-2. The following information is excerpted from the IRI Report prepared by GEI, dated September 2007:

- The East 14th Street Station was located near the corner of East 14th Street and Avenue C. Sanborn® maps show six gas holders, one meter house, and one purifying house on the + 2-acre station site.

Currently, portions of residential buildings at 245 Avenue C and 625-645 East 14th Street, an underground parking garage, and a child day care center (629 East 14th Street) occupy the area of the former East 14th Street Station. In addition, a portion of the adjacent service road and pedestrian walkways along Avenue C and East 14th Street appear to have also been located within the former station footprint.

- The East 17th Street Station was located off the present-day Stuyvesant Town Avenue C Loop Road. Sanborn® maps show two gas holders, material-storage areas, and an area subsequently labeled "cinder yard" on the + 1.5-acre station site. Portions of residential buildings at 285-287 Avenue C and 16 Stuyvesant Oval, and an underground parking garage currently occupy the area of the former East 17th Street Station. Additionally, the segment of the Avenue C Loop Road between the noted residential buildings, as well as adjacent walkways and a small portion of a basketball court, lie within the former station footprint.

- The East 19th Street Station was located off the present-day Stuyvesant Town East 20th Street Loop Road. Sanborn® maps show one gas holder and a small unidentified structure located on the + 0.3-acre station site. Portions of a residential building at 522-524 East 20th Street and an underground parking garage currently occupy this area.

2.2 Physical and Environmental Setting

2.2.1 Site Design and Infrastructure

As discussed above and by GEI in the IRI (GEI, 2007a), the surface topography of Stuyvesant Town is made-land and ranges from approximately 4 to 22 feet above Mean Sea Level (MSL). The areas not covered by buildings were developed to include four loop roads with additional parking, corresponding to East 20th Street, East 14th Street, Avenue C, and First Avenue, paved walkways, playgrounds, multi-use game courts, and green space. There are also six parking garages on the property that are situated only slightly below the adjacent street grade and are single-level structures. Above the garage structures are playgrounds, landscaped areas, and paved walkways. They also provide building access to upper floors. The overall design, as can be seen on Figure 2-2, exhibits a general radial symmetry with a large fountain at the center of the property and plenty of landscaped areas throughout the property. This allows any precipitation reaching the ground to infiltrate those landscaped areas as well as drain towards the storm water basins located along the perimeter roads and loop roads.

The utility infrastructure underlying Stuyvesant Town is complex and not completely known. H&A conducted a review of available utility maps during their work on the SC in 2004 and determined that a dense network of numerous private and public utility lines of varying size cross beneath the site. There are also a large number of inactive and abandoned lines traversing the site subsurface that once served the pre-Stuyvesant Town community, and these utilities are largely unknown.

In addition, underground utilities and transportation corridors in the immediate vicinity of Stuyvesant Town must be taken into consideration when evaluating the environmental conditions below the former MGP stations. There is a Pollution Control Intercepting Sewer and several main feeders into the East River Generating Station, as well as the 14th Street – Canarsie Subway line beneath the city streets on the perimeter of the property. H&A cited the Metropolitan Transportation Authority (MTA) microfilm drawings 388 and 338, dated March 1916, and reported that the rail bases for the east and west bounds of the East 14th Street – Canarsie ("L") subway Line that runs beneath 14th Street from 8th Avenue in Manhattan beneath the East River to Brooklyn, are located approximately 47 feet below East 14th Street at the intersection with Avenue C and the approximate tunnel cross section near the property boundary was 15 feet in diameter.

Also as part of the SC activities, H&A reviewed drawings, dated July 1967, from the New York City Department of Environmental Protection that showed the North Branch Intercepting Sewer. This intercepting

sewer was installed as a pollution-control measure and is approximately + 108 inches in diameter and located roughly 40 feet below grade on the east side of First Avenue between East 21st and East 23rd Streets. It then continues along the south side of East 20th Street and proceeds south along the west side of Avenue C where intercepted waste water from lateral-combined lines feeding into the East River is pumped to the Newtown Creek Water Pollution Control Plant via the East 13th Street Pump Station.

The abovementioned subsurface utilities and transportation corridors significantly impact the homogeneity of the subsurface at the former MGP station sites and create noteworthy heterogeneities within the subsurface that can influence groundwater and potential contaminant flow. In addition, these heterogeneities can provide insight into potential anomalies regarding subsurface contaminant chemistry.

2.2.2 Environmental Setting

The regional geology and hydrogeology are summarized below and more expressly detailed in Section 4 of this report.

2.2.2.1 Regional Geology

The geology beneath Stuyvesant Town is generally described by stratigraphic unit and included the following materials, which were encountered in order of increasing depth:

- Fill
- Organic Deposits/Peat
- Glacial Lacustrine/Glacial Outwash Deposits
- Bedrock

The following discussion is based on published information on the known and anticipated subsurface conditions in the vicinity of Stuyvesant Town and much of the information was detailed by GEI in the 2007 IRI Report and is detailed further in Section 4 of this report.

In the mid to late 1800s, the area of the Lower East Side of Manhattan was filled and leveled to extend the shoreline of the East River eastward and provide more land for construction for the inhabitants of New York City. As such, the materials constituting the fill layer include an assortment of soils and materials used in reclaiming the land.

Below the fill layer, Holocene age organic deposits consisting mainly of black to gray organic clays and silts with marine shell fragments and peat deposits are present. These peat deposits are associated with the marshland that was eventually filled over.

The glacial deposits in the area of Stuyvesant Town include fine to coarse grained silty sands (till) and varved silt and clay materials (rhythmites) (Baskerville, 1994). According to published information, as well as known information based on field activities, these deposits range in thickness from approximately 10 feet to 140 feet in Manhattan. Rhythmite deposits accumulated within an ancestral glacial lake associated with the damming of the Hudson River by the Harbor Till Terminal Moraine, which was located to the south at the Narrows section of New York Harbor (Meguerian 2003, Baskerville 1994).

The bedrock beneath Stuyvesant Town varies below the three former MGP station sites. According to published information, the bedrock beneath the East 14th and East 17th Street Stations is classified as the Ravenswood Granodiorite (Baskerville, 1994). The Ravenswood Granodiorite is igneous and described as a medium to dark gray granodiorite with a granitic or gneissic texture formed during the Middle Ordovician to

Middle Cambrian periods or approximately 460 to 500 million years ago (Baskerville, 1994). The surface dips sharply to the northeast and is located approximately 40 to 80 feet (ft) below ground surface (bgs) in the area near the former East 14th Street Station and more than 80 ft below the footprint of the East 17th Street Station (Baskerville, 1994).

Also underlying the Stuyvesant Town apartment complex is the Inwood Marble, which underlies the area of the former East 19th Street MGP Station. The Inwood Marble is a metamorphic rock generally described as white to blue-gray, fine to coarse grained calcitic to dolomitic marble, middle Ordovician to Late Cambrian in age (Baskerville, 1994). It is present approximately 60 to 80 ft bgs at the East 19th Street Station site and is part of the northeast-southwest trending Cameron thrust fault which reportedly bisects the Stuyvesant Town property. According to the 2002 MGP Research Reports published by Langan, bedrock in the vicinity of the fault dips roughly 45 degrees to the northwest.

2.2.2.2 Regional Hydrology/Hydrogeology

This section summarizes the regional Upper Glacial Aquifer present beneath Stuyvesant Town, as well as the nearest surface water body, the East River. Additional site-specific information is discussed in further detail in Section 4 of this report.

The Upper Glacial Aquifer is comprised of Pleistocene and Holocene aged deposits that cover the lower portion of Manhattan and can yield large quantities of water (Baskerville, 1994). The aquifer is generally unconfined; however less permeable silts and clays may confine it locally. According to research by GEI, the Upper Glacial Aquifer is characterized by typical horizontal conductivities of approximately 270 ft per day ($9.5x10^{-2}$ centimeters per second [cm/s]) within the glacial outwash sand and approximately 135 ft per day ($4.4x10^{-2}$ cm/s) within the poorly sorted till deposits located nearby on Long Island (GEI, 2007).

Baskerville (1994) indicated that streams and tidal marshes buried during the mid-1800s can and do influence water flow on Manhattan. These filled tidal wetlands beneath Stuyvesant Town can also be affected by tidal fluctuations within the East River and the water within the Upper Glacial Aquifer is somewhat impacted with salt water from that river due to those tidal fluctuations. Historic maps and stream patterns indicate that the general groundwater flow beneath Stuyvesant Town is eastward towards the East River. As previously reported in H&A's SC Report (2005) and in GEI's IRI Report (2007a), the depth to groundwater at Stuyvesant Town is approximately 10 ft bgs and the water is classified by the NYSDEC as GA (aesthetic – fresh waters), indicating that the water is potable water, suitable for drinking. The Stuyvesant Town apartment complex, along with surrounding areas of Lower Manhattan, however, is served by the New York City Water Supply System which obtains water from reservoirs within the Catskill, Delaware, and Croton watersheds located 50 to 125 miles north of New York City (GEI 2007a).

The nearest surface water body to Stuyvesant Town is the tidally influenced, saline East River. It is located east of the property approximately 200 to 1,500 ft at the eastern boundary of the property to 1,750 to 2,250 ft from the western boundary of the property, as can be seen in Figure 2-1. The East River is classified by the NYSDEC as a Class I saline surface water which is used for ship traffic and non-contact recreational purposes. Class I saline surface waters are also designated for fishing, however, numerous New York State Department of Health (NYSDOH) health advisories exist for consumption of fish caught in the East River. The western shoreline of the East River in the vicinity of the site is listed in the National Wetlands Inventory (Langan, 2002a and 2002b).

2.3 Previous Investigations

Previous investigations performed at the site prior to the RI are summarized in the following sections. Previous investigation locations are shown on Figure 2-3. The areas of concern of this RI include those where the former East 14th, 17th, and 19th Street MGP Stations were located, as well as an area on the First Avenue

Loop. Boring logs and well construction diagrams for both the 2006 and 2008 RI, along with those from the 2004 SC, are available in Appendix B to this report.

2.3.1 MGP Research Reports – Langan (2002, 2003)

2.3.1.1 East 14th Street Works

Historical research regarding the former East 14th Street MGP Works was conducted by Langan in 2003 on behalf of Con Edison. The findings were reported in the MGP Research Report, East 14th Street Works, dated January 19, 2003. The former East 14th Street Works was defined as two areas: the eastern portion, which is comprised of the majority of the works site and encompassed 9.2 acres, including area between East 14th Street to East 16th Street between Avenue C and the FDR Drive; and the western portion (East 14th Street Station), which included 1.8 acres in the southeastern corner of the Stuyvesant Town apartment complex. The objective of the research report was to review historical and environmental records and summarize the former MGP operations of Con Edison and its predecessor companies and was conduced as a part of Con Edison's efforts to prioritize its sites with MGP operations for future investigations.

A summary of Langan's findings regarding the western portion of the former East 14th Street Works (ie., the East 14th Street Station) is provided below:

2.3.1.2 East 14th Street Station

The area formerly occupied by the East 14th Street Station is located in the southeastern corner of the Stuyvesant Town apartment complex and is privately owned. Prior to being sold in 1944, Con Edison used the area as a warehouse and storage yard. The property has since been redeveloped with multi-story residential buildings with basements, underground parking, a day care facility, playgrounds, and landscaped areas. There was no regulatory information encountered regarding this portion of the former East 14th Street Works.

Langan reported that there was a limited potential of exposure to MGP-related impacts at this site, including potential exposure to soil vapor for building occupants and for exposure for subsurface utility activity. In addition, Langan stated that the East River and its shore were potential environmental receptors of offsite impacts from the former East 14th Street Works.

2.3.1.3 East 17th Street Station

Under contract to and on behalf of Con Edison, Langan conducted research regarding the former MGP operations at the East 17th Street Station site, located within the Stuyvesant Town apartment complex property. Langan documented their findings in the report entitled MGP Research Report, East 17th Street Station, dated September 9, 2002.

Results of the 2002 Langan research report are summarized below:

- Site reconnaissance revealed that there are no former holder structures in public areas, however the location and existence of potential buried structures and foundations is unknown. Also, it is unknown how decommissioned wastes were handled during the construction of the Stuyvesant Town residential complex.

- Potential pathways by which residents and utility workers could be exposed to impacts (if further investigation provides evidence of those impacts) include soil vapor, groundwater, soils, and utility conduits. In addition, the East River and its shore were identified as potential environmental receptors of offsite impacts, should they be present.

- There was no regulatory information encountered regarding the East 17th Street Station.

Prior to any further excavation at the site, Langan proposed visual inspection of basement foundations and utility manholes as well as characterization of subsurface materials, based on their reported findings.

2.3.1.4 East 19th Street Station

Under contract to and on behalf of Con Edison, Langan conducted research regarding the former MGP operations at the East 19th Street Station site, located within the Stuyvesant Town apartment complex property. Langan documented their findings in the report entitled MGP Research Report, East 19th Street Station, dated August 30, 2002.

Results of the 2002 Langan research report are summarized below:

- The East 19th Street Station encompassed approximately 0.3 acres of land that have since been redeveloped as a single 13-story residential building with a basement, a portion of an underground parking garage, and landscaped areas.

- Site reconnaissance revealed that there are no former holder structures in public areas, however the location and existence of potential buried structures and foundations is unknown. Also, it is unknown how decommissioned wastes were handled during the construction of the Stuyvesant Town residential complex.

- If impacts are present, residents and utility workers could be exposed through soil vapor, groundwater, and utility conduits, which Langan identified as potential pathways. Potential environmental receptors identified by Langan include the East River and its shore, which are located east of the former MGP station.

- There was no regulatory information encountered regarding the East 19th Street Station.

Prior to any further excavation at the site, Langan proposed visual inspection of basement foundations and utility manholes as well as characterization of subsurface materials, based on their reported findings. In addition, a limited characterization of subsurface materials was proposed, prior to any future intrusive work at the site, to address potential health, safety, and regulatory compliance issues that may arise.

2.3.2 Air and Soil Gas Sampling – RETEC (2003)

Under contract to and on behalf of Con Edison, RETEC conducted an evaluation of indoor air and soil vapor at the Stuyvesant Town apartment complex in January and August of 2003. The primary goal of this sampling effort was to determine if the volatile organic compounds (VOCs) associated with former MGP activities at Stuyvesant Town were adversely affecting the air quality of the apartment buildings on the property. In January 2003, RETEC collected indoor and ambient air samples from buildings and exterior areas within the footprints of the former MGP stations. The August 2003 sampling event focused on collecting soil gas samples from the East 14th, East 17th, and East 19th Street Station sites and the findings were documented in their report, E.14th Works and E.17th and E.19th Street Stations, Report of Evaluation of Indoor Air and Soil Gas Sampling. The report was dated October 7, 2003.

The soil gas, indoor air, and ambient air sampling locations are shown on Figure 2-3 of this report and the analytical findings are discussed in Section 5. Information from this report is also incorporated into the figures, tables, and discussion of this RI report. A summary of RETEC's findings is provided below:

- At the East 14th Street Station site, both potential MGP-related and non-MGP-related compounds were detected in the soil gas samples collected. The elevated detection of methyl-tert-butyl-ether (MTBE, a common gasoline additive) suggests the concentrations are not MGP-related. Concentrations of

naphthalene and/or xylenes above the typical background indoor air values were found in two of the seven indoor air samples from this station as well.

- The indoor air samples from within the former East 17th Street Station footprint did not contain any concentrations of MGP-related constituents above background levels, however the soil gas sample collected contained low levels of both potentially MGP-related and non-MGP-related compounds.

- The majority of detected concentrations of potentially MGP-related compounds found in the samples from within the former East 19th Street Station footprint were within the range of typical background levels for indoor air. There was, however, naphthalene detected above the range of background levels, though the elevated concentrations were attributable to naphthalene-containing mothballs used nearby. The VOCs detected in the soil gas samples at the former East 19th Street Station were attributed to non-MGP-related compounds due to the detection of MTBE.

The 2003 RETEC report concluded that the air quality at Stuyvesant Town is not impacted by MGP-related compounds, though they did recommend reviewing the air sampling results as needed based on future intrusive site characterization findings. The sources of VOC concentrations found in the indoor air samples were attributed to non-MGP-related sources including mothballs, cleaning products, paint, etc. In addition, the VOC concentrations found in the soil gas and ambient air samples were attributed to non-MGP-related sources, due to the presence of compounds typically found in vehicle emissions.

2.3.3 Site Characterization – Haley & Aldrich (2004)

Haley & Aldrich (H&A) conducted an environmental site investigation for the former MGP stations within the Stuyvesant Town apartment complex on behalf of Con Edison in 2004. The work was completed in accordance with the VCA between Con Edison and the NYSDEC and the 2003 NYSDEC-approved H&A SC Work Plan. H&A documented their methods and findings of their work in the report dated October 2004 and subsequently revised April 2005.

The purpose of the SC was to investigate impacts of the former MGP stations at Stuyvesant Town through test pit excavations, soil borings, soil sampling, monitoring well installation, and groundwater sampling. As previously stated, their findings were documented in the SC Report (2005). The report also included evaluation of groundwater and soil in areas not impacted by MGP operations to establish background levels of constituents of concern (COCs) in non-MGP areas of the site. Investigation locations are shown on Figure 2-3 and their findings are addressed in later sections of this report.

The following summarizes the results of the SC Report and is taken directly from that document:

- A total of six background borings were conducted during the investigation. The surface and subsurface soils were found to contain concentrations of semivolatile organic compounds (SVOCs) and arsenic above NYSDEC Recommended Soil Cleanup Objectives (RSCO). The surface and subsurface soil samples also contained lead and the subsurface soils contained cyanide; there is no specific RSCO criterion for lead and cyanide.

- Two monitoring well couplets were installed to evaluate background groundwater quality. Analytical results indicate that all four monitoring wells exceeded NYSDEC Ambient Water Quality Standards and Guidance Values (AWQSGV) primarily for metals and inorganic parameters, many of which are not typically associated with MGP-related materials. One monitoring well exceeded the VOC criteria. Cyanide, which is related to MGP operations, was detected in a background well.

- At the former East 14th Street Station, subsurface soil and groundwater exceeded their applicable screening criteria. Seventeen soil borings were conducted to investigate the former gas holders, meter house and purifying house. Although a total of 17 soil borings were conducted at this station, only one

surface soil sample was collected because most of this area is covered with concrete and cobblestones. The surface soil sample was below RSCO criteria for VOCs and SVOCs and below Site-Specific Background Values (SSBV) and RSCO for arsenic, lead and cyanide. Subsurface soil testing results indicate concentrations of VOCs and SVOCs above RSCO and arsenic, lead and cyanide concentrations above RSCO and/or SSBV. Two well couplets were installed and groundwater testing results show concentrations of VOCs, SVOCs and cyanide above the AWQSGV.

