GEI Consultants

Geotechnical
Environmental
Water Resources
Ecological

Feasibility Study

Fulton Municipal Works Former Manufactured Gas Plant Site

Brooklyn, New York
AOC Index No. A2-0552-0606
Site No. 224051

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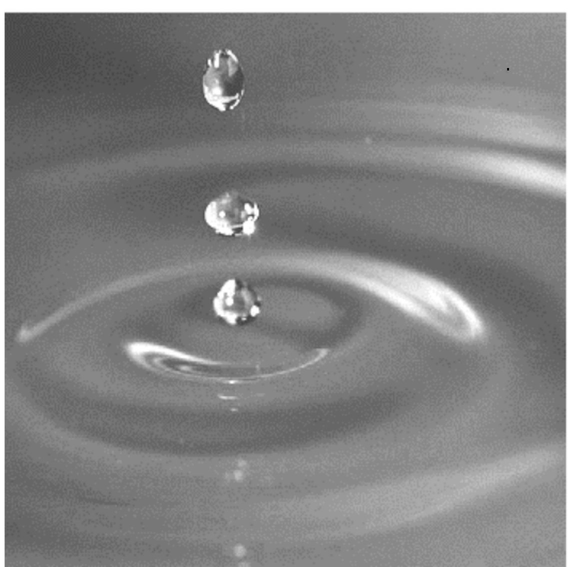

Professional Engineer's Certification

The undersigned on behalf of National Grid and GEI Consultants, Inc., P.C. certifies: that I am currently a NYS registered Professional as defined in 6 NYCRR Part 375 and that this Feasibility Study was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

March 31, 2015
Date

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Abbreviations and Acronyms

AOC	Administrative Order on Consent
bgs	below ground surface
cm/s	centimeters per second
COCs	Contaminants of Concern
CP-51	NYSDEC CP-51 Soil Cleanup Guidance
CSM	Cutter Spoil Mixer
CSOs	Combined Sewer Overflows
DER-10	NYSDEC’s Technical Guidance for Site Investigation and Remediation
DSM	Deep Soil Mix
El.	Elevation
EPA	United States Environmental Protection Agency
FS	Feasibility Study
GEI	GEI Consultants, Inc., P.C.
GRAs	General Response Actions
IRM	Interim Remedial Measure
ISCO	In-Situ Chemical Oxidation
ISS	In-Situ Solidification
mg/kg	milligram per kilogram
MGP	Manufactured Gas Plant
MTBE	Methyl tert-butyl ether
NAPL	Non-Aqueous Phase Liquid
NAVD88	North American Vertical Datum of 1988
NPL	National Priorities List
NYCRR	New York State Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
PAHs	Polycyclic Aromatic Hydrocarbons
PDI	Pre-Design Investigation
PRAP	Proposed Remedial Action Plan
QHHEA	Qualitative Human Health Exposure Assessment
RAOs	Remedial Action Objectives
RI	Remedial Investigation
RIR	Remedial Investigation Report
ROD	Record of Decision
ROWs	Right-of-Ways
SCGs	Standards, Criteria, and Guidance
SCOs	Soil Cleanup Objectives
SMP	Site Management Plan
SVOC	Semivolatile Organic Compound
TCE	Trichloroethene
VOC	Volatile Organic Compound
USACE	United States Army Corps of Engineers

Executive Summary

On behalf of National Grid, GEI Consultants, Inc., P.C. (GEI) has prepared this Feasibility Study (FS) for the Fulton Municipal Works Former Manufactured Gas Plant (MGP) site (the Site). This FS evaluates remedial alternatives for the site parcels, off-site parcels, and adjacent street right-of-ways (ROWs), east of the Gowanus Canal.

The Site is located in the Gowanus neighborhood of Brooklyn, New York, adjacent to and upland from the Gowanus Canal. The Gowanus Canal and surrounding area have supported industrial and commercial activities for approximately 150 years. The Site and adjacent areas are currently zoned for manufacturing use (M1-2 and M2-1).

The Fulton Municipal Works MGP manufactured and provided gas for use by businesses and residences between approximately 1879 and 1929. There are five properties within the footprint of the former MGP (Parcels I through V). In addition to these five parcels, the Remedial Investigation (RI) included three off-site properties (Parcels VI through VIII) and adjacent street ROWs.