- At the former East 17th Street Station, surface soil, subsurface soil and groundwater exceeded their applicable screening criteria. A total of 14 surface soil samples were collected from this area and all 14 samples exceeded either RSCO for SVOCS or SSBV for arsenic and lead. Sixteen subsurface soil borings were conducted to investigate the former gas holders and cinder yard. The soil borings contained concentrations of VOCs and SVOCs above RSCO and arsenic and led above RSCO and/or SSBV. Groundwater contained concentrations of VOCs, SVOCs, lead and cyanide above AWQSGV.

- At the former East 19th Street Station, surface soil, subsurface soil and groundwater exceeded applicable screening criteria. In general, this station has fewer soil and groundwater exceedances than the other two MGP stations. One surface soil sample was collected from the area. The surface soil sample exceeded RSCO for SVOCs. Arsenic exceeded RSCO and/or SSBV in the surface soil sample. Three subsurface soil borings were conducted to investigate the former gas holder and adjacent building. The soil samples collected from the three borings exceeded RSCO for SVOCs. Arsenic exceeded RSCO and SSBV in one soil sample. Groundwater testing results from the monitoring well couplet contained concentrations of SVOCs and lead slightly exceeding AWQSGV.

In addition, the SC Report reviewed the information from the RETEC 2003 report and stated:

- Indoor air and soil gas sampling and evaluation were conducted in January 2003 and August 2003 by RETEC. The results of the indoor air and soil gas sampling were presented separately in a report entitled *E.14th Works and E.17th and E.19th Street Stations, Report of Evaluation of Indoor Air and Soil Gas Sampling*, dated October 7, 2003. The report concluded that the sources of the VOC detected in the indoor air samples collected in the Stuyvesant Town apartment buildings appear to be moth balls, cigarette smoke, floor waxes, paints, or cleaning products used in the building, with a contribution from vehicle emissions (as evidenced by VOC detections in outdoor air). However, based on the results of the SC, MGP-related compounds could be contributing to the VOCs in the soil gas. The concentrations of these compounds were at low levels – at least two orders of magnitude below the Worker Guidance Values and similar to typical background concentrations.

- A qualitative human health exposure assessment (QHHEA) identified potentially completed exposure pathways at the former East 14th Street, East 17th Street, and East 19th Street MGP Stations for surface soil, subsurface soil, groundwater and outdoor air due to the presence of VOCs, SVOCs, lead, arsenic and/or cyanide in these exposure media. Some or all of these exposure pathways may be rendered incomplete upon further assessment or action. Since potentially complete exposure pathways have been identified, further evaluation of contaminant fate and transport is needed.

  As a result of their findings, H&A stated that additional investigation and sampling would be required to delineate the extent of impacts at both the former East 14th and East 17th Station sites, as well as to confirm the absence of MGP residuals at the former East 19th Street Station site.

2.3.4 Interim Remedial Investigation – GEI (2007)

GEI undertook remedial investigation activities at all three former MGP stations at the present-day Stuyvesant Town apartment complex in 2006. Sampling included indoor air, soil gas, groundwater, and soil and took place in accordance with Con Edison's VCA with the NYSDEC, the February 2006 RI Work Plan, and the March 6, 2006 addendum. Data generated during the IRI conducted by GEI will be discussed in detail, along

with the data generated during the 2008 SRI conducted by AECOM on behalf of Con Edison. Therefore, the IRI sample locations are illustrated on figure 3-1 and discussed in Section 3.

2.3.5 Valve Replacement Project – GEI (2007)

Unrelated to the RI activities, valves on water mains and hydrants servicing the Stuyvesant Town apartment complex were replaced as part of a capital-improvement plan during 2006 and 2007. A report entitled *Valve Replacement Project – Observation Summary Report* was prepared by GEI and included as an appendix to the 2007 Interim Remedial Investigation Report. Due to the presence of the three former MGP stations located within the Stuyvesant Town complex, GEI and RETEC provided third-party oversight of the water valve replacement activities on behalf of Con Edison. The previously mentioned report summarizes the quality of the soil and groundwater encountered in the excavations associated with valves and also provides a summary of the material disposed during excavation activities. A copy of the report is provided as Appendix C to this report and the conclusions are summarized below:

- MGP-related impacts were observed in soil and/or groundwater outside of the former MGP station sites and Site Characterization and Remedial Investigation areas, including in the excavations along the Avenue C and East 20th Street Loop Roads. These areas are beyond the former station and investigation areas for the former East 17th and East 19th Street Stations.

- A single excavation (number 31) along the First Avenue Loop Road showed MGP-related impacts at approximately 12 ft bgs.

- The observations made during excavations at the former East 14th Street Station site support the findings of previous reports and indicate that MGP-related subsurface impacts do not extend west of the former station.

GEI concluded that the presence of MGP-related impacts at the Avenue C and East 20th Street Loop Roads may require additional investigation, however no further investigation would be necessary at that time at the First Avenue and East 14th Street Loop Road. Comments from the NYSDEC dated August 24, 2007 indicated the need for further investigation at the First Avenue Loop Road. Observations indicate that MGP-related impacts within the variable fill beneath Stuyvesant Town were not generally seen above 5 ft bgs and would only be exposed during major construction events. These events would be managed by the appropriate soil and groundwater management plans for the site, along with the site-specific worker and community health and safety plans.

3.0 Supplemental Remedial Investigation Field Activities

This section provides a description of the methodologies used during the field investigation of the former East 14th, East 17th, and East 19th Street MGP Stations sites. The first round of RI field tasks was completed by GEI between March and June 2006. Additional aquifer conductivity testing was completed by GEI in October 2006. GEI field activities were conducted in accordance with their NYSDEC-approved RIWP (GEI, 2006). Following comments from the NYSDEC dated August 24, 2007, the second round of RI field activities was completed by AECOM between March and September 2008. AECOM field activities were conducted in accordance with the methods and procedures specified in the NYSDEC-approved SRIWP (ENSR, 2008d) for the site. Representatives of the NYSDEC, Division of Environmental Remediation of Albany, New York, were on site at various points throughout the project to observe boring installation and soil sampling.

The location and number of samples collected, along with corresponding analytical parameters, are presented in the following subsections and are available in Table 3-1. Descriptions of all field activities are included by field task and/or environmental media and sample locations are illustrated on Figure 3-1. Specific tasks performed during the RI include the following:

- Underground utility clearance
- Community air monitoring
- Surface soil sampling and analysis
- Upper fill sampling and analysis
- Lower fill/native soil sampling and analysis
- Monitoring well installation and development
- Groundwater elevation and NAPL thickness measurements
- Groundwater sampling and analysis
- Aquifer conductivity testing
- Indoor air survey
- Soil gas sampling
- Management of Investigation-Derived Waste
- Survey of remedial investigation sampling locations and basemap development
- Quality Assurance/Quality Control

3.1 Underground Utility Clearance

As part of GEI's RI program at the sites, GEI contracted with Utility Survey Corporation (USC), a geophysical survey and private utility clearance survey company, to complete a limited geophysical survey within the

footprint of the former East 19th Street Station, not presently covered by buildings or other structures. This survey was completed on March 5, 2006 and was done instead of supplemental test pitting within close proximity of existing building foundations.

In addition to the survey completed on March 5, 2006, USC was contracted by GEI to survey the area between the East 20th Street Loop Road and the 522-524 East 20th Street building. Using ground penetrating radar (GPR), USC was able to indicate and/or confirm the presence of a number of utilities and/or subsurface debris beneath the surface. Boring locations were then advanced or moved accordingly to avoid debris and/or utilities.

Underground utility clearance for both phases of intrusive RI field activities was performed in accordance with the Con Edison Utility Clearance Process for Intrusive Activities EH&S Remediation Program, Revision 2, dated September 24, 2004.

Under contract to GEI, Aquifer Drilling and Testing, Inc. (ADT) notified the New York City One Call Center to coordinate utility mark outs of underground utilities including electric, gas, and communication lines, on public Right-of-Ways (ROWs) adjacent to the Stuyvesant Town property, prior to the initiation of intrusive fieldwork during the 2006 field activities. In addition, sewer and water utility line maps were obtained from the NYCDEP for the public ROWs adjacent to Stuyvesant Town and a utility map of the property previously compiled by H&A were referenced prior to beginning intrusive fieldwork.

ADT performed intrusive utility clearance at each proposed boring location, on behalf of GEI, during the 2006 field activities. This pre-clearance included saw cutting concrete surfaces, as needed, and employed a combination of hand tools and vacuum extraction for clearing the locations to a minimum depth of 5 ft bgs. In the event an obstruction was encountered, the boring location was moved and a new location was cleared prior to commencing with the drilling.

Prior to the initiation of intrusive fieldwork during the 2008 SRI performed by AECOM, the drilling subcontractor, Paragon Environmental Construction, Inc. (PEC), contacted Dig Safely New York to arrange for location and marking of all underground utilities in the vicinity of proposed soil borings, as required by New York Code of Rules and Regulations (NYCRR) Part 753. Where possible, AECOM worked directly with the representatives of each utility company to ensure that all underground lines were properly identified and marked-out, on the perimeter sidewalks of the Stuyvesant Town property. In addition, a utility map of the property previously compiled by H&A, was referenced prior to beginning intrusive fieldwork.

For the 2008 SRI, utility clearance was performed by NAEVA Geophysics, Inc. (NAEVA) and Advanced Geophysical Services (AGS) under contract to AECOM. These companies used GPR as well as electro-magnetic (EM) survey methods to scan each proposed investigation location. Con Edison provided utility plates of gas and steam mains, high tension lines, low tension lines, and composite feeders. The sewer as-builts were prepared and provided by the City of New York Department of Public Works, Division of Sewage Disposal, and Bureau of Sewage Disposal Design.

Prior to advancing soil borings using a drill rig or geoprobe, each boring location was hand cleared to a minimum depth of 5 ft bgs with 2 foot by 2 foot dimensions. These excavations were performed in accordance with applicable guidelines and meant to locate any utilities that may have been incorrectly marked, are privately owned, have been abandoned, were not known to exist, or were not detectable by surface investigation methods. Under contract to AECOM, hand clearing was performed by PEC using shovels, posthole diggers, and other non-mechanical means.

As locations were pre-cleared for drilling activities, the material was logged for lithology, visually inspected for MGP-related impacts, and field screened for VOCs with a photoionization detector (PID), during both the 2006 and 2008 phases. In some cases, soil grab samples were collected to further characterize surficial and/or shallow subsurface soil conditions (Table 3-1).

3.2 Community Air Monitoring

Community air monitoring was performed and documented during both the 2006 and 2008 field programs to provide real-time measurements of total VOCs and particulate (airborne dust) concentrations upwind and downwind of each designated work area during intrusive investigation activities. Site personnel monitored any odors produced during these activities. The monitoring was designed to provide protection to the public downwind of the work area from any potential releases of airborne contaminants due to investigation activities and to document air quality during intrusive activities.

Instrumentation used during the Community Air Monitoring Program (CAMP) was located upwind and downwind of the work area on stands located in the breathing zone. The instruments were calibrated daily and recorded on separate field forms. The instrumentation used during the 2008 investigation activities included the following: a photoionization detector (PID) 10.6 eV to measure volatiles in parts per million (ppm) and a Dustrak meter to detect the particulate concentrations in milligrams per cubic meter (mg/m^3). A Dräeger pump and benzene colorimetric tubes were used to detect the presence of benzene. Equipment used by GEI during the 2006 field activities included a PID, used to measure and record VOC concentrations, and a MIE pDR-1000AN connected to a SKC single-port low-flow module, used to measure particulate dust. Response levels were programmed into the meters at the beginning of the field programs. Exceedance of these response levels would trigger an alarm to alert site workers that targeted compounds had exceeded the response levels.

During the 2008 field activities, the instruments were programmed to log air quality data once per minute during intrusive work activities. Personnel recorded readings and any observations from these instruments every 15 minutes on a separate CAMP field form. If elevated readings were observed, they were noted and the PID used to screen soil samples was placed next to the CAMP PID for direct comparison of readings. If both PIDs indicated sustained elevated readings for 15 minutes, a Dräeger pump with a colorimetric tube was used to test for the presence of benzene. Data from the PID and Dustrak monitors were downloaded to a field laptop computer on a daily basis. The recorded logs were reviewed for any exceedances and downloaded to a daily file with the work area location as the file name.

During the 2006 SRI, there were a few instances where CAMP action levels (PID readings greater than 1 ppm) were reached or exceeded at downwind locations during subsurface investigation activities. According to GEI, exceedances were generally due to humidity and ambient background conditions. None of the colorimetric benzene tubes indicated the presence of benzene. Exceedances recorded during the 2006 field activities were outlined by GEI in Section 3.11 of the IRIR (GEI, 2007a). During the 2008 RI activities, there were also a few instantaneous exceedances of CAMP action levels; however these exceedances were not sustained and were attributed to humidity and/or the presence of dust near roadways and/or landscaping equipment and were not due to invasive RI field activities. Based on the air quality monitoring data, the intrusive activities performed during both phases of the RI did not negatively impact the air quality at the site.

3.3 Surface Soil Sampling and Analysis

During the IRI in 2006, eight surface soil samples were collected to evaluate the extent of surface soil impacts noted during previous investigations at the Stuyvesant Town former MGP sites. No surface soil samples were proposed or taken as a part of the SRI work completed by AECOM in 2008. The location of the surface soil samples are shown on Figure 3-1. Table 3-1 summarizes the surface soil sample designation, depth, date, collection method, rationale, and laboratory analyses of each surface soil sample.

Surface soil samples were collected as grab samples from the walls of utility clearance excavations prior to the commencement of drilling and were collected from 0 to 0.2 ft below the vegetative root mat where “exposed” soils were present. In those areas where concrete or cobblestones were present, the “surface” soil samples were collected from the 0 to 0.2 ft below the base of the concrete or cobblestone.

Surface soil samples were collected for laboratory analysis, including Quality Assurance/Quality Control (QA/QC), and were placed directly into laboratory-supplied containers, placed in coolers, and preserved by ice. They were then sent under chain-of-custody protocol to Chemtech Laboratories (Chemtech) of Mountainside, New Jersey for analysis.

Excavated soils that showed evidence of contamination were placed in 55-gallon drums and managed in accordance with Subsection 3.8 of this report. Excavated soils that did not show signs of contamination were placed back in the utility clearance test pit.

3.3.1 Upper Fill Sampling and Analysis

The upper fill is comprised of material from 0.2 ft to 17 ft bgs, as originally characterized by GEI during the IRI in 2006. Thirteen upper fill soil samples were collected from 2 to 17 ft bgs by GEI during the 2006 IRI activities. The location of the upper fill soil samples are shown on Figure 3-1 and details including sample designation, depth, date, collection method, rationale, and laboratory analyses of each surface soil sample are summarized on Table 3-1. These samples were taken to delineate horizontal and vertical impacts observed during SC activities performed by H&A in 2004. Upper fill soil samples taken by GEI below the initial pre-clear depth were collected from split spoon recovery. These upper fill samples were collected for laboratory analysis, including QA/QC, and were placed directly into laboratory-supplied containers, placed in coolers, and preserved by ice. They were then sent under chain-of-custody protocol by courier to Chemtech.

Eleven upper fill soil samples were collected during the 2008 SRI to evaluate the extent of upper fill impacts noted during the 2006 IRI, as addressed by the NYSDEC August 24, 2007 comment letter. The location of the upper fill soil samples are shown on Figure 3-1 and details including sample designation, depth, date, collection method, rationale, and laboratory analyses of each upper fill soil sample are summarized on Table 3-1.

Upper fill samples from 0.2 to 5 ft bgs were collected during utility clearance activities. Aliquots of soil were collected at 1-foot intervals with a steel trowel to a depth of 2 feet. A hand auger, posthole digger, or shovel was used to collect soil aliquots at 1-foot intervals from a depth of 2 to 5 ft bgs. The steel trowel was decontaminated between each use. Upper fill samples collected from 5 to 17 ft bgs were sampled directly from either split spoon or macro-core recovery, depending on drilling method used to advance the boring. Further explanation of drilling and sampling procedures for the 2008 work can be found in the following subsection of this report. Sample aliquots were placed in plastic bags and screened with a PID for VOCs. The sampling instrument was decontaminated between each sample aliquot collection. If there were no olfactory or instrument indications of contamination, the sample for VOC analysis was collected by scraping soil from along the side of the utility clearance hole, split spoon, or macro-core liner. If there were olfactory or instrument indications of contamination, the soil aliquot exhibiting the highest PID reading was jarred and submitted for VOC analysis. The soils for the remaining analyses were composited and placed in the appropriate sample jars. Sample jars were labeled, placed in a cooler of ice, and sent under chain-of-custody protocol by courier to Chemtech.

Excavated soils from the utility clearance excavation that showed evidence of contamination were placed in 55-gallon drums and managed in accordance with Subsection 3.8 of this report, as were remaining soils in split spoons and macro-cores. Excavated soils from the utility clearance excavation that did not show signs of contamination were placed back in the utility clearance test pit.

3.3.2 Lower Fill/Native Soil Sampling and Analysis

During the 2006 IRI activities, 13 soil borings with continuous sampling were advanced and 40 lower fill/native soil samples were taken. Table 3-1 describes the purpose and sampling rationale for each sample taken, as well as which constituents the samples were analyzed for. Locations of the borings are presented on Figure 3-1. Of the borings proposed in GEI's RIWP (GEI, 2006), only two were not completed. ST17SB02 was to be

located within the Underground Parking Garage # 5, shown on Figure 2-2, between ST14SB01 and the entrance to the garage on the western side of Avenue C. The presence of boulders and fill materials within the subsurface prevented this boring from being advanced. The second proposed boring that was not completed during the IRI was ST14SB07, which was meant to be completed on the eastern side of Avenue C between ST14SB06 and ST14SB08. Active underground and adjacent station utilities located in the vicinity of the proposed boring posed a safety concern for Con Edison and the boring location was abandoned.

According to the IRIR, soil borings were advanced using either a hollow stem auger (HSA) drill rig outfitted with stainless steel split spoon samplers or using a propane-powered geoprobe-type rig outfitted with macro-core samplers with dedicated and disposable acetate liners. Those borings advanced outside of the parking garage areas were generally completed with HSA drill rigs using either mud-rotary or driving casing drilling methods. Mud-rotary methods were required due to the presence of silty sands and widely-graded running sands. Though this method was used, continuous split spoon sampling was maintained. A geoprobe-type rig was required for advancing borings within parking structures. Continuous cores were taken using macro-core samplers.

Drilling was performed by ADT and soil borings were advanced to the target depth or equipment refusal, whichever occurred first. Soils were logged in the field by GEI. Additional information regarding IRI sampling is available in Subsection 3.6 of the IRIR (GEI, 2007a). GEI boring and monitoring well completion logs are provided in Appendix B of this report.

The SRI soil borings were completed by PEC under contract to AECOM between March and July 2008 under the supervision of an AECOM geologist or engineer. Soil borings were advanced using HSA drilling rigs (truck- and track-mounted variations) or direct-push technology using a geoprobe rig. Continuous soil samples were generally collected from a depth of 5 ft to the base of each borehole. The upper 5 ft of each boring was logged continuously during utility clearance. The soils were logged for composition and presence of visual and olfactory impacts and were field screened with a PID for the presence of VOCs. Boring logs are provided in Appendix B of this RI report.

Samples were collected using a 2-inch outside diameter, 2-foot long split-spoon sampler. Soil samples were collected in advance of the augers by driving the split-spoon sampler through the sample interval with a 140 pound hammer on an anvil attached to the drive head on the sampler (via automatic hammer). Blow counts were recorded for every 6-inch interval. Split-spoon sampler refusal was considered 100 blows per 6-inches. Split spoons were decontaminated with Alconox® and water between each sample. The downhole drilling equipment was decontaminated by steam cleaning between each boring.

Soil borings advanced by direct-push geoprobe used a 5-foot long steel sampling tube (macro-core sampler) with an acetate liner. New liners were used for each 5-foot sample interval.

Upon completion, boreholes were grouted from the base of the boring. IDW was managed in accordance with Subsection 3.8 of this SRI report.

During 2008 SRI activities, 37 lower fill/native soil samples were taken. Information regarding sample location, depth, date, rationale, and analyses is available in Table 3-1 and boring locations are shown on Figure 3-1. Lower fill/native soil samples were collected in accordance with proposed samples from the SRIWP (ENSR, 2008d) and taken mainly to delineate the horizontal and vertical extent of impacts from the former MGP station sites, as requested by the NYSDEC in the August 24, 2007 comment letter.

Soil for VOC analysis was collected directly from the interval exhibiting the highest PID readings when detected. Soil collected for the remaining analyses was sampled across the sample interval. Soil samples were collected in jars, labeled, placed in coolers of ice, and sent under chain-of-custody protocol by courier to Chemtech.

Soils remaining in split spoon and/or macro-core samplers following sample collection were containerized in 55-gallon drums and managed in accordance with Subsection 3.8 of this report.

Four proposed borings, 19WVSB03, 17WVSB01, ST14SB14, and ST14SB15, were not completed during SRI field activities, and therefore their associated samples were not taken. Borings 19WVSB03 and 17WVSB01 were not completed due to refusal at 12.3 ft and 8 ft bgs, respectively. Borings ST14SB14 and ST14SB15 were not installed due to access constraints.

3.4 Monitoring Well Installation and Development

There were no additional monitoring wells installed during the 2008 SRI field activities. As such, the following section summarizes the work performed by GEI in 2006 and submitted as Subsection 3.7 of the IRIR in 2007.

Under the direction of GEI, 13 monitoring wells were installed as part of the IRI field program and were located within or adjacent to the former East 14th and East 17th Street Stations. The rationale for these wells and associated groundwater samples can be found on Table 3-1 and the wells may be seen on Figure 3-1. All IRI monitoring wells were installed by ADT under contract to GEI and were completed as a 2-inch inner diameter monitoring well with flush-threaded polyvinyl chloride (PVC) 0.010-inch slotted screen, a solid PVC riser, and a flush-mounted protective cover. Five wells were installed within or near the former East 14th Street Station site and eight wells were installed within or near the former East 17th Street Station site.

Wells were installed as clusters and screened intervals were identified as shallow (S), intermediate (D), and deep (DD) to indicate the groundwater flow zone within which each well was screened. In general, shallow monitoring wells were installed to a depth of 17 ft bgs, intermediate wells were installed to a depth of approximately 32 ft bgs, and deep wells were installed to a depth below 50 ft bgs. Monitoring well construction logs for wells installed during the GEI IRI and the H&A SCS are available in Appendix B of this RI report and the details of monitoring well construction are available in Table 3-2.

The monitoring wells installed during the IRI in 2006 were developed by GEI to remove silt and clays from the well, as well as stabilize the well filter pack. Additional information on monitoring well installation and development may be found in Subsection 3.7 of the IRIR (GEI, 2007).

3.4.1 Groundwater Elevation and Nonaqueous Phase Liquid Thickness Measurements

As part of the SRI field activities, AECOM conducted a round of water level and NAPL thickness measurements in 25 of the 29 monitoring wells on September 24, 2008, in addition to recording the depth to water and presence or absence of NAPL during groundwater sampling. Water level and NAPL measurements were recorded in four wells (00MWS06, 00MWD06, 17MWDD04, and MW-10) during groundwater sampling activities in August 2008. Depths were measured using electronic water level meters and/or oil-water interface probes. The August 2008 and September 24, 2008 groundwater elevation data were compiled and are presented in Table 3-3 along with the June 2006 RI data.

3.4.2 Groundwater Sampling and Analysis

Groundwater sampling took place during both phases of remedial investigation field work. GEI took 28 groundwater samples from 11 well clusters, along with QA/QC samples, in June 2006. Groundwater was not sampled from monitoring well 14MWD02 due to the accumulation of NAPL in the bottom of the well. Monitoring well locations are shown in Figure 3-1 and sample collection rationale and laboratory analyses are provided in Table 3-1. Additional information regarding the 2006 groundwater sampling event is available in Subsection 3.8.4 of the IRIR (GEI, 2007). In addition, groundwater sampling forms for this sampling event are available in Appendix D of this RI report, along with those forms generated during AECOM's 2008 groundwater sampling event.

Twenty-eight monitoring wells were sampled between August 19 and September 29, 2008 as part of the SRI field activities. As with the previous sampling event, NAPL was encountered at 14MWD02 and a sample was not taken from that well. AECOM took 29 groundwater samples from the 28 wells that were sampled. Monitoring well 17MWS05 was sampled on September 10, 2008 and re-sampled on September 29, 2008 due to limited volume submitted to the laboratory after the first round of sampling. Monitoring well locations are shown in Figure 3-1 and sample collection rationale and laboratory analyses are provided in Table 3-1. Field forms for the groundwater sampling events are included as Appendix D to this report.

Monitoring wells were purged and groundwater samples were collected using a peristaltic pump and low-flow sampling methodologies. Prior to purging and sampling the depth to water and presence/thickness of NAPL were measured to the nearest 0.01 of a foot in each monitoring well. NAPL was only found in monitoring well 14MWD02 where approximately one foot was noted. Tubing (and for the deep DD-series wells, a foot valve) was placed at the approximate midpoint of the screened interval unless NAPL was observed/detected in the well.

Groundwater purge rates were set below the maximum sustainable flow rate to ensure that the water table remained within 0.3 feet of the initial depth to water reading in the well. During purging activities, groundwater passed through a Horiba U-22 flow-through cell which contained probes to measure the water temperature, pH, conductivity, and oxidation-reduction potential. Samples of water discharging from the cell were collected at 5-minute intervals and analyzed for turbidity using a LaMotte® 2020 turbidity meter. After passing through the cell, the water was discharged and temporarily contained in 5-gallon buckets. The purged water was later transferred to 55-gallon closed top drums and managed in accordance with Subsection 3.8 of this report.

Once the water quality parameters had stabilized, the Horiba U-22 flow-through cell was disconnected and groundwater samples were collected directly into appropriate laboratory-supplied glassware. Sample bottles were labeled, wrapped in plastic, placed in coolers with ice, and sent by courier to Chemtech for analysis under chain-of-custody protocol.

3.4.3 Aquifer Conductivity Testing

Aquifer conductivity testing was performed at the site by conducting slug tests at three locations: 14MWS01, 17MWS04, and 14MWD01. This testing was done by GEI in October 2006 and is summarized below. Additional information is provided in subsection 3.9 of the IRIR (GEI, 2007a) and Section 4 of this report.

On October 9 and 10, 2006, GEI conducted in-situ (slug) tests on three wells (14MWS01, 17MWS04, and 14MWD01) screened in the shallow and intermediate groundwater zones of the Upper Glacial Aquifer underlying Lower Manhattan, including the Stuyvesant Town property. These tests were conducted using a downhole data logger. The data were analyzed by the Bouwer and Rice method (1989) to calculate aquifer hydraulic conductivity values for the two depth intervals within the overburden aquifer. Table 3-4 shows a summary of the hydraulic conductivity values and Appendix E includes the data files for the slug tests and subsequent hydraulic conductivity calculations provided by GEI.

3.5 Indoor Air Survey

GEI simultaneously completed a building assessment survey and the collection of indoor air samples within the Stuyvesant Town buildings at the former East 14th Street Station site on March 16, 2006. These sample locations were generally coincident with those that had been sampled by RETEC in 2003 as shown on Figure 2-3. A total of eight (seven samples, one duplicate sample) indoor air samples were taken from within five buildings located within the footprint of the former East 14th Street Station. Additional information regarding this survey was reported in the IRIR by GEI and is available in Subsections 3.3 and 3.8.1 of that report (GEI, 2007a).

Indoor air samples were neither proposed in the SRIWP (ENSR, 2008d) nor collected during the SRI activities.

3.6 Soil Gas Sampling

GEI also collected 13 soil vapor samples and one duplicate sample from 11 temporary soil vapor monitoring points and 2 temporary sub-slab vapor points installed during the IRI activities in 2006. Sample locations are shown on Figure 3-1 and were within the footprints of all three former MGP station sites. The two temporary sub-slab vapor points were installed in Underground Parking Garage #5, also illustrated on Figure 3-1, and the vapor samples were collected. These samples were taken in accordance with GEI's RIWP (GEI, 2006) and further information regarding sampling procedures are available as Section 3.5 of the IRIR (GEI, 2007a).

No soil gas or sub-slab vapor samples were proposed in the SRIWP (ENSR, 2008d) or collected during the SRI activities.

3.7 Chemical Analytical Program

The majority of the soil and groundwater samples collected during both phases of this RI were analyzed for the following:

- VOCs by USEPA SW-846 Method 8260B
- SVOCs by USEPA SW-846 Method 8270C
- Metals by USEPA SW-846 6000/7000 Series
- Total cyanide by USEPA SW-846 Method 9012A

Additionally, the 2006 IRI samples were analyzed for amenable cyanide by USEPA SW-846 Method 9012A, and select groundwater samples were analyzed for dissolved metals. These analyses were performed by Chemtech in accordance with NYSDEC Analytical Services Protocol (ASP).

3.8 Management of Investigation-Derived Waste

GEI outlined their management of IDW in Section 3.12 of the IRIR (GEI, 2007a). A total of 103 IDW drums were generated during the 2006 IRI activities, including 32 classified as construction and debris material (C&D), 29 classified as soil, and 42 classified as liquids. IDW records from that report are included as Appendix F to this report.

The management of IDW was performed by AECOM field personnel during the SRI activities at the site. Waste generated during the SRI included soil cuttings, decontamination fluids, groundwater purge and development water, and C&D, including personal protection equipment (PPE). All of the waste was containerized in either closed-top (liquid) or open-top (soil and C&D) 55-gallon drums. The drums were collected at the end of each day and transported to the equipment storage area underneath the FDR Drive. Drums were labeled and composite samples were collected from the soil and water drums for waste characterization analysis, which was completed by Chemtech. Samples submitted to the laboratory for analysis were requested for a 5-day turnaround time to expedite disposal. Clean Earth of North Jersey, Inc. provided transport and disposal of the drums.

A field log was developed and maintained to keep track of the number of drums, waste type, and designation. Table 3-5 provides a summary of the 2008 data, including date, manifest number, and the total number and type of drums included on the manifest for the waste that was generated and disposed during the RI field activities. The waste generated during the investigation was separated as per waste profiling with the transport/disposal facility (Clean Earth of North Jersey, Inc.). The manifests for the IDW are located in Appendix F, preceding the information provided by GEI for the 2006 IDW management. In total, 73 drums were generated during SRI activities, including: 14 liquid, 38 C&D, and 21 soil.

3.9 Survey of Remedial Investigation Sampling Locations and Basemap Development

The 2006 IRI sample locations were surveyed by a surveyor licensed in the State of New York. Although previously reported by GEI as having been surveyed in the East Zone of the New York State Plane Coordinate System, the 2006 sample locations were actually surveyed in the Long Island Lambert Zone of the New York State Plane Coordinate System. These locations were then tied into the site map prepared by H&A during the SCS. That map is based on the Borough of Manhattan Vertical Datum which is equivalent to +2.75 United States Geologic Survey (USGS) Vertical Datum of 1929. Elevations were surveyed to the nearest 0.01 foot. The 2006 RI locations were tied into the site plan using coordinates provided for previously installed monitoring wells, fixed utility locations (lights), and buildings on the Stuyvesant Town property. Surveyed property features were referenced to the Borough of Manhattan Horizontal Coordinate System.

The AECOM 2008 RI sample locations were surveyed by Geod, Inc. These locations were surveyed in the 1983 North American Datum (NAD 83) Long Island Lambert Zone of the New York State Plane Coordinate System and were referenced to the 1988 North American Vertical Datum (NAVD88). Surveyed locations were then added to the previous data to create the new basemap (Figure 3-1).

3.10 Quality Assurance/Quality Control

QA/QC protocols and procedures were implemented during both phases of the remedial investigation at the Stuyvesant Town former MGP station sites, in order to ensure accuracy, precision, and completeness of chemical data collected during investigation activities. Samples for QA/QC were taken during all portions of environmental work done at the site in order to evaluate the validity of sampling, decontamination, and analytical methods employed throughout the work.

QA/QC samples were taken of soil, groundwater, and air and included trip blanks, duplicates, and field blanks or equipment rinsates. The samples taken for QA/QC have been summarized in Table 3-6. There were two types of field duplicates taken during RI activities: "blind" duplicates and matrix spike/matrix spike duplicate (MS/MSD) samples. Blind duplicates were labeled in such a manner that the laboratory would not know which samples they were duplicating, nor that they were actually duplicates in some cases. This process allowed both GEI and AECOM to verify laboratory reproducibility of analytical data. MS/MSD samples were also submitted and were identified as such on the chain-of-custody so the laboratory could perform internal quality checks on instrument performance.

Field blanks were used to monitor equipment decontamination procedures and lower the possibility of cross-contamination between samples and sample locations. Trip blanks were submitted to monitor possible sources of contamination during the transportation of analytical samples from the site to the laboratory.

During both the 2006 and 2008 RI activities, QA/QC samples were submitted to Chemtech for analysis. The samples were analyzed for the following:

- VOCs by USEPA SW-846 Method 8260B
- SVOCs by USEPA SW-846 Method 8270C
- Metals by USEPA SW-846 6000/7000 Series
- Total cyanide by USEPA SW-846 Method 9012/9013

Full data evaluation packages were submitted to GEI and AECOM by Chemtech for the 2006 and 2008 data, respectively, in accordance with NYSDEC Electronic Data Deliverables (EDD) requirements. Data usability summary reports were conducted by GEI and AECOM based on the following parameters:

- Preservation and technical holding times
- Calibration verification results
- Blanks
- Field duplicates
- Laboratory fortified blank recovery

Copies of both the GEI and AECOM data packages and data usability summary reports (DUSRs) that were provided by Chemtech are provided in Appendix G of this report. Qualifiers are included in those reports as well as in the summary tables within this report.

4.0 Regional Geology/Hydrogeology

Information concerning the site stratigraphy and hydrogeology were obtained from observations made during the installation of environmental borings and monitoring wells during the SRI performed by AECOM in 2008, IRI performed by GEI in 2007, and during the SC by H&A in 2004. This section discusses the geologic and hydrogeologic characteristics of the subsurface in and adjacent to the First Avenue Loop, East 14th Street, East 17th Street, and East 19th Street Station footprints.

4.1 Site Geology

There were four major stratigraphic units identified during investigation drilling programs. As shown on the boring logs and cross sections, the site geology generally consists of the following four units from ground surface downward:

- Fill
- Organic Deposits/Peat
- Glacial Lacustrine/Glacial Outwash Deposits
- Weathered Bedrock

Six geologic cross sections (A-A' through F-F') were developed based on boring log data collected during the various investigation activities and are based on the original cross sections created by H&A and expanded upon by GEI and AECOM. In addition to the geological conditions, the cross sections illustrate the physical and analytical observations of MGP-related impacts and petroleum impacts related to non-MGP sources. Geologic cross section locations are illustrated on Figure 4-1 and the cross sections are provided on Figures 4-2A through 4-7B. The boring logs and well construction diagrams on which the cross sections are based are provided in Appendix B.

The site geology was described in detail in the IRIR (GEI 2007a) by depositional environment. The SRI borings encountered subsurface material consistent with that described in that and as such, much of the geologic information below is excerpted from the IRIR with additional detail or modifications provided from observations made during the SRI field activities.

4.1.1 Fill

The fill layer beneath the former MGP station sites, as well as the First Avenue Loop Road, consists of intermixed sand, silt, and gravel with varying amounts of brick, concrete, boulders, wood, ash, cinders, metal fragments, and glass. Clinker and ash-like material along with bricks and concrete, were occasionally observed in the split-spoon samples.

The depth of fill at the site ranged from approximately 20 ft near the First Avenue Loop Road to almost 50 ft bgs at boring location ST17SB04, located just off of the Avenue C Loop Road on the eastern portion of the site. In general, the fill depth is between 20 and 30 ft bgs across the site and most likely reflects man-made disturbances to pre-existing natural soils from historical building construction and eastern expansion of the shoreline.

4.1.2 Organic Deposits/Peat

Deposits of organic material were encountered within and beneath the fill layer at the former MGP station sites, as well as nearby adjacent areas. The deposits consist mainly of gray to black clayey silt, organic silt,

and brown to black peat and are characterized by an organic or hydrogen sulfide-like odor. In a number of borings, shell fragments were found, along with plant material, in addition to the organic odor. This layer, though sporadic, was found at a number of borings at each of the former MGP station sites, however was not encountered at the boring on the First Avenue Loop (A4WVSB01). This is most likely due to the fact that the boring did not extend deep enough and was completed to 20 ft bgs, within the fill layer.

The organic deposits found during the various drilling activities are consistent with low energy marsh and mud flat environments, which existed in the area up through the early 1800s, at which time the area was filled in to extend the shoreline and create more land for industrial use. The organic deposits, therefore, reflect those former mud flats and stream and creek beds known to have fed the East River in this area. The inconsistencies in the presence of these deposits are attributable to the infilling and leveling activities associated with extending the shoreline eastward.