The RI was performed between April 2008 and May 2011. Prior to the approval of the Remedial Investigation Report (RIR), the New York State Department of Environmental Conservation (NYSDEC) required National Grid to begin pre-design work for the completion of an Interim Remedial Measure (IRM) consisting of an impermeable barrier wall and non-aqueous phase liquid (NAPL) collection system to prevent potential migration of coal tar to the canal. The RIR was completed in July 2012, and the NYSDEC required National Grid to complete this FS. NYSDEC recently requested that National Grid evaluate the barrier wall as part of this FS, rather than being completed independently as an IRM. Therefore, the NAPL barrier wall is evaluated in this FS.

This FS outlines the Remedial Action Objectives (RAOs) for the Site, identifies and evaluates remedial technologies, organizes them into remedial alternatives for a site-wide remedy and applies them to Parcels I, II, III, IV, VI, VII, and the adjacent street ROWs (collectively, the Fulton Site Parcels). With NYSDEC approval, Parcel V was not included in the FS due to an absence of MGP-related impacts. Accordingly, there is to be no further action for Parcel V. Also with NYSDEC approval, Parcel VIII, on the west side of the Canal, is not included in this FS. It is believed that impacts west of the Gowanus Canal are due to contaminants from a number of sources, and therefore, are not addressed in this FS.

The results of the RI indicated that there is impacted soil and groundwater at the Site, and residual, and potentially mobile, tar-like NAPL in the subsurface. A Qualitative Human Health Exposure Assessment (QHHEA) was performed as part of the RI to evaluate potential exposure pathways to MGP-related Contaminants of Concern (COCs) in soils, groundwater, and soil vapor. The QHHEA concluded that under current conditions, the MGP-related impacts do not pose a risk to human health. There is a potential risk to workers, but only if they perform intrusive activities that expose them to contaminated subsurface soil, groundwater, and soil vapor. There is also a potential risk to pedestrians (adults/children), trespassers, and construction/utility workers, but again, only if they come into contact with work-related dust and vapors released during intrusive activities.

Remedial Action Objectives

The RAOs are site-specific goals that address the media of concern, specific contaminants, and the exposure pathways at the Site for the protection of human health and the environment. The following RAOs were developed for the Site:

Soil

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of contaminants volatilizing from contaminants in soil.
- Remove source material where practicable.

NAPL

- Prevent NAPL from migrating to the Gowanus Canal, to the extent practicable.
- Prevent NAPL from migrating off-site, to the extent practicable.
- Remove source material where practicable.

Groundwater

- Prevent contact with, ingestion of, or inhalation of volatiles from contaminated groundwater.

The New York State Code of Rules and Regulations Subpart 375-6 (6[NYCRR] Part 375) Commercial Use Soil Cleanup Objectives (SCOs) were applied to the parcels evaluated in this FS due to the current and assumed future commercial/industrial site use. In addition, a soil cleanup level for total Polycyclic Aromatic Hydrocarbons (PAHs) of 500 milligrams per kilogram (mg/kg), as stated in NYSDEC Soil Cleanup Guidance (CP-51), Paragraph H, for areas where the Commercial Use SCOs apply, will be used in lieu of achieving individual COC-specific cleanup levels for PAHs. Consideration will also be given to soils that meet this criterion, but could contribute to a nuisance condition as described in Paragraph G of the CP-51 guidance.

Technology Screening and Remedial Alternative Development

In accordance with NYSDEC's Technical Guidance for Site Investigation and Remediation (DER-10), remedial technologies are screened to identify those that are technically implementable and can, either alone or in combination with other technologies, meet the RAOs. Technologies that were screened for the Site include:

- Excavation and off-site Treatment or Disposal

- In-Situ Treatment
    - In-Situ Chemical Oxidation (ISCO)
    - In-Situ Solidification (ISS)
- Containment
    - Capping
    - Barrier Wall
        - Structural Cement-Bentonite Slurry Wall
        - ISS
        - Secant Pile Wall
        - Sealed Joint Sheet Pile Wall
- NAPL Recovery
- Institutional Controls, such as site management plans and environmental easements

Significant implementation issues were identified for many of the technologies due to the highly developed and populated nature of the Site and the depth and extent of NAPL impacts. Therefore, only the most practicable technologies were carried forward for development of alternatives and subsequent detailed evaluation.