4.1.3 Glacial Deposits

Beneath the fill and peat/organic deposit layers, glacial deposits were encountered. The deposits range in depth from approximately 16 ft to 85.5 ft bgs and consist primarily of glacial lacustrine deposits, interbedded and underlain by layers of glacial till and outwash. The majority of the environmental borings drilled during site characterization and remedial investigation activities at Stuyvesant Town were completed within the glacial deposits, however four borings in the footprint of the former East 14th Street Station extended to bedrock. Samples from these four borings suggest that the thickness of the glacial deposit layer exceeds approximately 60 ft at some areas beneath Stuyvesant Town.

The glacial lacustrine deposits consist of layers of gray to red-brown sand, silty sand, silt and clay, and clay layers and are thinnest beneath the former East 14th Street Station. These deposits get thicker beneath the former East 17th Street Station, as can be seen in the cross sections (Figures 4-2A through 4-7B) and boring logs (Appendix B). There is a fine-grained sand layer present at each of the former stations, beneath the fill or organic deposits, where they are present. This fine-grained sand layer may be remnants of the damming of the Hudson River by the Harbor Hill Terminal Moraine, which dammed the river to the south (Meguerian, 2003). Some glacial outwash sands were encountered within and below the fine-grained glacial lacustrine deposits near the southeastern portion of the former East 14th Street Station, however they were not continuous and were in rather isolated layers. These sands are generally red-brown to olive-gray and brown with occasional fine-grained silt and clay lenses. They were found between approximately 30 ft and 85 ft bgs.

4.1.4 Bedrock

The bedrock beneath Stuyvesant Town varies below the three former MGP station sites. During AECOM's RI activities, bedrock was only encountered in a single boring (ST14SB09) and is described as crushed mica schist at 45 ft bgs, which is interpreted as being the surface of bedrock. The inferred bedrock surface was encountered beneath the southeastern portion of the former East 14th Street Station in three borings between 49.5 ft bgs (ST14SB05) and 85.5 ft bgs (ST14SB03). The inferred bedrock surface was encountered on the south side of East 14th Street between 41 ft bgs (ST14SB10) and 44 ft bgs (ST14SB11). The surface of bedrock was determined through split-spoon and auger refusal. Black and white striated weathered rock fragments were encountered and previously identified as the Ravenswood Granodiorite. As previously noted and according to published information, the bedrock beneath the East 14th and East 17th Street Stations is classified as the Ravenswood Granodiorite (Baskerville, 1994). The Ravenswood Granodiorite is igneous and described as a medium to dark gray granodiorite with a granitic or gneissic texture formed during the Middle Ordovician to Middle Cambrian periods or approximately 460 to 500 million years ago (Baskerville, 1994). The surface dips sharply to the northeast and is located approximately 40 to 80 ft below ground surface in the area near the former East 14th Street Station and more than 80 feet below the footprint of the East 17th Street Station (Baskerville, 1994).

Also underlying the Stuyvesant Town apartment complex is the Inwood Marble, which underlies the area of the former East 19th Street MGP Station. The Inwood Marble is a metamorphic rock generally described as white to blue-gray, fine to coarse grained calcitic to dolomitic marble, middle Ordovician to Late Cambrian in age (Baskerville, 1994). It is present approximately 60 to 80 ft bgs at the East 19th Street Station site and is part of the northeast-southeast trending Cameron thrust fault which reportedly bisects the Stuyvesant Town property. According to the 2002 MGP Research Reports published by Langan, bedrock in the vicinity of the fault dips roughly 45 degrees to the northwest (GEI, 2007a). Borings advanced at the former East 17th Street and East 19th Street Stations, as well as boring A4WVSB01, which was advanced on the First Avenue Loop Road, did not extend to bedrock.

4.2 Site Hydrogeology

The site hydrogeology was described by GEI (2007a) in terms of the closest surface water body, the East River, and the groundwater table aquifer, Upper Glacial Aquifer, located beneath Stuyvesant Town. As such, the majority of the information below is excerpted from the IRI report, with additional detail or modifications provided from observations made during the 2008 SRI field activities.

The nearest surface water body to the Stuyvesant Town site is the East River, which is located approximately 200 ft to 2,250 ft from the property boundaries to the east. The East River is classified by the NYSDEC as a Class I saline surface water which is used for ship traffic and non-contact recreational purposes. Class I saline surface waters are also designated for fishing, however, numerous NYSDOH health advisories exist for consumption of fish caught in the East River. The west shoreline of the East River in the vicinity of the site is listed in the National Wetlands Inventory (Langan, 2002). A single groundwater aquifer, the Upper Glacial Aquifer, has been identified beneath the property, and is generally an unconfined aquifer exhibiting some semi-confined conditions at depth because of the presence of tighter silty sand and clay materials.

Fourteen monitoring wells were installed by H&A during the SC field activities in 2004, and 13 monitoring wells were installed by GEI during the IRI field activities in 2006. Two monitoring wells (MW-36 and MW-10) were installed prior to 2004 and are closest to the former East 14th Street Station. These 29 monitoring wells are used to evaluate groundwater conditions at the site. Table 3-2 provides a summary of the monitoring well designations, screened intervals and aquifer zones, total depth, and top of casing and screened interval elevations. No monitoring wells were installed during the SRI field activities, however a round of groundwater sampling was completed in September, 2008.

As shown in Table 3-2, the monitoring wells are screened at three general depth zones within the unconfined overburden aquifer beneath the site. The shallow zone wells (S-series) are generally screened between 5 and 15 ft bgs. The intermediate zone wells (D-series) are generally screened between approximately 21 and 31 ft bgs. The deep zone wells (DD-series) are generally screened between approximately 40 and 50 ft bgs. Seven each of the S and D-series wells were installed by H&A during SC activities in 2004. All eight of the DD-series wells, along with two S-series wells and three of the D-series wells were installed by GEI during IRI activities in 2006. The wells were constructed using 2-inch PVC casing threaded to 2-inch Schedule 40 PVC riser.

GEI evaluated groundwater flow in the Upper Glacial Aquifer by dividing the aquifer into a shallow (water table) zone and a deeper intermediate groundwater zone. Groundwater elevation data are summarized in Table 3-3. Groundwater contour maps are shown on Figure 4-8 and were initially created using depth to groundwater measurements taken on June 6, 2006. The 2008 contours are based on measurements taken AECOM during groundwater sampling events in August and September, 2008. The shallow contours were created using data from the following wells: 14MWS01, 14MWS02, MW-36, MW-10, 17MWS03, 17MWS04, 17MWS05, 17MWS06, 19MWS05, 00MWS06, and 00MWS07. Contours in the intermediate zone were created using the following wells: 14MWD01, 14MWD02, 14MWD05, 17MWD03, 17MWD04, 17MWD06, 17MWD06, 19MWD05, 00MWD06, and 00MWD07. Groundwater flow and hydraulic gradients for the two zones beneath Stuyvesant Town were determined based on the groundwater contours.

Horizontal hydraulic conductivities were calculated by GEI using the Bower Rice Method based on in-situ tests performed on two monitoring wells screened in the shallow water table zone and one well screened in the intermediate groundwater zone. Table 3-4 provides hydraulic conductivity data calculated by GEI (2007a).

4.2.1 Upper Glacial Aquifer – Shallow (Water Table) Zone

Water level data collected during the 2006 IRI and the 2008 SRI were converted to groundwater elevations using surveyed well elevations and are presented on Table 3-3. Groundwater elevation contour maps for these data are illustrated on Figure 4-8. Direction of flow can be inferred from this figure and is shown as a blue arrow.

During the IRI, water table elevations in the shallow zone ranged from 4.75 ft NAVD88 (00MWS06) to -0.17 ft NAVD88 (17MWS05). During the 2008 SRI, water table elevations in the same zone ranged from 6.25 ft NAVD88 (00MWS06) to -0.62 ft NAVD88 (14MWS01). The top of the screened intervals within the shallow zone wells range from 7.25 feet NAVD88 (00MWS07) to -0.85 ft NAVD88 (17MWS05).

As can be seen in Figure 4-8, the general trend for groundwater flow in the shallow upper glacial aquifer is east-southeast towards the East River, however flow may vary locally due to the heterogeneity of fill materials in the upper portions of the aquifer, thereby causing localized disparities in the flow direction.

According to calculations by GEI, the average hydraulic gradient of the shallow groundwater aquifer ranges from 0.0019 foot/foot to 0.01 foot/foot with the steepest hydraulic gradient being located in the southeast corner of the former East 14th Street Station along East 14th Street. Based on the 2008 data, the average hydraulic gradient of the shallow groundwater aquifer ranges from 0.016 foot/foot to 0.0025 foot/foot. Generally, the horizontal hydraulic gradients were lower in the central portion of Stuyvesant Town, to the west of the former MGP station sites (GEI, 2007a).

Rising head slug tests conducted on monitoring wells 14MWS01 and 17MWS04 were conducted by GEI on October 26, 2006 to determine the hydraulic conductivity of the shallow zone of the Upper Glacial Aquifer. The two wells used in this test are screened in a sand-and-clay fill material and silty-sand fill material and the calculated hydraulic conductivity is 15 ft per day for 14MWS01 and 169 ft per day for 17MWS04 (GEI, 2007a).

Average linear flow velocities were also calculated by GEI for the shallow zone. Calculations were based on the calculated horizontal hydraulic gradients and hydraulic conductivities. The estimated average linear flow velocities range from 390 ft per year in the central portion of Stuyvesant Town, near monitoring well 17MWS04, to roughly 182 ft per year in the southeastern portion of the former East 14th Street Station (GEI, 2007a). The calculated average linear flow velocity for the central portion of Stuyvesant Town using the 2008 data is approximately 514 ft per year, while the calculated average linear flow velocity in the southeastern portion of the property is approximately 292 ft per year. An estimated porosity of 30% was used for calculating the average linear flow velocity.

4.2.2 Upper Glacial Aquifer – Intermediate and Deep Groundwater Zones

The deep groundwater zone within the footprints of the former East 14th, East 17th, and East 19th Street Stations and adjacent areas is located within fill material, organic deposits, and glacial deposits, as can be seen on the cross sections (Figures 4-2A through 4-7B). There were 16 monitoring wells located within this deeper groundwater zone, as well as two background monitoring wells located west of the former stations within the Stuyvesant Town property. These wells (00MWD06 and 00MWD07) are screened within glacial deposits.

Below the shallow (water table) groundwater zone, groundwater is monitored by wells screened in the intermediate and deep groundwater zones. Wells screened in the intermediate zone are screened from approximately -8.17 ft NAVD88 (19MWD05) to -26.23 ft NAVD88 (14MWD05) and are labeled as “D” wells

within each well cluster. These wells are screened within fill material, organic deposits, and glacial deposits. Those wells screened within the deep groundwater zone are screened from approximately -29.51 ft NAVD88 (17MWDD04) to -52.52 ft NAVD88 (14MWDD03) and are labeled as "DD" wells. These wells are primarily screened within glacial deposits at or near the former East 14th and East 17th Street Stations. All wells were constructed using Schedule 40, 20-slot PVC and have a 10-foot screened interval.

During the IRI, groundwater elevations in the intermediate zone ranged from 4.86 ft NAVD88 (00MWD07) to 0.43 ft NAVD88 (14MWD05). During the 2008 SRI, water table elevations in the same zone ranged from 5.00 ft NAVD88 (00MWD07) to 0.13 ft NAVD88 (14MWD05).

Deep ("DD") groundwater monitoring wells were not used in generating the groundwater elevation contour map for the deep groundwater zone (Figure 4-8) due to the lack of these wells throughout the site. Only seven monitoring wells designated as "DD" wells were installed, none of which were installed as background wells or at the former East 19th Street Station. Groundwater elevations, however, ranged from 2.66 ft NAVD88 (17MWDD04) to -0.43 ft NAVD88 (14MWDD05) during SRI 2008 field activities.

As seen in Figure 4-8, the groundwater in the intermediate zone appears to flow eastward towards the East River. In addition to the man-made structures and heterogeneity of the fill beneath Stuyvesant Town causing local variations in groundwater flow, two sewer lines flowing east to west bisect the Stuyvesant Town property and most likely intersect the Pollution Control Interceptor Sewer running along East 20th Street and south along Avenue C. Though not seen in the "D" wells near the former East 14th Street Station, groundwater flow in that area may be affected by the MTA subway structures and foundations for the "L" line located beneath the East 14th Street ROW and roadway (GEI, 2007a).

According to the 2006 GEI data, the average hydraulic gradient of the intermediate groundwater zone within the aquifer underlying Stuyvesant Town ranges from 0.00046 foot/foot to 0.008 foot/foot with the steepest gradient being located in the southeast corner of the former East 14th Street Station along East 14th Street. Hydraulic gradient calculations were made based on groundwater elevations between two well pairs: 17MWD04, 17MWD06 and 14MWD01, 14MWD02. Using the same well pairs, the average hydraulic gradient of the intermediate groundwater zone according to the 2008 data ranges from 0.003 foot/foot in the central portion of the Stuyvesant Town property to 0.006 foot/foot at the former East 14th Street Station site with the steeper gradient being found in the central portion of the property near 17MWD04.

A single rising head slug test conducted on monitoring well 14MWD01 was conducted by GEI on October 26, 2006 to determine the hydraulic conductivity of the intermediate zone of the Upper Glacial Aquifer. The well used in this test is screened in a silty-sand material and the calculated hydraulic conductivity for 14MWD01 is 129 ft per day (GEI, 2007a).

Average linear flow velocities were also calculated by GEI for the intermediate zone and are based on the calculated horizontal gradients and hydraulic conductivities. The estimated average linear flow velocities range from 72 ft per year in the area of Stuyvesant Town near the former East 17th Street Station to 1,255 ft per year within the East 14th Street Station footprint, near the East 14th Street ROW and the "L" subway line (GEI 2007a). Using the 2008 calculated horizontal gradients and the 2006 hydraulic conductivity of 129 ft per day the average linear flow velocities range from approximately 471 ft per year near the former East 17th Street Station to approximately 942 ft per year within the footprint of the former East 14th Street Station. An estimated porosity of 30% was used in these calculations.

4.2.3 Vertical Head Gradients

The potential for vertical groundwater flow between flow zones within an aquifer is of interest because of the potential for groundwater contaminant migration between different zones. The calculation of the vertical head gradient between the two groundwater flow zones, therefore, can provide a means to assess the potential for groundwater, and thus contaminant, flow between separate flow zones. Groundwater may not actually move

vertically between two aquifers or flow zones, however, if a confining layer, such as varved silt-clay or rythmite deposits, is present.

Based on groundwater elevations collected in both 2006 and 2008, vertical head gradients were calculated to assess the potential for vertical movement of groundwater between flow zones within the Upper Glacial Aquifer underlying Stuyvesant Town and the former MGP stations sites. These calculated values are provided in Table 4-1. According to the 2006 data, there was a slight downward gradient between the shallow and intermediate groundwater zones for the majority of the well clusters within the former East 14th, East 17th, East 19th Street Stations and surrounding areas. These downward gradients ranged from -0.014 for 17MWS06/17MWD06 to -0.137 for 19MWS05/19MWD05. GEI also noted slight upward gradients within the background monitoring well cluster 00MWS07/00MWD07 at 0.009 and at the 17MWS05/17MWD05 well cluster at 0.053 (GEI, 2007a).

Groundwater elevations and subsequent calculations of vertical head gradient using 2008 data showed some change from a more downward gradient to a slightly more upward gradient for flow between the shallow and intermediate groundwater flow zones within the Upper Glacial Aquifer. A downward gradient was only seen in six well clusters, as opposed to the eight well clusters that had previously exhibited the potential for downward flow. The downward gradient ranged from -0.008 at 17MWS04/17MWD04 to -0.073 at the 17MWS05/17MWD05 well cluster. The upward gradient ranged from 0.071 in the 17MWS03/17MWD03 well cluster to 0.305 in the 14MWS01/14MWD01 well cluster.

Also shown in Table 4-1 are the vertical head gradients for the intermediate to deep groundwater flow zones. The data from the 2006 as well as the 2008 field activities show both upward and downward head gradients observed between the “D” and “DD” well pairs and do not exhibit a similar change of gradient over time as seen in the shallow to intermediate data. In 2006 upward gradients were noted in well pairs 14MWD01/14MWDD01, 17MWD03/17MWDD03, and 17MWD04/17MWDD04. The remaining intermediate and deep well pairs exhibited a downward vertical gradient in 2006. In 2008 only one intermediate/deep well pair exhibited an upward vertical gradient, 14MWD02/14MWDD02. The remaining intermediate/deep well pairs exhibited downward vertical gradient in 2008.

5.0 Analytical Results and Subsurface Observations

This section presents and describes the analytical results for the soil, groundwater, and soil gas samples collected during the RI and SCS as well as the visible MGP-related impacts noted during subsurface intrusive activities including the capital improvement campaign to replace water and hydrant valves throughout the Stuyvesant Town property. Analytical results tables for the surface soil, upper fill soil, lower fill/native soil, groundwater, and soil gas samples collected during the RI and SCS are presented in the following subsections. The analytical results were compared to applicable NYSDEC guidance values and/or standards, as well as site-specific background values. The discussion is presented by environmental media and area of concern.

5.1 Surface Soil

A total of 44 surface soil samples and 4 duplicate samples of surface soils were collected at the Stuyvesant Town property by H&A and GEI. The majority (36) were collected by H&A during the 2004 SC work. There were no surface soil samples collected during the 2008 RI. Surface soil samples were taken beneath concrete, cobblestone, or landscaped surfaces and extended to a depth of 0.2 ft. Analytical results for surface soils can be found in Tables 5-1, 5-2, and 5-3. Surface soil sample locations and concentrations of compounds detected in surface soil are illustrated on Figure 5-1.

5.1.1 Former East 14th Street Station Results

Of the 44 surface soil samples and 4 duplicate samples taken at the Stuyvesant Town property, 18 soil and 3 duplicate samples were taken in the footprint of the former East 14th Street Station (Figure 5-1). Only one sample (ST14SB02) was collected by GEI in 2006. The rest were collected by H&A in 2004. As shown on the cross sections (Figures 4-2A through 4-7B) and in the boring logs (Appendix B), fill materials extend to approximately 14 to 25 ft bgs in this portion of the Stuyvesant Town property. As previously reported by GEI, the surface soil samples were taken from areas that did not show evidence of MGP-related impacts and as can be seen on Table 5-1, the concentrations of VOCs and non-carcinogenic PAHs were both below their respective RSCOs and SSBVs. The concentrations of some individual carcinogenic PAHs and several metals were consistent across the site and exceeded the individual RSCOs and SSBVs. Benzo(a)pyrene (BaP) equivalents concentrations exceeding both the RSCO (0.061 mg/kg) and SSBV (1.046 mg/kg) ranged from 1.188 mg/kg in sample 14PH003 to 14.37 mg/kg in sample 14GH007. The total SVOCs RSCO is 500 mg/kg. The maximum total SVOC concentration found in this portion of the site was 122.569 mg/kg (14GH007), well below the RSCO.

In addition to comparison with the RSCOs and SSBVs, concentrations of metals and carcinogenic PAHs were compared to the New England urban soil background levels and/or Eastern United States background values, as referenced in Appendix H – Table 1. The only exceedance of these PAH values was seen in sample 14GH007, which was collected beneath the floor of the parking garage near the corner of East 14th Street and Avenue C (Figure 5-1). In addition, the only two metals that exceeded both the RSCOs and/or SSBVs to also exceed the researched background values were copper and lead. These compounds are not typically associated with MGP operations and are most likely related to the quality of fill present at the site.

5.1.2 Former East 17th Street Station Results

Fill extends to approximately 22 to 47 ft bgs at the former East 17th Street Station site, as shown on Figures 4-2A, 4-2B, and 4-3 and in the boring logs, found in Appendix B. Within the footprint of the former East 17th Street Station, 22 surface soil samples and 1 duplicate sample were collected. Six of the soil samples were collected by GEI in 2006 and the remainder, along with the duplicate sample, were collected by H&A in 2004. Analytical data and summary statistics for the East 17th Street Station surface soil samples are presented in Table 5-2 and illustrated on Figure 5-1. As shown on Table 5-2, detected VOCs and non-carcinogenic PAHs

did not exceed their respective RSCOs and SSBVs. The maximum detected concentration of benzene was 0.027 mg/kg (17CY009), which is well below the NYSDEC RSCO of 0.06 mg/kg for benzene. Individual carcinogenic PAH concentrations in the surface soil samples were generally consistent across the site and slightly exceeded the individual RSCOs and/or SSBVs. The maximum BaP equivalent concentration (3.863 mg/kg) was detected in sample ST17SB02 as was the maximum total SVOC concentration (34.6 mg/kg). While the BaP equivalent concentration exceeds both the RSCO (0.061 mg/kg) and the SSBV (1.046 mg/kg), the total SVOC concentration falls well below the 500 mg/kg RSCO for total SVOCs.

As with the carcinogenic PAHs and metals concentrations detected in the surface soil samples collected from the former East 14th Street Station, those of the East 17th Street Station samples were compared to New England urban soil background levels and/or Eastern United States background values found in Appendix H – Table 1 due to the urban setting and historic use of this station site and adjacent properties. As previously reported by GEI, all the detected carcinogenic PAHs, as well as those metals exceeding their RSCOs and/or SSBVs, were found to be within the researched background concentration ranges.

5.1.3 Former East 19th Street Station Results

The remaining four surface soil samples collected from the holder sites within the Stuyvesant Town property were collected from the former East 19th Street Station site. Three samples were collected by H&A in 2004 with the final one (19GHSB01) being collected by GEI in 2006 (Figure 5-1). Analytical results and statistics for the East 19th Street Station surface soil samples are presented in Table 5-3.

The fill layer in this portion of the property extends to approximately 23 to 25 ft bgs and, as shown in Table 5-3, all detected VOCs and non-carcinogenic PAHs were below both the respective RSCOs as well as SSBVs for samples collected at this former holder station. The BaP equivalents concentrations within these samples ranged from 0.09977 mg/kg (14GH002) to 1.1041 mg/kg (19GH001). The sample taken at 19GH001 exceeded the BaP equivalents RSCO (0.061 mg/kg) as well as its SSBV (1.046 mg/kg). Total SVOC concentrations ranged from 1.178 mg/kg (19GH002) to 10.664 mg/kg (19GH001), which is well below the 500 mg/kg RSCO for total SVOCs.

As with the carcinogenic PAHs and metals concentrations detected in the surface soil samples collected from the other former holder stations, those of the East 19th Street Station samples were compared to New England urban soil background levels and/or Eastern United States background values found in Appendix H – Table 1 due to the urban setting and historic use of this station site and adjacent properties. As previously reported by GEI, all the detected carcinogenic PAHs, as well as those metals exceeding their RSCOs and/or SSBVs, were found to be within the researched background concentration ranges.

5.2 Subsurface Soils

To facilitate illustration of subsurface soil quality, the soil results are shown by depth: shallow soils (0.1-17 ft bgs), intermediate soils (17 ft bgs to native soil), and deep soils (native soil). Generalized analytical results are shown on Figures 5-2A, B, and C for shallow, intermediate, and deep soils, respectively. Figures 5-3A, B, and C present summaries of compounds that were detected at concentrations exceeding RSCO and/or SSBV by former holder station. Analytical data are presented in Tables 5-4 through 5-7 for East 14th Street, East 17th Street, East 19th Street Stations, and the First Avenue Loop road (soil boring AWV4SB01), respectively.

5.2.1 Former East 14th Street Station Results

In addition to the borings completed during the SC and IRI field activities, six borings were completed in and around the footprint of the former East 14th Street Station during the 2008 SRI field activities for delineation purposes. As previously reported by GEI, physical evidence of MGP-related impacts were observed below 10 ft bgs at SC and IRI borings adjacent to the former holder locations as illustrated on Figures 5-2A, B, and C. GEI and H&A generally observed impacts in soils from borings located along East 14th Street, south of the holders, with heavier MGP-related impacts including tar-saturated soils, being observed in isolated and

discrete depths within and immediately adjacent to the northernmost former gas holders. More specifically, these tar-saturated soils were observed between 24 and 28 ft bgs at boring 14GH004 and between 14 and 15 ft bgs at boring 14GH007. A single isolated tar-saturated lens was also present at location ST14SB06 from 25 to 26 ft bgs. This lens was interpreted by GEI as being associated with the former East 14th Street Works located to the east of Avenue C, based on the non-impacted soils along the western ROW of Avenue C (Figures 4-6, cross section E-E').

Petroleum-like impacts were observed in several perimeter investigation locations. Petroleum-coated soils were encountered at or near the water table at ST14SB05 (along East 14th Street) and as deep as 35 ft bgs within ST14SB01 (northwest corner of East 14th Street and Avenue C.) Petroleum-like, oil-coated, and stained soils were also encountered at sample location ST14SB06 within the Avenue C ROW (east side) and may be associated with historic petroleum releases.

During the SC, H&A sent three samples exhibiting high PID readings and/or gasoline-like or petroleum-like odors for fingerprint analysis. Samples from 14GH002 and 14GH009 were surface soil samples collected directly beneath the floor of the parking garage. These samples exhibited fingerprint patterns suggesting highly-weathered coal tar and/or motor-oil type contaminants. The other sample was collected from 14PH001 (13-15) and exhibited gasoline-like and petroleum-like odors. This sample showed chemical signatures consistent with #6 fuel oil (H&A, 2005).

In general, the highest concentrations of total VOCs and SVOCs detected in subsurface soil samples were associated with soils exhibiting observable MGP-related impacts. Total BTEX and PAH concentrations were the primary contributors to the total VOC and total SVOC concentrations found within the subsurface soil samples. Comparatively, those locations with MGP-type odors only or no apparent MGP-related impacts generally exhibited total VOC and SVOC concentrations at least one to two orders of magnitude below the 10 mg/kg and 500 mg/kg RSCO, respectively.

Concentrations of total VOCs and SVOCs in the vicinity of the gas holders ranged from non-detect to 1,177 mg/kg and 7,927 mg/kg, respectively. Within the Stuyvesant Town property, the highest concentrations of VOCs and SVOCs were detected in sample 14GH004 (24-26), which was within a tar-saturated lens. The highest total VOC and SVOC detections of 1,520 mg/kg and 15,213 mg/kg, respectively, were detected in sample ST14SB06 (24-25), also within a tar-saturated lens. According to GEI, due to the location of this boring and its location on the corner of East 15th Street and Avenue C, it is more likely that this impact is associated with the former East 14th Street Works rather than the former East 14th Street Holder Station located within the Stuyvesant Town property (GEI, 2007). RSCO and SSBV exceedances of individual VOC and SVOC concentrations in the East 14th Street Station subsurface investigation samples are shown on Figure 5-3A and detailed in Table 5-4.

Cyanide was not detected in the majority of the subsurface soil samples collected at the East 14th Street Station (Table 5-4). Detected cyanide concentrations ranged from 0.77 mg/kg to 56 mg/kg, which was detected in sample 14PH002 (5-7), and is above the SSBV concentration of 0.705 mg/kg.

Minimal impacts were observed in the delineation borings drilled during the 2008 SRI field activities. As shown on Figures 5-2A, B, and C, the only boring installed within the footprint of the former East 14th Street Station was ST14SB09. ST14SB09 was also the only boring in which visible impacts were observed at this former holder station during the 2008 SRI. As described in the boring log (Appendix B), staining was observed between 24.5 and 24.7 ft bgs and between 28.3 and 28.5 ft bgs and MGP-odor was noted between 24.5 and 28.5 ft bgs. In addition, petroleum-like odors were observed between 14 and 15 ft bgs. As summarized in Table 5-4 and illustrated on Figure 5-3A, four analytical samples were collected from boring ST14SB09. Total VOCs and total SVOCs were detected at concentrations exceeding the RSCO of 10 mg/kg and 500 mg/kg for these compounds, respectively, in the sample collected from 22 to 24 ft bgs, generally coincident with visible staining observed in boring ST14SB09. The majority of the VOCs detected included BTEX compounds and the majority of the SVOCs detected included PAH compounds. Cyanide was also detected at a concentration

exceeding the SSBV in the 22 to 24 ft bgs sample collected from boring ST14SB09. The remaining samples collected from boring ST14SB09 generally did not contain concentrations of VOCs, SVOCs, or cyanide exceeding RSCO or SSBV. West of boring ST14SB09 and outside of the footprint of the former holder station, boring ST14SB16 exhibited no odor or visible impacts. Subsurface soil samples collected from 22 to 24 ft bgs and 48 to 50 ft bgs from boring ST14SB16 did not contain concentrations of compounds above the RSCO or SSBV as summarized in Table 5-2 and illustrated on Figure 5-3A. Therefore, MGP-related impacts associated with the former East 14th Street Station are delineated to the west.

Two borings, ST14SB10 and ST14SB11, were completed on the south side of East 14th Street to delineate the southern extent of impacts observed at the East 14th Street Station. These borings could not be drilled closer to the southern boundary of the East 14th Street Station due to underground and surface obstructions/utilities and the Canarsie Subway line. Other than asphalt-like material noted from 10.4 to 12 ft bgs in boring ST14SB10, no visible impacts were observed on the south side of East 14th Street. A slight MGP-odor was observed between 19.2 and 19.4 ft bgs and petroleum-like odors were observed at boring ST14SB11 between 6 and 10 ft bgs. Subsurface soil analytical results for borings ST14SB10 and ST14SB11 are summarized in Table 5-4 and illustrated on Figures 5-2A, B, C, and 5-3A and show that no compounds were detected at concentrations exceeding the RSCO. Therefore, the MGP-related impacts associated with the former East 14th Street Station are delineated to the south.

The SRI work plan included the installation of two borings (ST14SB14 and ST14SB15) within the underground parking garage at the East 14th Street Station to evaluate the extent of NAPL observed from 24 to 24.5 ft bgs and 27 to 28 ft bgs in boring 14GH004 . These borings could not be drilled due to access constraints. Two borings were drilled further east along Avenue C (ST14SB12) and north along the south side of the Avenue C Loop (ST14SB13) for delineation purposes as agreed with NYSDEC. No odors or visible impacts were observed in these two borings. Subsurface soil samples were collected from 24 to 28 ft bgs in both borings and from 44 to 48 ft bgs in ST14SB12 and 49 to 50 ft bgs in ST14SB13. As illustrated in Table 5-4 and on Figures 5-2C and 5-3A, no organic compounds or cyanide were detected at concentrations exceeding RSCO in the samples collected from these locations. Therefore, MGP-related impacts associated with the East 14th Street Station are delineated to the north and east.

Subsurface soil samples were collected below the deepest observed visible and analytical impacts at the majority of the boring locations associated with the East 14th Street Station except for borings within or immediately adjacent to the former holders, where shallow refusal was generally encountered (14GH007 through 14GH013). The analytical results for the deeper subsurface soil samples collected from borings outside of the holder structures illustrate that the vertical extent of soils containing concentrations of organic compounds exceeding the RSCO has been defined except at locations 14GH004, ST14SB01, and ST14SB05 as illustrated in Table 5-4 and Figure 5-3A. The concentrations of organic compounds detected in subsurface soils in boring 14GH004 decreased by at least two orders of magnitude with depth (total VOCs of 1,177 mg/kg at 24 to 28 ft bgs to total VOCs of 10.02 mg/kg at 28 to 30 ft bgs). Benzene was detected at estimated concentrations of 0.21 and 0.13 mg/kg in the deepest samples collected from borings ST14SB01 and ST14SB05. Data from borings drilled to the north and east of 14GH004 and ST14SB01 and to the south, west, and east of ST14SB05 provide delineation of these impacts. Bedrock was encountered between 45 and 85.5 ft bgs at the East 14th Street Station. Boring refusal, inferred to be the top of bedrock, was encountered at 41 and 44 ft bgs on the south side of East 14th Street. No visible MGP impacts were noted at the top of the bedrock surface or the bottom of the boreholes at locations where bedrock was encountered or inferred (ST14SB03, ST14SB04, ST14SB05, ST14SB09, ST14SB10 and ST14SB11). As summarized in Table 5-4, no compounds were detected at concentrations exceeding RSCO at the top of the bedrock/bottom of the borehole at these locations except for the estimated 0.13 mg/kg benzene reported for the 48 to 49 ft bgs sample collected from boring ST14SB05. Therefore, the vertical extent of MGP-related impacts at the former East 14th Street Station has generally been defined.

5.2.2 Former East 17th Street Station Results

According to IRI report, isolated intervals of tar staining and/or sheens were observed within the fill and organic deposits beneath the former holder locations and adjacent areas at the East 17th Street Station, particularly at locations 17CY006, 17GH006, and ST17SB04, as illustrated on Figures 4-2A, B, C, and 4-3. These impacts were generally within the soils between 26 and 29 ft bgs and visible impacts were often accompanied by naphthalene-like odors. Naphthalene-like odors were also noted within fill materials from several borings conducted in the vicinity of the former southernmost gas holder. To the east of the Avenue C Loop Road (downgradient of the holders), naphthalene odors were the only MGP-related impacts noted in subsurface soils.

Six boring locations showed evidence of possible purifier materials in the form of sporadic wood chips within the fill layer, between approximately 7 and 25 ft bgs: ST17SB03, ST17SB04, 17GH002, 17GH005, 17CY006, and 17CY007 (GEI, 2007a). According to the IRIR, it appears that these materials were potentially incorporated into the fill used for the development of the residential site and may have been whole or partially imported from other local fill sources during the property-wide grading operations that took place prior to construction of the apartment complex.

Staining and petroleum-like odors were observed in a number of borings within the former station footprint, as shown on Figures 4-2A, B, C, and 4-3. Petroleum-related impacts were observed at or near the water table near 17MWS04 and as deep as 32 ft bgs within the fill layer at ST17SB04. Four subsurface soil samples exhibiting petroleum-, gasoline-, or paint thinner-like odors, collected from within the fill layer, were sent for fingerprint analysis during H&A's 2004 SC. Fingerprint analysis of 17GH001 (17-19) indicated that the soils contained chemical signatures consistent with petroleum products similar to #2 or #4 fuel oil. Analysis of 17CY007 (14-16) indicated potential coal tar and/or motor oil contaminants present. Motor oil was also suspected contaminant source in sample 17MWS04 (2-4). Analytical results of the fingerprinting of sample 17CY010 (9-11) indicated the presence of #2 fuel oil and potentially low-level, weathered coal-tar residues.

During the 2008 SRI activities at the East 17th Street Station, two borings were drilled to evaluate the MGP impacts observed during the valve replacement activities (17WVSB01 and 17WVSB02) and two borings were drilled to further delineate MGP-related subsurface soil impacts observed at the former East 17th Street Station (ST17SB07 and ST17SB08). Boring ST17SB08 was drilled further south than desired due to subsurface utility and above grade structure interference. Analytical results for the subsurface soil samples collected at the East 17th Street Station during the SC, IRI, and SRI are summarized in Table 5-5 and illustrated on Figures 5-2A, B, C, and 5-3B.

As with the previous station results, those samples from the East 17th Street Station with the highest concentrations of total VOCs and SVOCs were associated with subsurface soils exhibiting observable MGP-related staining and/or sheen. In general, the total BTEX and PAH concentrations were the primary contributors to the total VOC and SVOC concentrations in these samples. Comparatively, those locations with MGP-type odors only or no apparent MGP-related impacts generally exhibited total VOC and SVOC concentrations at least one to two orders of magnitude below the 10 mg/kg and 500 mg/kg RSCOs, respectively.

Within the vicinity of the former gas holders, concentrations of total VOCs ranged from less than 1 mg/kg within fill samples collected at sample locations 17GH001 through 17GH006 and ST17SB01 through ST17SB03 to 1,148.583 mg/kg at ST17SB04 (Table 5-5). Boring ST17SB08 was drilled to delineate the extent of the pockets of tar-like material (TLM) noted in the boring log for 17GH001 from 15.2 to 15.3, 15.9 to 16.2, and 21 to 27 ft bgs. No visible impacts were noted in boring ST17SB08 however, an MGP odor was noted between 4.5 and 5 ft bgs. Subsurface soil samples collected from 14 to 16, 22 to 26, and 32 to 36 ft bgs from ST17SB08 did not contain concentrations of organic compounds above RSCOs. The high VOC concentration in sample ST17SB04 (27-29) was collected from within a tar-stained fill interval. The only other exceedance of the 10 mg/kg RSCO for total VOCs was from sample 17CY006 (25-25.5), which yielded a total

VOC concentration of 39.48 mg/kg and was also collected from a tar-stained interval. Boring ST17SB07 was drilled to the east of boring 17CY006 to delineate the extent of impacts noted in 17CY006. Stain was observed in boring ST17SB07 between 14 and 14.6 ft bgs and 31.05 and 31.3 ft bgs. Accompanying this staining was a slight MGP-like odor from 26 to 28 ft bgs and from 31.05 to 31.3 ft bgs. The analytical sample collected from 26 to 28 ft bgs in boring ST17SB07 did not contain total VOCs exceeding the RSCO of 10 ppm, although benzene was detected at a concentration of 0.26 mg/kg (slightly above the 0.06 mg/kg RSCO). Apart from the two previously mentioned samples, all other SC, IRI, and SRI subsurface soil samples from within and adjacent to the former East 17th Street Station footprint had total VOC concentrations below the 10 mg/kg RSCO.