Each of the parcels is currently developed and owned by third parties. NYSDEC required that remedial alternatives for future site use be developed and evaluated as part of this FS. Accordingly, two categories of alternatives are presented: (1) Actions that could be implemented to meet the RAOs under current site use and (2) Actions that could be implemented if redevelopment of the property is planned and the planned redevelopment allows for access to subsurface impacts (i.e., redevelopment specifies demolition of existing structures and/or surface features to be completed by others). Each of the alternatives consists of various technologies selected to address each of the RAOs.

The site-wide remedial alternative evaluated for implementation under current site use is as follows:

- Construction of a Barrier Wall at the Canal for NAPL Containment (Parcels I, VI, and VII only)
- NAPL Recovery
- Institutional Controls
- Investigation to delineate potential shallow source material near utilities in ROWs

Three site-wide remedial alternatives were developed and evaluated for a potential future site use/redevelopment scenario. As noted above, the QHHEA concluded that current conditions do not pose a risk to human health. The only potential risk would be from intrusive activities, which are not currently contemplated. In addition there are no redevelopment plans for the parcels. Under these circumstances, if/when a parcel is to be redeveloped, an appropriate remedy will be designed at that time, following pre-design work, including sampling, to define excavation areas and depths, design excavation support and dewatering systems, confirm the presence and depth of former MGP structures, and potentially pre-characterization sampling for waste management. Since it is expected that each parcel will be redeveloped independently, all of these activities will require a parcel-specific design and remediation of each of the parcels will be implemented independently.

The three alternatives for a potential future site use/redevelopment scenario are:

- Excavation of Soil to meet the Unrestricted Use SCOs: Excavation of all MGP-impacted soil on Parcels I, II, III, IV, VI and VII and the ROWs in exceedance of the unrestricted use criteria. Excavation depths would range from 20 to 150 feet below ground surface (bgs).
- Excavation of Former MGP Subsurface Structures: Includes the excavation of former MGP subsurface structures containing source material on Parcels I, II, III and IV; excavation of MGP-impacted soil in exceedance of CP-51 criteria as needed by future redevelopment; NAPL recovery on Parcel II and potentially Parcel III, as appropriate; cap or surface cover; and institutional controls.
- Excavation of Former MGP Subsurface Structures and Remediation of Potentially Mobile NAPL above the Meadow Mat: Includes the above alternative plus the delineation and potential remediation of NAPL impacts present above the meadow mat (approximately 20 feet bgs) on Parcels II, III and VI.

Recommended Remedy for Current Site Use

The site-wide alternative recommended for current site use is as follows:

- Construction of a Barrier Wall: A sealed-joint, steel, sheet pile barrier wall will be installed along Parcels I, VI, and VII to a depth of approximately 50 feet bgs to prevent NAPL migration to the canal.
- NAPL Recovery: NAPL recovery wells, as appropriate, will be installed immediately upgradient of the barrier wall on Parcels I, VI, and VII and the Degraw Street ROW to reduce the volume of source material. A pre-design investigation (PDI) will be performed to identify potential recovery well locations with wells installed at select locations. The wells will be monitored to determine potential NAPL collection volume and recharge rates. A NAPL recovery program will be developed for wells with sufficient NAPL recharge capacity.
- Institutional Controls: Institutional controls are required for Parcels I, II, III, IV, VI, VII, and on select adjacent ROWs to prevent potential exposure to impacted soil and groundwater during soil intrusive activities. It is anticipated that institutional controls will include long term agreements with property owners requiring compliance with site-specific Site Management Plans (SMP) for each parcel, as appropriate. These agreements will provide notice to the property owners of the SMP requirements and will also require the property owners to notify National Grid of planned redevelopment activities and/or major renovations so that National Grid can address remedial issues consistent with the final remedial selection. Other institutional control tools that may be used depending on

site conditions include environmental easements (Parcels I, II, III, and IV), interim SMPs, and groundwater use restrictions.

- Investigation to delineate potential shallow source material in ROWs: An investigation will be performed to determine if source material is present adjacent to shallow utilities in an area of potential impacts identified at the intersection of Nevins and Degraw Streets.

Schedule and Estimated Cost

The barrier wall and NAPL recovery components of the current use remedy will follow a formal remedial design process. Additional pre-design work will be required to design both the barrier wall and NAPL recovery well network. Additional information is needed and includes data on the foundations of buildings and bulkheads adjacent to the proposed barrier wall, refinement of the hydraulic model, and New York City infrastructure data relating to the Flushing Tunnel, Combined Sewer Overflows (CSO) outfalls and other outfalls proximate to the proposed barrier wall.