Total SVOC concentrations ranged from non-detect to a maximum of 2,253 mg/kg (17GH005 (27-27.8)) at the former East 17th Street Station. This boring was located within the former southernmost gas holder, and the sample exhibited heavy tar-like staining. The only other sample exceeding the 500 mg/kg RSCO for total SVOCs was ST17SB04 (27-29), which had a concentration of 887 mg/kg. The subsurface soil samples collected from 22 to 26 and 32 to 36 ft bgs in boring ST17SB08 to the southeast of ST17SB04 did not contain concentrations of SVOCs exceeding RSCOs. Apart from the two previously mentioned samples, all other SC, IRI, and SRI subsurface soil samples from within and adjacent to the former East 17th Street Station footprint had total SVOC concentrations below the 500 mg/kg RSCO.

RSCO and SSBV exceedances of individual VOC and SVOC concentrations in the East 17th Street Station subsurface investigation samples are illustrated on Figures 5-2A, B, C and 5-3B. As previously discussed in the IRI report, individual compound exceedances of PAHs were reported in shallow fill materials within and adjacent to the former station footprint and within the above-mentioned intervals of observed MGP-related impacts. Individual compound exceedances of BTEX were confined to discrete intervals of observed MGP-related impacts below 20 ft bgs. Additionally, a number of metals not associated with MGP operations were detected above the RSCOs and SSBVs in both the fill and native overburden horizons beneath the site and site perimeter.

Cyanide was not detected in the majority of the subsurface soil samples analyzed from the East 17th Street Station site. Analytical data are available in Table 5-5. The eleven detections of cyanide ranged from 0.891 mg/kg (ST17SB04 (2-4)) to 96 mg/kg (ST17SB04 (27-29)). These concentrations are above the SSBV of 0.705 mg/kg for cyanide (Figure 5-3B). Arsenic concentrations ranged from non-detect to 21.5 mg/kg (17CY008 (2-4)), which exceeded the RSCO of 7.5 mg/kg and the SSBV of 13.63 mg/kg.

Boring 17WVSB01 was proposed to evaluate subsurface soil quality where MGP-type odors and staining were noted at 10 to 12 ft bgs in water valve excavation 14 (see Figure 5-2A) and to evaluate the southern extent of soil impacts noted in borings ST14SB04 and 17GH001. This boring was drilled to a depth of 8 ft bgs where refusal on a water main was encountered. Visible impacts were not noted in 17WVSB01 however an MGP odor was noted from 4 to 5 ft bgs. No subsurface soil samples were collected for laboratory analysis from 17WVSB01. Boring 17WVSB02 was drilled to evaluate the subsurface soil quality where MGP-type odors and staining were noted at 10 to 13 ft bgs in water valve excavations 9 through 12. Gray staining was observed in 17WVSB02 between 13.2 and 14.1 ft bgs and between 16 and 20 ft bgs. A naphthalene-like odor was observed between 20 and 24 ft bgs in this boring. Subsurface soil samples were collected from 10 to 13, 20 to 23.5, and 28 to 30 ft bgs from boring 17WVSB02. No organic compounds were detected above the RSCO in the soil samples collected from 17WVSB02 except acetone (0.51 mg/kg at 20 to 23.5 ft bgs) and benzo(a)pyrene (estimated 0.11 mg/kg at 20 to 23.5 ft bgs). The sample collected between 10 and 13 ft bgs at boring 17WVSB02 did not contain arsenic, total cyanide, total VOC, or total SVOC concentrations above their respective RSCOs (Table 5-5). No significant MGP-related impacts were observed or detected analytically between 10 and 13 ft bgs in the vicinity of water valve excavations 9 through 12.

5.2.3 Former East 19th Street Station Results

Physical impacts observed in the subsurface at the East 19th Street Station during the SC included a piece of solid TLM encountered between 16 and 17 ft bgs in boring 19GH003 and slight petroleum/bituminous odors from 9 to 11 ft bgs in boring 19GH001. No MGP-related impacts such as tar-blebs, staining, or sheen were noted during the SC or IRI activities. Figure 4-4 illustrates the subsurface of the East 19th Street Station. Three borings were advanced during the 2008 SRI field activities outside the footprint of the former East 19th Street Station site to evaluate MGP-type impacts noted during excavation efforts at water excavations A and 24 through 27 and at hydrant valve excavation 17 (see Figure 5-2A). Some staining along with a hydrocarbon-like odor was noted from 4.6 to 5.3 ft bgs in boring 19WVSB01 which was drilled near valve excavation A and hydrant excavation 17. Hydrocarbon odor was also noted from 8.2 to 9.2 ft bgs and a fuel odor was noted from 13 to 16 ft bgs in 19WVSB01. Subsurface soil samples collected from 4 to 8 and 12 to 16 ft bgs from boring 19WVSB01 did not contain organic compounds exceeding their RSCOs except for an estimated concentration of 0.1 mg/kg benzo(a)pyrene in the the 4 to 6 ft bgs sample. Boring 19WVSB02 was drilled in the vicinity of valve excavations 24 through 27. Oil like material (OLM), sheen, and staining were encountered from 9.5 to 10.7 ft bgs along with a fuel like odor from 8.7 to 10.7 ft bgs in boring 19WVSB02. Additional fuel-like odor and staining and some sheen were also noted between 13.3 and 16.6 ft bgs in boring 19WVSB02. Subsurface soil samples were collected from 8 to 10 and 10 to 12 ft bgs in boring 19WVSB02. These samples did not contain concentrations of organic compounds exceeding RSCOs. No visible impacts or odors were noted in boring 19WVSB03. Based on these observations and analytical results, the borings drilled to evaluate MGP-related impacts reported at valve excavations did not encounter significant MGP impacts.

As shown on Table 5-6 and Figures 5-2A, B, C, and 5-3C, the highest concentrations of total VOCs and SVOCs, and total BTEX and PAHs, respectively, were generally present in the more shallow fill material. Total VOC and total SVOC concentrations within the subsurface samples were at least one order of magnitude below the 10 mg/kg RSCO for total VOCs and 500 mg/kg RSCO for total SVOCs, as shown on Figures 5-2A, B, and C. No detected VOCs exceeded either the RSCOs or SSBVs in any of the subsurface soil samples. Concentrations of individual PAH compounds and some metals exceeded the established RSCOs and/or SSBVs within shallow fill material at or adjacent to the former station footprint, however cyanide was not detected within the subsurface soils at the East 19th Street Station site.

5.2.4 First Avenue Loop Road Results

A single boring was advanced along the First Avenue Loop Road in order to investigate possible MGP-related impacts noted at 10.5 ft bgs in water valve excavation number 31. Boring A4WVSB01 was completed to 20 ft bgs and two subsurface soil samples were collected from 8 to12 ft bgs and 16 to 20 ft bgs for laboratory analysis. No odors or visible impacts were encountered during drilling (see boring log in Appendix B), unlike the water valve report, which indicated MGP-related impacts in the vicinity. Those MGP-related impacts could not be confirmed during SRI fieldwork. Analytical results for the subsurface soil samples collected from A4WVSB01 are presented in Table 5-7.

The only detected VOC was trichloroethene, which was detected in sample A4WVSB01 (16-20) at a concentration of 0.055 mg/kg, exceeding the SSBV of 0.00021 mg/kg. Total VOCs were non-detect in the sample from 8 to 12 ft bgs and 0.055 mg/kg in the sample from 16 to 20 ft bgs. Total SVOCs were detected at concentrations of 0.155 mg/kg (8-12 feet bgs) and 0.982 mg/kg (16-20 feet bgs). Cyanide was not detected in either sample and arsenic was detected at a concentration of 3.45 mg/kg in sample A4WVSB01 (8-12) and at a concentration of 0.898 mg/kg in sample A4WVSB01 (16-20). Both of these concentrations are well below the SSBV of 13.63 mg/kg for arsenic.

5.3 Groundwater

As previously discussed, 29 wells were used in the groundwater investigation of the former station sites within Stuyvesant Town. These wells are screened in three groundwater zones (shallow, intermediate, and deep zones) of the Upper Glacial Aquifer underlying the Stuyvesant Town property. Two monitoring wells were

installed prior to 2004, fourteen monitoring wells were installed by H&A during the SC field activities in 2004, and the remaining thirteen wells were installed by GEI during IRI activities in 2006. No new monitoring wells were installed during the 2008 SRI field activities (Table 3-2). Monitoring well locations and the target compound exceedance summary are illustrated on Figures 5-4A and B. Figure 5-5A illustrates the background groundwater analytical exceedances. Groundwater analytical results for 2004, 2006, and 2008 are summarized on Tables 5-8 (background wells), 5-9 (East 14th Street Station), 5-10 (East 17th Street Station), and 5-11 (East 19th Street Station). Figures 5-5B, C, and D illustrate analytical exceedances at the former East 14th Street, East 17th Street, and East 19th Street Stations, respectively.

5.3.1 Background Groundwater Results

Two monitoring well clusters served as background monitoring wells for the former holder stations located within the Stuyvesant Town property: 00MWS06, 00MWD06 and 00MWS07, 00MWD07. These background wells were sampled during all three phases of investigation (2004, 2006, and 2008). All four monitoring wells were sampled for VOCs, SVOCs, total metals, and total and amenable cyanide during all three rounds of sampling. Samples were analyzed for dissolved metals in 2006. Groundwater analytical results for the background wells are provided in Table 5-8 and illustrated on Figures 5-4A and B and 5-5A.

5.3.1.1 Shallow Zone

The two shallow zone wells (00MWS06 and 00MWS07) are screened between 4.06 to -5.94 ft NAVD88 and 7.25 to -2.75 ft NAVD88, respectively, within the sand and silty sand layer. Analytical data is presented in Table 5-8. The only VOC detected above its respective NYSDEC Ambient Water Quality Standards or Guidance Value (AWQSGV) was chloroform, which was detected at a concentration of 14 ug/L during the 2008 sampling event. The AWQSGV for chloroform is 7 ug/L. No other VOCs or SVOCs were detected above their AWQSGVs in the shallow wells.

Three dissolved metals (magnesium, manganese, and sodium) were detected above their respective AWQSGVs (35,000, 300, and 20,000 ug/L) during the 2006 sampling event in monitoring well 00MWS06. They were detected at concentrations of 48,700J ug/L, 977J ug/L, and 654,000 ug/L. Iron, manganese, and sodium were detected with total metal analysis at concentrations exceeding their AWQSGVs (300, 300, and 20,000 ug/L, respectively) in both of the shallow monitoring wells. Concentrations for total iron ranged from 671J ug/L to 11,700 ug/L. Concentrations for total manganese ranged from 452 ug/L to 1,610 ug/L and concentrations for total sodium ranged from 36,000 ug/L to 678,000J ug/L. Total and amenable cyanide, as well as other inorganics, were not detected above their appropriate AWQSGVs in the shallow background monitoring wells.

5.3.1.2 Intermediate Zone

The two background monitoring wells screened in the intermediate aquifer zone were designated 00MWD06 and 00MWD07. They were screened from -10.54 to -20.54 ft NAVD88 (00MWD06) and from -8.27 to -18.27 ft NAVD88 (00MWD07) within the glacial lacustrine sand and clay layer.

Benzene was detected in concentrations above the NYSDEC AWQSGV of 1 ug/L in monitoring well 00MWD06 in both 2004 and 2008, as shown in Table 5-8. No other BTEX compounds were detected in any of the background wells. Other VOCs detected above their respective AWQSGVs include cis-1,2-dicholorethene (AWQSGV 5 ug/L), which was detected in 00MWD06 during each round of sampling with concentrations ranging from 5.4 ug/L to 18 ug/L. No non-carcinogenic PAHs were detected above the appropriate AWQSGV in the background wells, however the carcinogenic PAH, benzo(a)anthracene, was detected during the 2008 sampling event at a concentration of 0.020J ug/L, which is above the AWQSGV of 0.002 ug/L. No other carcinogenic PAHs were detected above the AWQSGVs, nor were any other SVOCs.

Groundwater samples from the background wells were also analyzed for dissolved metals during the 2004 and 2006 sampling events. In addition, these wells were analyzed for total metals during all three sampling events.

Dissolved iron was detected above the AWQSGV (300 ug/L) at a concentration of 305 ug/L in 00MWD06 during the 2006 sampling event. Dissolved sodium, AWQSGV 20,000 ug/L, was detected at a concentration of 67,300 ug/L in monitoring well 00MWD07 during the 2006 sampling event. Total iron and sodium were also detected in concentrations above their AWQSGVs in monitoring wells 00MWD06 and 00MWD07 during all three sampling events. Concentrations of total iron ranged from 307 ug/L to 963J ug/L and concentrations of total sodium ranged from 41,600 ug/L to 117,000 ug/L. Total manganese was only detected above it's AWQSGV in monitoring well 00MW07 and the concentrations exceeding the standard ranged from 418 ug/L to 838 ug/L.

5.3.2 Former East 14th Street Station Results

During the RI, as well as previous investigations, groundwater was collected from two monitoring well clusters located within the footprint of the former East 14th Street Station, as well as two monitoring well clusters located east of the footprint along the eastern side of Avenue C (Figures 5-4A and B). Monitoring wells 14MWS01, 14MWD01, 14MWDD01, 14MWS02, 14MWD02, and 14MWDD02 are located within the footprint of the former holder station. Monitoring wells MW-36, 14MWDD03, MW10, 14MWD05, and 14MWDD05 are located on the east side of Avenue C, outside of the footprint of the former holder station. Well construction details are outlined in Table 3-2. As previously mentioned, monitoring well 14MWD02 was not sampled during the 2006 or 2008 RI activities due to the presence of NAPL within the well.

5.3.2.1 Shallow Zone

As presented in Table 5-9 and on Figures 5-4A, B and 5-5B, several BTEX and PAH compounds exceeded the NYSDEC AWQSGVs. In the vicinity of the former holders, the total VOC concentrations have continued to decrease from 2004 to 2006 while the total SVOC concentrations have increased over the past two years in monitoring well 14MWS02. As previously reported, monitoring well 14MWS02 was installed in 2004 by H&A and was screened across soils exhibiting gasoline and petroleum odors characteristic of #6 fuel oil thereby suggesting that the shallow zone groundwater is influenced by non-MGP-related sources.

Downgradient of the former holders at 14MWS01, total VOC concentrations (predominantly benzene) increased from 3.7 ug/L to 10 ug/L between 2004 and 2008. Total SVOC concentrations increased from 0.4 ug/L to 4.2 ug/L between 2004 and 2006, and subsequently decreased to 0.257 ug/L in the 2008 sampling event. Although the data show some fluctuation at 14MWS01, concentrations of total VOCs and SVOCs remained higher at 14MWS02 than at 14MWS01 during all three events (Table 5-9).

Further downgradient monitoring wells MW-10 and MW-36 were not sampled by H&A during SC field activities in 2004, however they were sampled by both GEI and AECOM during the subsequent 2006 and 2008 RI field events. During the 2006 GEI groundwater sampling event, only a trace detection (estimated 0.4 ug/L) of xylene was present within the groundwater at MW-10. No other BTEX or VOCs were detected in that well during the 2006 event, nor were they detected during the 2008 RI field activities. The only SVOC detected in the groundwater collected from MW-10 2006 was bis(2-ethylhexyl)phthalate, which was detected at a concentration of 2.1J ug/L. During the 2008 sampling event, trace amounts of acenaphthene, fluoranthene, and pyrene were detected in the groundwater sample collected from MW-10 for a total SVOC concentration of 1.89 ug/L.

No BTEX compounds were detected in MW-36 during either of the sampling events, however trace concentrations of MTBE and non-carcinogenic PAHs were detected in the samples from MW-36. Some carcinogenic PAHs were also detected at concentrations exceeding AWQSGV in the groundwater collected from MW-36 in 2006 and 2008. Concentrations of compounds detected in groundwater on the east side of Avenue C may also be associated with impacts at the East 14th Street Works site.

Across the three sampling events, total cyanide concentrations ranged between non-detect at MW-10 to 91 mg/L at 14MWS01 (2008 result), which is below the established AWQSGV of 200 mg/L. Total arsenic was

detected at concentrations ranging from non-detect to 6.2 ug/L (2004 result) at 14MWS02, historically, also below the applicable standard of 25 ug/L. In 2008, total arsenic was not detected at 14MWS02 (Table 5-9). Iron, manganese, and sodium were the only metals detected at concentrations exceeding the AWQSGV in the shallow zone groundwater beneath the East 14th Street Station. These metals are not considered to be associated with the former MGP station operations. Lead was detected at concentrations exceeding the AWQSGV in groundwater collected from MW-36 on the east side of Avenue C during the 2006 and 2008 sampling events.

5.3.2.2 Intermediate Zone

As presented in Table 5-9 and on Figures 5-4A, B and 5-5B, several BTEX and PAH compounds exceeded the NYSDEC AWQSGV in groundwater samples collected from intermediate zone wells. In 2004, total VOCs and total SVOCs were generally present at the highest concentrations in monitoring well 14MWD02 which is located on the south side of the former gas holders and decreased in concentration in the downgradient intermediate zone well to the southeast (14MWD01). NAPL was observed in monitoring 14MWD02 during the 2006 and 2008 groundwater sampling events. Approximately one foot of NAPL was measured in monitoring well 14MWD02 during the 2008 groundwater sampling event. Due to the presence of NAPL in monitoring well 14MWD02 at the site, Con Edison directed AECOM to develop the Interim Remedial Measure Work Plan for NAPL Monitoring and Recovery (IRMWP) at the site. This work plan was finalized and submitted to NYSDEC in December 2008, and is considered to be part of the SMP.

The greatest groundwater VOC and SVOC concentrations were detected in the sample collected immediately downgradient of the former holders at 14MWD01 and exceeded AWQSGV and decreased in concentration to levels below the AWQSGV in downgradient monitoring well 14MWD05. Groundwater VOC concentrations increased in monitoring well 14MWD01 between 2004 and 2008. Groundwater SVOC concentrations increased between 2004 and 2006 and decreased between 2006 and 2008 in monitoring well 14MWD01. Groundwater collected from monitoring well 14MWD05 did not contain VOCs or SVOCs at concentrations exceeding AWQSGVs in the 2006 or 2008 groundwater sampling events.

Cyanide was detected at concentrations exceeding the AWQSGV in groundwater collected from monitoring well 14MWD01 and 14MWD05 in 2008. Iron, magnesium, manganese, and sodium were the only metals detected at concentrations exceeding the AWQSGV in the intermediate zone groundwater beneath the East 14th Street Station. These metals are not considered to be associated with former MGP station operations.

5.3.2.3 Deep Zone

The deep zone groundwater analytical results for the East 14th Street Station are presented in Table 5-9 and on Figures 5-4A, B and 5-5B. Several BTEX and PAH compounds exceeded the NYSDEC AWQSGVs. Similar to the shallow and intermediate zones, the greatest concentrations of VOCs and SVOCs were detected in groundwater in the vicinity of the former holders (14MWDD02) and generally decreased downgradient to the east (in monitoring wells 14MWDD01, 14MWDD03, and 14MWDD05). Concentrations of compounds detected in monitoring well 14MWDD03 may also be associated with the former East 14th Street Works site on the east side of Avenue C. The concentrations of VOC and SVOC compounds in the deep monitoring wells are relatively consistent between 2006 and 2008, although there was an order of magnitude decrease in total SVOCs concentrations in monitoring well 14MWDD03.

Cyanide was detected in the groundwater sample collected from 14MWDD02 in 2008 at a concentration above the AWQSGVs. No other groundwater samples collected from the deep zone beneath the East 14th Street Station contained concentrations of cyanide exceeding the AWQSGV. Iron, manganese, and sodium were the only metals detected at concentrations exceeding the AWQSGV in the deep zone.

5.3.3 Former East 17th Street Station Results

Groundwater was collected from four well clusters within and around the former East 17th Street Station during both phases of RI work at the Stuyvesant Town property. Two well clusters (17MWS03, 17MWD03, and 17MWDD03 and 17MWS04, 17MWD04, and 17MWDD04) are located within the former holder station while the other two well clusters (17MWS05, 17MWD05, and 17MWDD05 and 17MWS06, 17MWD06, and 17MWDD06) are located within the ROW of Avenue C to the east-southeast of the former station holders. In addition, monitoring wells 17MWS03, 17MWD03, 17MWS04, and 17MWD04 were sampled during the SC work completed in 2004 by H&A. The monitoring well locations can be seen on Figures 5-4A, B, and 5-5C. Analytical data from all three sampling events, including statistics, is presented in Table 5-10. A summary of the June 2006 sampling event is shown on Figure 5-4A, a summary of the August – September 2008 sampling event is shown on Figure 5-4B and a summary of detected compounds exceeding regulatory standards for the sampling events is shown on Figure 5-5C.

5.3.3.1 Shallow Zone

Table 5-10 provides analytical data for all groundwater samples taken during SC and RI activities at and around the former East 17th Street Station site. Total VOC and SVOC concentrations for groundwater samples collected from the shallow aquifer zone within and adjacent to the former East 17th Street Station were greater downgradient of the former holders at 17MWS03 and 17MWS04 and decreased downgradient to the east at 17MWS05 and 17MWS06. The greatest total VOC concentration (165.3 ug/L) detected in the shallow zone was detected in the groundwater sample collected from monitoring well 17MWS03 in 2008. The greatest total SVOC concentration (81.9 ug/L) detected in the shallow zone was detected in monitoring well 17MWS04 in 2004. The detected concentrations of compounds are relatively consistent between 2004 and 2008 except for the decrease in total SVOCs in monitoring well 17MWS04. Cyanide was not detected at concentrations exceeding the AWQSGV in any of the groundwater samples collected from the shallow zone wells at the East 17th Street Station. The only metals detected at concentrations exceeding AWQSGV in groundwater samples from shallow zone wells at the East 17th Street Station were iron, magnesium, manganese, and/or sodium except for lead and mercury detected in the groundwater sample collected from 17MWS04 in 2004.

5.3.3.2 Intermediate Zone

As shown in Table 5-10 and Figures 5-4A, B, and 5-5C, several compounds were detected in intermediate zone groundwater at concentrations exceeding their respective AWQGSV. In general, the greatest concentrations of VOCs and SVOCs were detected in the groundwater sample collected from 17MWD04 located immediately downgradient of the southernmost holder and decreased in concentration downgradient and to the east in groundwater samples collected from 17MWD03, 17MWD05, and 17MWD06. These results differ slightly from the shallower zone in that the greatest concentrations were detected in groundwater samples collected from the 17MW04 well cluster rather than the 17MW03 well cluster. Concentrations of VOCs and SVOCS have decreased over time in groundwater from 17MWD03 and 17MWD04 between 2004 and 2006 but remained relatively consistent between 2004 and 2006. VOC concentrations in groundwater at 17MWD05 are consistent between 2006 and 2008 however the SVOC concentrations decreased between 2006 and 2008. The VOC and SVOC concentrations in groundwater from 17MWD06 have been consistent and low to non-detect between 2006 and 2008. The organic concentrations in the intermediate zone groundwater samples are generally greater than the organic concentrations in the shallower zone.

Cyanide was only detected above the AWQSGV in one groundwater sample collected from the intermediate zone monitoring wells at the East 17th Street Station (17MWD04 in 2008) at a concentration of 493 mg/kg. The only metals detected at concentrations exceeding the AWQSGV in groundwater samples from the intermediate zone wells at the East 17th Street Station were iron, magnesium, manganese, and sodium except for lead detected in the groundwater sample collected from 17MWD05 in 2006 and 2008.

5.3.3.3 Deep Zone

The analytical data for the deep groundwater aquifer zone are presented in Table 5-10 and illustrated on Figures 5-4A and B and 5-5C. Similar to the shallow and intermediate zones, the highest VOC concentrations in groundwater were detected adjacent to and downgradient of the former holders in monitoring wells 17MWDD04 and 17MWDD03 and decreased in concentrations further east and downgradient in monitoring wells 17MWDD05 and 17MWDD06. Total SVOC concentrations were relatively low (generally less than 2 ug/L) in the groundwater samples collected from the deep zone wells except for the sample collected from monitoring well 17MWD06 in 2006 (contained a total SVOC concentration of 26 ug/L). The organic compound concentrations were generally consistent between the 2006 and 2008 sampling events except for the decrease in total SVOCs from 36 ug/L to 3 ug/L in the groundwater samples collected from 17MWDD06. The organic compound concentrations in the deep zone groundwater were similar to the concentrations in the shallow zone groundwater and less than the concentrations in the intermediate zone groundwater. Cyanide was not detected at concentrations exceeding the AWQSGV in any of the groundwater samples collected from the deep zone monitoring wells at the East 17th Street Station. The only metals detected at concentrations exceeding the AWQSGV in groundwater samples from the deep zone wells at the East 17th Street Station were iron, magnesium, manganese, and sodium.

5.3.4 Former East 19th Street Station Results

Groundwater was collected from a shallow monitoring well (19MWS05) and an intermediate monitoring well (19MWD05) during the SC in 2004 and during both rounds of RI activities. These wells are located adjacent to the former East 19th Street Station, as shown on Figures 5-4A and B and 5-5D. The analytical results from all three groundwater sampling events are presented in Table 5-11.

5.3.4.1 Shallow Zone

As previously stated by GEI in the 2006 IRIR, the groundwater at the former East 19th Street Station does not appear to be impacted by MGP residuals. In 2004, low levels of BTEX were detected in the sample taken from 19MWS05, however in 2006 and 2008, BTEX were not detected in groundwater collected from this well. Total VOCs were also not detected during these last two rounds of sampling. Total SVOCs were initially detected at a concentration of 13.1 ug/L in 2004 and most recently were detected at a concentration of 0.034 ug/L. Cyanide was not detected within the groundwater samples during any of the sampling events. Arsenic was detected in 2004 at a concentration of 7.4 ug/L, which is well below the AWQSGV of 25 ug/L, and has not been detected in this well since. The only metals detected in the shallow groundwater at concentrations exceeding the AWQGSV were iron, magnesium, manganese, and sodium except for the detection of lead in the 2004 groundwater sample.

5.3.4.2 Intermediate Zone

BTEX have not been detected in the intermediate groundwater zone in this area of the Stuyvesant Town property and total VOC concentrations have ranged from 4.1 ug/L in 2004 to 10 ug/L in 2008. The only detected VOC, cis-1,2-dichloroethene, was detected at a concentration of 10 ug/L, exceeding its AWQSGV of 5 ug/L. Total SVOCs were initially detected at a concentration of 0.8 ug/L and have most recently been detected at a concentration of 0.16 ug/L. Neither cyanide nor arsenic was detected within the groundwater samples during any of the sampling events. The only metals detected in the intermediate groundwater at concentrations exceeding the AWQGSV were iron, magnesium, manganese, and sodium.

5.4 Indoor Air and Soil Gas

Indoor air sampling was performed in the following buildings: 522 East 20th Street, 16 Stuyvesant Oval, 245 Avenue C, and 615, 625, 629, 635, and 645 East 14th Street during the IRI. In addition, air quality within all Stuyvesant Town buildings was investigated in 2007 on behalf of the Owners; these data have not been reviewed by Con Edison or NYSDEC and are not presented in this report.

The analytical results for the indoor air samples and soil gas samples collected during the IRI were compared to applicable New York State standards. As previously stated, no indoor air or soil gas samples were collected during the 2008 SRI and therefore, the data presented below has been summarized from the IRIR (GEI, 2007a).

Compounds detected in air and soil gas samples were compared to the 2004 NYSDOH study, *Summary of Indoor and Outdoor Levels of Volatile Organic Compounds from Fuel Oil Heated Homes in NYS, 1997-2003*, (NYSDOH Air Study). Additionally, results from ambient air samples collected from Stuyvesant Town, presented in Table 5-12, were used to evaluate the soil gas in comparison with standard urban air quality.

Four ambient air samples were taken by GEI in 2006 to duplicate those taken by RETEC in 2003 however the results for only two samples were provided in the IRIR report. The data in Table 5-12 is for two of the initial ambient air samples taken in 2003 (STY-AMB-3 and STY-AMB-4) and two of the four samples taken in 2006 (AMB-2 and AMB-4). STY-AMB-2, STY-AMB-4, and AMB-4 were taken within the footprint of the former East 14th Street Station. STY-AMB-1 and STY-AMB-3 were taken within the footprint of the former East 19th Street Station. There were no ambient air samples taken at the former East 17th Street Station.

5.4.1 Former East 14th Street Station Results

RETEC and GEI collected indoor air samples from crawl spaces, stairwells, and other interior areas within six buildings within the footprint of the former East 14th Street Station site in 2003 and 2006, respectively. GEI sample locations were set to duplicate those of RETEC to the extent practicable. Sample locations are shown in Figure 2-4 and analytical data is presented in Table 5-13.

Benzene concentrations in the indoor air samples ranged from non-detect to 13 ug/m^3 for all 15 samples collected. The NYSDOH Air Study's 75th percentile for benzene is 13 ug/m^3. The other BTEX compounds found in both the RETEC and GEI air samples were only slightly above the NYSDOH Air Study's 75th percentile and were at or below the study's 95th percentile with only a few exceptions. Comparatively, the concentration of benzene within soil gas samples collected beneath or adjacent to the sampled buildings ranged from non-detect to 150 ug/m^3. Toluene, ethylbenzene, and xylenes were typically detected in soil gas samples at concentrations at least one order of magnitude higher than those reported in the indoor air samples.

Compounds present in soil gas at significant concentrations were generally absent in indoor air samples. Carbon disulfide was detected in soil gas samples at concentrations ranging from 9 ug/m^3 to 746 ug/m^3, however the compound was only detected in 2 indoor air samples and at a maximum concentration of 8 ug/m^3. Cyclohexane was detected at concentrations ranging from 7 ug/m^3 to 230 ug/m^3 in soil gas samples, however was not detected in any of the indoor air samples taken. Concentrations of gasoline-related additives, including MTBE, found in soil gas were generally up to three orders of magnitude greater than respective concentrations in indoor air samples, when detected. Thus when comparing the soil gas and indoor air samples at the former East 14th Street Station, it appears that the indoor air more closely resembles the ambient air (Table 5-13) in chemical constituents and concentrations than it does the subsurface soil gas.

5.4.2 Former East 17th Street Station Results

Three indoor air and one soil gas sample were taken at the former East 17th Street Station site by RETEC in 2003. Six soil gas samples were collected in 2006 by GEI in this area of the Stuyvesant Town apartment complex. The sample locations are shown on Figure 2-4. Analytical data is provided in Table 5-13.

There were BTEX compounds, acetone, ethanol, and a few other compounds were detected in the indoor air samples. The concentration of benzene ranged from 3 ug/m^3 to 4 ug/m^3, which is below the NYSDOH Air Study's 75th percentile for benzene (13 ug/m^3). The only individual BTEX compound detected at concentrations slightly above its NYSDOH Air Study 75th percentile concentration was m, p-xylene, which was

detected at 6.9 ug/m^3 in sample STY-1A-2E17. Although this value is above the 75th percentile, it is still below the 95th percentile concentration of 11 ug/m^3. Of the VOCs detected in the indoor air samples, ethanol had the highest concentration (1,100 ug/m^3) in STY-1A-2E17. This concentration is above the NYSDOH Air Study's 75th percentile of 540 ug/m^3, however it is less than the 95th percentile concentration of 1,300 ug/m^3. Chloroform, chloromethane, 1,4-dichlorobenzene, and dichlorodifluoromethane were all detected in sample STY-1A-2E17 at concentrations greater than their respective 95th percentile concentrations. The chemicals present and concentrations detected during the 2003 indoor air sampling event are similar to those within the ambient air samples collected during that study. (GEI, 2007a)

The seven soil gas samples taken at the former East 17th Street Station site contained many of the same compounds as were found in the indoor air samples, however the concentrations were variable and two of the soil gas samples were found not to contain any ethylbenzene or xylenes, though the concentrations of BTEX compounds were generally found to be higher in the soil gas samples than in the indoor air samples. Benzene concentrations ranged from 5 ug/m^3 to 191.4 ug/m^3 in the soil gas samples with the highest concentration found in sample ST17SV01. Carbon disulfide, cyclohexane, heptane, and MTBE were some of the compounds detected in the soil gas samples that were not reportedly detected in indoor air.

5.4.3 Former East 19th Street Station Results

Indoor air was not sampled as part of GEI's 2006 IRI field activities, however two indoor air samples were collected by RETEC in 2003. Sample locations are shown on Figure 2-4 and analytical results are presented in Table 5-13. In addition to the two indoor air samples (STY-1A-1E19 CRAWL and STY-1A-2E19 STAIRS) in this area, RETEC took one soil gas sample (SG-1-E19) in 2003. In 2006, GEI took one soil gas sample (ST19SV01), which was co-located with the previous sample location.

Benzene was detected below the NYSDOH Air Study's 75th percentile of 13 ug/m^3 in both indoor air samples, however m, p-xylenes were detected at concentrations of 8.6 ug/m^3 in the crawlspace sample and 8.2 ug/m^3 in the stairwell sample. These concentrations are above the NYSDOH Air Study's 75th percentile concentration of 4.6 ug/m^3 for this compound, however they are below the 95th percentile concentration of 11 ug/m^3. Concentrations of other VOCs ranged from non-detect to a maximum concentration of 370 ug/m^3 for acetone detected in the stairwell sample. This is well above the NYSDOH Air Study's 95th percentile concentration of 115 ug/m^3. Other VOCs detected in indoor air samples include chloroform, 1, 3-dichlorobenzene, tetrachloroethene, and 1, 2, 4-trimethylbenzene. In addition, naphthalene was detected in the crawlspace sample at a concentration of 18 ug/m^3. It was not detected in the stairwell sample.

The soil gas samples collected at the former East 19th Street Station contained higher concentrations of each of the BTEX compounds than did the indoor air samples, however the presence and concentrations of other VOCs found within the soil gas samples are inconsistent with those detected in the indoor air. While there were a number of VOCs detected in the soil gas samples that were not detected in the indoor air samples, there were also a few compounds, including chloromethane, ethanol, 2-propanol, and methylene chloride, that were detected in the indoor air but in only one or neither of the soil gas samples, and at lower concentrations. This suggests that the soil gas does not appear to be affecting indoor air quality at the former East 19th Street Station site..

6.0 Qualitative Human Health Exposure Assessment

This section integrates the data and information gathered during the RI and provides a qualitative assessment of the potential for exposure to MGP-related contaminants that are associated with the environmental conditions encountered at the site. This assessment was performed by identifying potential sources, migration routes for the COCs discussed in Section 5, potential receptors, and potential exposure pathways at and in the vicinity of the site. The assessment follows guidelines specified in the NYSDEC *DER-10 Draft Technical Guidance for Site Investigation and Remediation* (NYSDEC, 2002).

6.1 Site Setting

A description of the site is presented in Section 2.1. Stuyvesant Town is comprised of the lands bounded by and extending from East 14th Street north to East 20th Street and from First Avenue east to Avenue C. Figure 2-1 illustrates the site location on a portion of the Brooklyn New York quadrangle topographic map.

The Stuyvesant Town apartment complex extends from First Avenue to Avenue C and from East 14th Street to East 20th Street and includes 35 high-rise buildings, playgrounds, sport courts and underground parking garages across a 61-acre area.

6.2 Exposure Assessment

Exposure is the process by which humans come into contact with COCs in their environment. Humans can be exposed to COCs in a variety of environmental media including surface soil, subsurface soil, surface water, sediment, groundwater, and air. Exposure to these media can occur through several routes including ingestion, dermal contact, and inhalation. The exposure assessment identifies pathways by which humans are potentially exposed to COCs. The assessment includes the following:

1) Development of a conceptual site model

2) Discussion of potential sources

3) Discussion of potential release mechanisms

4) Identification of potential human receptors and receptor-specific exposure pathways

Although the potential for exposure to MGP residuals for Stuyvesant Town includes an evaluation of the potential for exposure to COCs via drinking impacted site groundwater as previously mentioned, the City of New York obtains drinking water from sources located in upstate areas. Other than an evaluation of potential incidental ingestion of impacted groundwater during subsurface repair or construction activities, this pathway is not further discussed in this exposure assessment. The NYSDEC groundwater classification for the site area is GA (aesthetic-fresh waters). The management of groundwater impacted by site-related residuals will be addressed in the alternatives analysis report.

6.2.1 Conceptual Site Model

Figure 6-1 presents the conceptual model for the Stuyvesant Town RI investigation area. Included on the figure is information regarding the known or potential sources of COCs, the identified release mechanisms, and the affected source media. The potential migration pathways, the exposure media, and the potential exposure routes are identified. Note that the exposure routes are considered potential unless there is an on-going or documented exposure.

Information regarding the potential receptors identified in each area of interest is presented on Table 6-1.

6.2.2 Potential Sources of Residuals

The sources of environmental impacts for the site are residual materials associated with the former MGP structures and process areas. Exposure to surface soil could be a potential exposure pathway; however, the upper five feet of soil is believed to have been imported to the site following cessation of the MGP operations, and the concentrations of COCs in the surface soil samples collected at the site are generally within the site background study values (H&A, 2005) with total PAH concentrations less than 500 ppm. Hydrocarbon materials, including NAPL, have been observed in subsurface soil of the site. VOCs and SVOCs in these materials have leached to groundwater and the dissolved groundwater plume extends from the site to the east with likely discharge to the East River. In the MGP-impacted areas, the lower molecular weight hydrocarbons could also volatilize and migrate into ambient and/or indoor air.