The United States Environmental Protection Agency (EPA) Gowanus Canal Record of Decision (ROD) presents a remedy for the canal adjacent to the Fulton Site that includes dredging, ISS, and capping. Given the interrelated nature of the Fulton barrier wall and the Gowanus Canal remedy, a final design for the Fulton barrier wall cannot be developed until key elements of the Gowanus Canal remedy are determined. The ultimate schedule for the design of the barrier wall will also rely upon data generated from the completion of the Former Citizens Gas Works MGP Site, Pilot Test Program (evaluating the sealed sheeting approach, constructability and construction methods, and noise and vibration impacts).

The cost for the recommended current site use alternative (barrier wall, NAPL recovery, ROW investigation, long-term operations, maintenance and monitoring, and institutional controls) is estimated to be approximately $16.3 million.

Recommended Remedy Future Use

The recommended site-wide alternative in conjunction with future redevelopment is the excavation of former MGP subsurface structures and the investigation of potentially mobile NAPL above the meadow mat, where applicable. For each parcel, this alternative could include some or all of the following, based on parcel conditions, redevelopment plans, and the extent of redevelopment, which would have to allow for access to the subsurface impacts (i.e., redevelopment specifies demolition of existing structures and/or surface features to be completed by others):

- Excavation of former MGP subsurface structures containing source material on Parcels I, II, III, and IV, which were part of the MGP plant footprint. Subsurface structures containing source material on these parcels and impacted material adjacent to these structures will be excavated. This alternative assumes that a major redevelopment by the property owner is being undertaken to allow for access to the subsurface structures.

- A PDI will be performed on Parcels II, III, and VI to define the presence of or nature and extent of potentially mobile NAPL above the meadow mat. A specific remedy to address these impacts will be developed based on the findings and using the screened technologies presented above, as appropriate, with NYSDEC approval.
- In other areas, where future subsurface activities occur, soils in those areas that exceed CP-51 criteria (total PAHs greater than 500 mg/kg) due to MGP-related impacts, if any, will be excavated to a depth required for subsurface repair, maintenance or redevelopment activities. Prior to subsurface repair, maintenance or redevelopment activities, additional soil analytical sampling will be performed, as needed, to ensure the CP-51 criteria are met for MGP-related impacts, taking into account the nature of the activities and the redevelopment plans.
- Cap or Surface Cover: A cap or cover system, such as pavement, a permanent structure or 1-foot of clean fill will be evaluated on a case-by-case basis, and where necessary, installed during future redevelopment of a parcel to prevent exposure to shallow soil that meets the CP-51 criteria, but exceeds the Commercial Use SCOs for PAHs.
- Subsurface NAPL Barriers: Subsurface NAPL barriers will be evaluated to prevent the recontamination of previously remediated areas if adjacent NAPL impacts are present.
- NAPL Recovery: The need for NAPL recovery systems, if any, will be evaluated dependent upon the findings of the PDI.
- Institutional Controls: Institutional controls are generally required to prevent potential exposure to impacted soil and groundwater during soil intrusive activities. It is anticipated that institutional controls will be needed for Parcels I, II, III, IV, VI, VII, and on the adjacent ROWs, including long term agreements with property owners requiring compliance with site-specific SMPs for each parcel, as appropriate. These agreements will provide notice to the property owners of the SMP requirements and will also require the property owners to notify National Grid of redevelopment plans, redevelopment activities, and/or major renovations so that National Grid can address remedial issues consistent with the final remedial selection. Other institutional control tools that may be used depending on site conditions include environmental easements (Parcels I, II, III, and IV), interim SMPs, and groundwater use restrictions.

<u>Schedule and Estimated Cost</u>

In the event a parcel is to be redeveloped, an appropriate remedy will be designed at that time, following a PDI and consistent with the scope of the redevelopment activities. Since it is expected that each parcel will be redeveloped independently, each parcel will likely require a parcel-specific design. The schedule for any future remedial action at each parcel will depend on the availability of the parcel for evaluation and remediation. In the meantime, interim institutional controls and site management plans will be implemented.

Currently, there is limited information regarding the scope of a future remedial alternative and no redevelopment plans for the parcels. As a result, pre-design work, including sampling, will be required to further define excavation areas and depths, design excavation support and dewatering systems, confirm the presence and depth of former MGP structures, and potentially pre-characterization sampling for waste management.

In the event there is future redevelopment of a parcel that requires excavation of MGP-impacted material above the CP-51 criteria (total PAHs greater than 500 mg/kg), National Grid will work with the property owner to establish a plan to address that impacted material in accordance with the SMP and the NYSDEC-approved FS for the Site. The property owner will need to contact National Grid once it has plans and before undertaking any work. National Grid is responsible for MGP-impacted material only. Any activities associated with standard redevelopment, construction, and/or urban or historic fill is the responsibility of the property owner.

A potential cost range for the recommended future use remedial alternative is estimated to be between $23.9 and $38.9 million. Currently there are no property redevelopment plans for parcels related to the Fulton MGP. Consequently, these cost estimates are based on numerous assumptions with limited information regarding the scope of the remedy and/or the future redevelopment plan. Assumptions were made regarding the depth and location of the future redevelopment for each parcel, the redevelopment of potential minimum and maximum remedial areas based on the limited data, the selected remedial technology, the amount of soil that could potentially be re-used on site, and the requirement and type of excavation support, dewatering systems, and odor control. Accordingly, the estimated cost range represents a projection that will likely change if/when information and data are obtained from a PDI, engineering design, and redevelopment plans.

1. Introduction

On behalf of National Grid, GEI Consultants, Inc., P.C. (GEI) has prepared this Feasibility Study (FS) for the Fulton Municipal Works Former Manufactured Gas Plant (MGP) site (the Site), shown in **Figure 1**. The Site is under an Order on Consent and Administrative Settlement (AOC) #A2-0552-0606, which was entered into by KeySpan Corporation, now National Grid, and the New York State Department of Environmental Conservation (NYSDEC) in 2007. This FS evaluates remedial alternatives for four properties within the footprint of the former MGP site (Parcels I through IV) and two off-site properties (Parcels VI and VII) and adjacent street right-of-ways (ROWs), east of the Gowanus Canal (Collectively the Fulton Site Parcels).

National Grid completed the Remedial Investigation (RI) for the Site in May 2011. The final RI Report (RIR), *Final Remedial Investigation Report, Fulton Municipal Works Manufactured Gas Plant (MGP) Site*, dated July 2012, was approved by the NYSDEC in July 2012. In the approval letter, the NYSDEC directed National Grid to complete a FS for the Site.

In a letter from the NYSDEC dated January 18, 2012, following the submittal of the draft RIR, NYSDEC directed National Grid to prepare a pre-design investigation (PDI) work plan for an Interim Remedial Measure (IRM) consisting of an impermeable barrier wall and non-aqueous phase liquid (NAPL) collection system to prevent migration of coal tar to the Gowanus Canal. National Grid developed the work plan and completed this initial PDI between June and September 2012.

On February 25, 2013, National Grid met with the NYSDEC to discuss the sequencing and development of the IRM design. At that time, it was not currently feasible to complete a barrier wall design for the Site given the many design uncertainties raised by the issuance of the United States Environmental Protection Agency's (EPA) Gowanus Canal Proposed Remedial Action Plan (PRAP) on December 27, 2012. The barrier wall requires integration with elements of the EPA's remedy for the Gowanus Canal, and therefore, final design elements will be dependent on the EPA's remedy for the canal presented in the Record of Decision (ROD) issued in October 2013. However, National Grid and the NYSDEC had agreed that the results of the PDI should be submitted to the agency in advance of the ROD. Therefore, National Grid submitted the PDI results to the NYSDEC in the *DRAFT IRM PDI Data Summary Report, Fulton Municipal Works MGP Site*, dated April 2013.

On May 10, 2013, National Grid met with the NYSDEC to discuss the Fulton FS. The NYSDEC informed National Grid that the NAPL barrier wall would no longer be completed as an IRM and that it should be evaluated as part of this FS. Therefore, the NAPL barrier wall is evaluated in this FS.