6.2.3 Potential Release Mechanisms

As shown on Table 6-1, there are several potential release mechanisms by which the constituents identified in the soil and groundwater may be transported to other media. Each mechanism is considered for the identified media and potential receptor group. Potential release mechanisms for soil include the following:

1) **Fugitive Dust.** Constituents in surface and subsurface soil could be a potential source for fugitive dust via physical disturbance.

2) **Volatilization.** Volatile constituents may potentially be transported from subsurface soil by volatilizing into soil-pore space and eventually emanate into ambient or indoor air.

3) **Leaching.** Constituents in surface or subsurface soil could potentially leach to groundwater.

There are three mechanisms by which constituents in groundwater can be transported to other media. These migration pathways include the following:

1) **Adsorption.** Constituents in groundwater may be sorbed onto subsurface soils.

2) **Volatilization to Ambient Air.** Volatile constituents in groundwater may potentially desorb into soil gas and be transported into ambient or indoor air.

3) **Extraction.** Constituents in groundwater may migrate to other media by extraction and use of impacted groundwater.

Each of these potential release mechanisms is evaluated for each potential receptor group on Table 6-1.

6.2.4 Potential Human Receptors and Exposure Pathways

This section discusses the identified potential receptors and the potential that the receptor may be exposed to Site-related residuals.

6.2.4.1 Stuyvesant Town Receptors

An exposure pathway analysis for receptors in Stuyvesant Town is summarized in Table 6-1. The analysis includes an identification of each potential receptor group, a listing of each potential exposure media and potential pathway, and a rationale for inclusion or exclusion of each potential receptor in the consideration of remedial actions in the alternatives analysis report. Each of the receptor groups, and the potential exposure pathways, are identified on Table 6-1. Potential receptor groups and potential exposure pathways that may exist for Stuyvesant Town are discussed below.

Apartment Building Resident

A resident of the apartment buildings could potentially be exposed to MGP-related COCs by the inhalation of impacted indoor air. The results of the soil vapor intrusion (SVI) evaluation sampling performed at the site indicate that the concentrations of COCs in indoor air that could possibly be MGP-related were attributable to other sources within the buildings rather than MGP residuals. Therefore, the potential for a resident to be exposed to air impacted by MGP-related COCs is considered to be low under standard conditions.

There are unique considerations when working inside buildings on this site during planned and emergency utility work that involve cutting or drilling into concrete slabs in the basements of site buildings. There is the possibility to temporarily come into contact with potentially MGP and non-MGP-impacted soil and groundwater under the sub-grade concrete slab in the basements of the buildings at Stuyvesant Town. The existing, intact basement floor structures in apartment buildings in Stuyvesant Town have proven to be effective barriers to stop the migration of subsurface vapors into buildings. Utility or other work that involves cutting or drilling into concrete slabs in the basements of buildings within Stuyvesant Town may provide a potential pathway for subsurface vapors into these buildings. The potential for a resident to be exposed to air impacted by MGP-related COCs during sub-slab activities is considered to be low and any potential exposure would be limited in duration and preventive measures would be used during sub-slab activities. However, the inhalation of VOCs by apartment building residents pathway is considered to be potentially complete and will be addressed in the alternatives analysis report. Additionally, the draft interim Site Management Plan (SMP) (ENSR 2008c) has been developed for the site and includes guidance to engineers and contractors for implementing procedures during projects that involve drilling or cutting through the basement slabs to prevent and control the potential for subsurface vapors entering and impacting the indoor air environment of these buildings.

As indicated above, it is believed that surface soil and the upper five feet of subsurface soil have been imported to the site following cessation of the MGP operations. Sampling and analysis of surface soils has indicated that the concentrations of VOCs and SVOCs are low and similar to background concentrations. Surface soils at the site are grass-covered or landscaped and the potential for residents to come into contact with surface soils is low. For these reasons, the potential for a resident to be exposed to COCs in surface soil is considered to be low.

Child Day Care Attendee

Children and adults present at the on-site day care facility at the former East 14th Street Station site could potentially be exposed to MGP-related COCs by the inhalation of impacted indoor air. Potential exposure concerns for the child day care attendee include inhalation of particulates during subsurface utility and other underground construction activities. The considerations for work inside of the day care facility are similar to those discussed for the apartment building resident. Based on previous and current investigations, vapor intrusion to indoor air is not considered to be a completed pathway.

Commercial Building Occupant/Parking Lot Attendant

Several commercial buildings are located within the footprint of the former MGP process area including an underground parking facility. An occupant or employee could potentially be exposed to MGP-related COCs by the inhalation of impacted indoor air. The results of the SVI evaluation sampling performed in this building indicated that the concentrations of COCs in indoor air that could possibly be MGP-related are low. Therefore, the potential for an occupant to be exposed to air impacted with MGP-related COCs is considered to be low under standard conditions. Similar to the apartment building resident, sub-slab construction within the building or parking garage may provide a potential pathway for subsurface vapors. Therefore, the inhalation of VOCs by commercial building occupants pathway is considered to be potentially complete and will be addressed in the alternatives analysis report and by the SMP.

Maintenance Workers

A maintenance worker at the commercial building or Stuyvesant Town complex could be involved in indoor and/or outdoor maintenance or construction activities. Based on a reconnaissance of the site buildings, none of the buildings have sumps that contain impacted groundwater. Based on the results of the SVI sampling performed in the site buildings (including the commercial building), concentrations of COCs in indoor air are within the range considered to be typical of residential buildings at uncontaminated sites or are attributable to non-MGP sources. Therefore, the potential for a maintenance worker to be exposed to groundwater or air impacted with MGP-related COCs is considered to be low under standard conditions. However, sub-slab construction within buildings may provide a potential pathway for subsurface vapors into the building. Therefore, the inhalation of VOCs by indoor maintenance workers pathway is considered to be potentially complete and will be addressed in the alternatives analysis report and by the SMP.

Another potential exposure pathway for outdoor maintenance workers is via direct contact with impacted soils (i.e., incidental ingestion, dermal contact, and inhalation of volatiles or particulates) while performing light maintenance activities such as lawn care or landscaping. However, the concentrations of MGP-related COCs in surface soils are low, and the soil is covered with grass or landscaping materials. The period of time that a worker would be in contact with subsurface soils is anticipated to be minimal. For these reasons, the potential for an outdoor maintenance worker to be exposed to MGP-related COCs in surface and subsurface soils is considered to be low.

Subsurface Outdoor Maintenance or Utility Workers

Outdoor maintenance workers and subsurface utility workers could potentially be exposed to soil containing NAPL and other COCs in subsurface soil and groundwater via incidental ingestion, dermal contact, and inhalation of volatiles or particulates if subsurface excavation work is needed to repair or replace underground features such as gas, water or sewer lines, or other utilities or structures at the site. Only properly trained personnel should complete subsurface work at the site using methods specified in a site-specific HASP, until the area has been cleared of impacted materials.

Site Visitors and Pedestrians

Site visitors and pedestrians could potentially contact surface soil in the landscaped areas of the site, or inhale impacted indoor air while visiting site buildings or surrounding areas. As indicated above, the potential for exposure for each of these media is considered to be low under standard conditions. However, a site visitor could potentially be exposed to impacts to indoor air if sub-slab construction occurs in the building that they visit. Therefore, the inhalation of VOCs by site visitors pathway is considered to be potentially complete and will be addressed in the alternatives analysis report and by the site management plan.

6.3 Conclusions

For Stuyvesant Town, subsurface maintenance or utility workers who perform excavation and/or repair work on the site could possibly be exposed to NAPL, impacted soil, and/or groundwater. The draft site management plan (ENSR 2008c) (SMP) was developed and submitted to NYSDEC on August 15, 2008. The SMP specifically details institutional controls enacted on the Stuyvesant Town property to protect residents, maintenance, utility, and landscape workers from soil impacts present below five feet. The plan outlines procedures for detecting and managing impacted air, soil, and groundwater if they are encountered. While still draft, property owner personnel and all others doing subsurface work are subject to the procedures in the SMP. Therefore, subsurface work should only be performed by properly trained personnel, using methods specified in the draft SMP (ENSR 2008c).

An IRM consisting of an indoor air monitoring program is being implemented on the site and will continue to ensure that inhalation of indoor air is not a complete pathway. In addition, an IRM consisting of monitoring and

recovery of NAPL from groundwater monitoring wells is being implemented on the site. Both of these plans are considered part of the SMP and therefore are being implemented in accordance with that document.

7.0 Summary and Conclusions

Based on site observations and analytical data, it appears surface soils were imported to the site after the MGP operations ceased, possibly for final grading purposes during the construction of Stuyvesant Town apartment complex. The upper fill also generally appears to represent imported fill material brought to the site after closure of the MGP operations. The concentrations of compounds detected in the SCS and RI surface soil samples were generally consistent with site-background soil concentrations and are considered to be attributable to fill material quality, anthropogenic sources, or sources unrelated to former MGP operations. Station specific summary and conclusions are presented in the following sections. Subsurface soil observations and analytical data from borings advanced to investigate MGP-related impacts reported in specific water valve excavations indicate that significant MGP-related impacts are not present at valve locations.

7.1 Former East 14th Street Station

Soil gas samples were collected at and adjacent to the former East 14th Street Station between 2003 and 2006. VOCs common to both petroleum and MGP byproducts, for example, BTEX and naphthalene, were detected in most soil gas samples; however, other petroleum-related constituents, primarily those associated with gasoline, were also pervasively present in the soil gas samples, suggesting that petroleum-related residuals in the subsurface may be a more significant contributor to the overall BTEX and naphthalene concentrations than MGP-related tar and tar residues in the subsurface. Comparison of the distribution and concentrations of the compounds in indoor air, ambient air, and soil gas support the previous RETEC report, which indicated that the chemical constituents and concentrations in indoor air more closely reflect the ambient air quality than that of the subsurface soil gas. Thus, the results to date suggest that indoor air within residential buildings currently occupying the former station sites is not adversely affected by the soil gas concentrations beneath the former station.

Tar-like impacts in soil were typically encountered in discrete lenses or thin soil layers between 20 and 30 ft bgs within the station footprint, but were also present in soils at 12 feet at one location and as deep as 49 ft bgs at another location. A free-phase tar was observed during the RI program within one previously installed monitoring well screened between 22 and 32 ft bgs along East 14th Street. The subsurface soil impacts encountered beneath the former East 14th Street Station have been horizontally and vertically delineated.

MGP-impacts to groundwater were generally in wells screened below the water table. The highest total VOC and SVOC concentrations (and highest total BTEX and PAH concentrations, respectively) were typically found in groundwater adjacent to the footprint of the former holders in areas where soils were impacted with tar residuals. Monitoring well 14MWDD02 was not sampled due to the presence of tar at its base. Otherwise, concentrations of VOCs and SVOCs generally decreased in both the shallow (water table) zone and deeper zones in downgradient wells near Avenue C. Downgradient and on the east side of Avenue C, groundwater does not appear to be impacted from the MGP operations at the former East 14th Street Station. Impacts on the east side of Avenue C may be associated with the former East 14th Street Works.

7.2 Former East 17th Street Station

Soil gas samples were collected within and adjacent to the former East 17th Street Station footprint. As with the former East 14th Street Station site, VOCs common to both petroleum and MGP byproducts, that is BTEX and naphthalene, were detected in most soil gas samples; however, other petroleum-related constituents, primarily those associated with gasoline, were also pervasively present in the soil gas samples, suggesting that petroleum-related residuals in the subsurface may be a more significant contributor to the overall BTEX and naphthalene concentrations than MGP-related tar and tar residues in the subsurface. The vadose zone is comprised of heterogeneous urban fill, and physical observations and analytical findings for the SC and RI soil

borings indicate that petroleum-related impacted soils are present beneath the site and are generally at shallower depths than those in which MGP-related impacts are noted (e.g., depths greater than 20 ft bgs).

No indoor air samples were collected as part of the RI, but comparison of the distribution and concentrations of the compounds in previous indoor and ambient air samples, and RETEC and RI soil gas samples, support the previous RETEC report findings. The RETEC findings indicate that the chemical constituents and concentrations in indoor air more closely reflect the ambient air quality than that of the subsurface soil gas. Thus, the results to date suggest that indoor air within residential buildings currently occupying the former station sites is not adversely affected by the soil gas concentrations beneath the former station.

Isolated intervals of TLM were encountered within the East 17th Street Station footprint to the west of the Avenue C Loop Road. Sporadic lenses of tar staining and/or residual tar blebs were observed within fill and organic deposits. Tar impacts were typically encountered within soils between 26 ft and 29 ft bgs, but were present as shallow as 15 ft bgs at one location and as deep as 30.5 ft bgs at another location. The subsurface soil impacts have been delineated at the East 17th Street Station.

During the valve excavation activities, MGP-impacts were also encountered at locations to the south of the station footprint along the Avenue C Loop Road and to the northeast of the station footprint near Avenue C. These impacts were generally encountered between depths of 9 and 13 ft bgs. In total, approximately 275 tons of non-hazardous characterized soils with potential MGP-impacts were removed from along the Avenue C Loop Road during the valve excavation activities.

The highest concentrations of VOCs and SVOCs (and BTEX and PAHs, respectively) were generally found downgradient from the former holder locations in shallow groundwater. BTEX and PAHs were primarily detected within groundwater samples from 17MWS03, which is downgradient of the former holders. Only trace concentrations of total BTEX and PAH compounds were detected in shallow groundwater samples collected immediately adjacent to the former holders. The pattern of VOC and SVOC concentrations (and BTEX and PAH concentrations respectively) was reversed for the intermediate wells. Here the highest VOC and SVOC concentrations were found in groundwater from intermediate wells immediately adjacent to the holder footprints and decreased in downgradient wells. Groundwater impacts in the intermediate zone were greater than the impacts noted in the shallow and deep zones.

During the valve replacement program, excavations where soil staining and MGP-type and/or petroleum-type odors were observed also exhibited sheens on the groundwater. These excavations were located both within and in the vicinity of the former station footprint.

7.3 Former East 19th Street Station

The RI activities conducted at the former East 19th Street Station were intended to provide physical and analytical confirmation regarding the absence of media impacts attributable to the former holder station. Previous environmental reports submitted to the NYSDEC for the former station site indicate that the limited, low-level impacts identified at and near the site were most likely attributable to other urban sources. Soil gas and indoor air contain detectable concentrations of BTEX compounds; however, as indicated in the previous RETEC findings, the low concentrations of VOCs detected within indoor air at the East 19thStreet Station appear to be linked to outdoor air concentrations containing vehicle combustion components, gasoline-related compounds and chemicals used as part of regular building activities. The RI soil gas results support the conclusion that soil gas does not appear to be affecting indoor air within residential buildings currently occupying the former East 19th Street station based upon inconsistent concentrations detected between indoor air and soil gas beneath the former holder site.

Impacts of MGP residuals in soil were limited, and no MGP-related impacts to groundwater beneath the former East 19th Street Station were detected during the RI sampling rounds.

During the valve replacement program, stained soils and MGP-type odors were observed in several excavations conducted along the East 20th Street Loop Road at depths typically between 5 and 13 ft bgs; in addition, product globules and sheens on groundwater within several of the impacted excavations were also noted. These excavations were located outside the former station footprint and investigation study area. The impacts were observed within and/or beneath the fill horizon, which may or may not be associated with former operations at the property, and were variable and localized in degree and extent. In total, approximately 415 tons of non-hazardous characterized soils with potential MGP-impacts were removed from along the East 20th Street Loop Road during the valve excavation activities.

7.4 Conclusions

There are no significant or imminent threats to human health that warrant an interim remedial action. Given the depths of the MGP-related impacts, the current and future planned use of the site, and the characteristics of the subsurface and the compounds of concern, exposure to human health or the environment to residual MGP tar residues is unlikely outside of significant construction or land development work for which the draft interim Site Management Plan (SMP) details environmental and health and safety controls to mitigate risks.

NAPL was noted in one of the monitoring wells at the site. Due to the presence of NAPL in a monitoring well at the site, Con Edison submitted an IRMWP for NAPL Monitoring and Recovery (ENSR 2008b). This work plan was finalized and submitted to NYSDEC in December 2008 and is considered to be part of the SMP.

Based on indoor air sampling during the RI, intrusion of vapors emanating from MGP-related material that may be present at the site was not evident. Although indoor air sampling has not indicated that subsurface vapors associated with former MGP residuals affect indoor air quality, Con Edison is performing additional sampling to determine that there has been no significant change of indoor air quality. Con Edison submitted an Interim Remedial Measure Work Plan for Indoor Air Sampling (ENSR 2008c) to NYSDEC on November 18, 2008. This IRMWP is also considered to be part of the SMP for Stuyvesant Town. The first round of indoor air sampling and analysis was performed in February and March 2009.

A qualitative human health exposure assessment (QHHEA) was performed to identify the potential exposure pathways associated with impacted media for workers, daycare attendees, residents, and visitors in Stuyvesant Town. Subsurface maintenance or utility workers who perform subsurface excavation work and/or repairs could possibly be exposed to impacted media and controls are recommended to limit potential exposures in these areas. As discussed, the draft interim SMP was developed and is currently being used to mitigate these risks. While still draft, property owner personnel and all others doing subsurface work are also subject to the procedures in the SMP. Remedial options for these areas will be evaluated in an alternatives analysis report. Exposure of residents and visitors to MGP residuals is considered to be unlikely.

Based on the combined findings of the SCS and RI, additional investigative work is not recommended for Stuyvesant Town. Additional delineation of subsurface soil and groundwater MGP-related impacts is not necessary to begin remedial alternative development and evaluation for impacts identified.

8.0 Recommendations

Based on the combined findings of the SCS and RI, the following activities are recommended for the site:

The delineation of subsurface soil and groundwater impacts associated with the former MGP stations located within the present-day Stuyvesant Town apartment complex has been completed to a sufficient degree to evaluate appropriate remedial technologies and begin development and evaluation of remedial alternatives for the impacts identified at the site for inclusion in an alternatives evaluation report. It is recommended that the alternatives analysis for the Stuyvesant Town Former MGP Station Sites be initiated. If additional delineation data are necessary for remedial alternative evaluation or remedial action implementation, it is recommended that they be collected during a pre-design investigation.

- Implement the Site Management Plan, including the Interim Remedial Measure Work Plans for NAPL Monitoring and Recovery and Indoor Air Monitoring, as appropriate.

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