In addition to evaluating the NAPL barrier wall, this FS outlines the Remedial Action Objectives (RAOs) for the Site, identifies and evaluates remedial technologies, organizes them into remedial alternatives for a site-wide remedy and applies them to the Site Parcels. An evaluation of remedial options for Parcel V is not included in this FS. The final RIR recommended that no further action was required on this parcel with respect to MGP-related contaminants. NYSDEC approved the RIR recommendations in its acceptance letter dated July 13, 2012.

West of the canal, including Parcel VIII, tar is encountered in close proximity to the existing bulkheads as well as at depths greater than 30 feet below ground surface (bgs). Petroleum impacts, unrelated to the Site, are also located on the west side of the canal. The co-mingled nature of tar and petroleum impacts dictates that they are more appropriately addressed in conjunction with the EPA's remedy for the Gowanus Canal and with the parties responsible for the non-Site related petroleum impacts. Therefore, impacts west of the canal will not be addressed as part of this FS.

National Grid revised the parcel boundaries that were originally defined in the RIR. These parcel boundaries did not match property boundaries and extended into the adjacent street ROWs. The parcel boundaries have been revised to match the property boundaries to better manage the Site and accommodate future property transfers. The RIR parcel boundaries and redefined parcel boundaries can be found in **Figure 2.**

1.1 Report Organization

This FS has been prepared in general accordance with the NYSDEC Division of Environmental Remediation *DER-10 Technical Guidance for Site Investigation and Remediation* (DER-10), dated May 3, 2010. This FS report has been organized as follows.

- Section 1 Introduction
- Section 2 Site Description and History
- Section 3 Summary of Site Investigations and Exposure Assessment
- Section 4 Remedial Goals
- Section 5 General Response Actions
- Section 6 Identification and Screening of Technologies
- Section 7 Development and Analysis of Alternatives
- Section 8 Recommended Remedy
- Section 9 References

2. Site Description and History

The Fulton Municipal Works Former MGP Site is located along and upland of the Gowanus Canal in the Gowanus neighborhood of Brooklyn, New York (**Figure 1**). The canal was created by channelizing the Gowanus Creek and filling the adjacent wetlands complex in the mid-1800s for the development of south Brooklyn. The Gowanus Canal and surrounding area have supported industrial and commercial activities for approximately 150 years. However, industrial use has diminished in the upper reach, north of Carroll Street, with no significant barge traffic within the last decade.

The Fulton Municipal Works Former MGP manufactured and provided gas for use by businesses and residences between approximately 1879 and 1929. Following decommissioning, the property was subdivided into five properties and sold by The Brooklyn Union Gas Company, now National Grid, between the mid-1930s and 1940s. The historical MGP footprint and structures as of 1928 are shown in **Figure 3** and **Appendix A**.

The Site and adjacent areas are currently zoned for manufacturing use (M1-2 and M2-1). The former MGP occupies five current properties (designated Parcels I through V). Three additional off-site properties (Parcels VI through VIII) were investigated to delineate the nature and extent of impacts as part of the RI. The parcel locations with modern and historical structures are shown in **Figure 2** and **Figure 3**, respectively.

- **Parcel I** is located at 270 Nevins Street (Block 425, Lot 1). During manufactured gas production, Parcel I housed MGP production facilities including an oil/naphtha tank, tar collection tank, generator/retort house, condenser/blower house, coal shed, engine house, gasoline house, and generators. The property is currently used as a filming studio.

- **Parcel II** is located at 225 Nevins Street (Block 419, Lot 1). During manufactured gas production, the southern portion of Parcel II housed production facilities including three oil tanks, one relief holder/hydrogen tank, six gas oil naphtha tanks, a paint shop, blacksmith shop, carpenter shop, pipe shop, garage, and several sheds. Nine tanks and a still house that were associated with the U.S. government’s toluol recovery operations during World War I were located on the northern portion of Parcel II. The toluol plant operated between July and November of 1918 and produced approximately 374,000 gallons of light oil, 172,000 gallons of crude benzol, 93,000 gallons of crude toluol, and 43,000 gallons of solvent naphtha. Currently, the property is the location of the Thomas Greene Playground and the Douglass and Degraw Pool. The playground includes a water feature, skate park, basketball courts, and handball courts. The Douglass and Degraw Pool includes an intermediate pool and a wading pool.

- **Parcel III** is located at 537 Sackett Street (Block 426, Lot 1). During manufactured gas production, Parcel III housed production facilities including a gas holder, purifying houses, oxidizing sheds, coal bin, shaving scrubbers, tower scrubbers for the toluol recovery operation, meter house, governor's house, and offices. The property is currently used as a textbook warehouse. Other post-MGP operation uses for the property have included a metal plating operation and an auto body shop.

- **Parcel IV** is located at 560 Degraw Street (Block 426, Lot 27). During manufactured gas production, Parcel IV housed production facilities including a gas holder and a coal shed. Currently, the property is used for storage of roll-off bins, truck maintenance equipment, and construction materials; as a parking lot; and for miscellaneous commercial uses.

- **Parcel V** is located at 191 3rd Avenue, also known as 575 Degraw Street (Block 420, Lot 1). During operation of the Fulton Municipal Works MGP, Parcel V was also known as the 3rd Avenue Holder Station, and the property housed a variety of facilities including a gas holder (storage only), water tank, engines/blowers, and coal shed. Currently, the property is used as a rock climbing gym and warehouse. Based on the findings of the RI, Parcel V does not exhibit soil, groundwater, or soil vapor impacts related to the former gas storage operations. The 2012 final RIR indicated that no further action was required on this parcel. NYSDEC approved the RIR recommendations in their acceptance letter dated July 13, 2012. As such, Parcel V is not addressed in the FS.

- **Parcel VI** is located at 242 Nevins Street (Block 418, Lot 1). This parcel is not part of the former MGP Site. The property is currently used for truck repair and parking and as offices. Historically, the property was used for coal storage and for petroleum storage.

- **Parcel VII** is located at 228 Nevins Street (Block 411, Lot 24). This parcel is not part of the former MGP Site. The property is currently used for truck repair. Historically, the property was used for petroleum storage.

- **Parcel VIII** is located at 479 Degraw Street (Block 417, Lot 21), west of the canal. This parcel is not part of the former MGP Site. The property is currently used as an office space and parking. Historically, the property was used for petroleum storage.

The EPA added the Gowanus Canal to the Superfund National Priorities List (NPL) on March 10, 2010. The Gowanus Canal has been impacted by multiple contaminant sources, both historically and on an ongoing basis. National Grid is committed to addressing canal impacts associated with the former MGP operations, in conjunction with the EPA's remedy for the Gowanus Canal. West of the canal, including at Parcel VIII, tar is encountered in close proximity to the existing bulkheads as well as at depths greater than 30 feet bgs. It is likely that these materials represent tars that have been released into the Gowanus Canal from multiple sources, and not directly from the Site. Petroleum impacts, unrelated to the Site, are also located on the west side of the canal. The co-mingled nature of tar and petroleum impacts dictates that they will need to be addressed in conjunction with the EPA's remedy for the Gowanus Canal and, therefore, will not be addressed as part of this FS.

2.1 Site Geology

According to published information, the Fulton Municipal Works Former MGP is underlain by the following geologic materials, presented in stratigraphic order (deepest to shallowest):

- Fordham Gneiss
- Jameco Gravel
- Gardiners Clay
- Glacial outwash sands with discontinuous silt and till lenses
- Alluvial/Marsh deposits
- Fill

The descriptions below define the geologic layers and where each was found during the RI.

Bedrock encountered beneath the Site is the Fordham Gneiss, which is described as a metamorphosed, medium- to coarse-grained igneous rock unit of Precambrian Age (Brock and Brock, 2001). Sandy lean clay with the same color characteristics and relocked layers as the Fordham Gneiss, likely weathered bedrock, was encountered at a depth of approximately 151 feet bgs [Elevation (El.) -142 feet North American Vertical Datum of 1988 (NAVD88)]. Bedrock was observed at a depth of 159 feet bgs [El. -150 feet NAVD88].

The Jameco Gravel consists of dark coarse sand and gravel with cobbles and boulders ranging in thickness from absent in some locations to approximately 200 feet thick in Queens County (Cartwright, 2002). The Jameco Gravel was encountered from approximately 124 feet to 160 feet bgs [El. -115.3 to -153 feet NAVD88].

Within Kings County, bedrock is generally overlain by lagoonal marine deposits (Gardiners Clay) (Cartwright, 2002). The Gardiners Clay was not encountered during the RI. However, a 1.5-foot-thick layer of grayish-brown silty-sand that contained approximately 50 percent shells was encountered at one boring at a depth consistent with the Gardiners Clay unit observed during investigations at the Citizens Gas Works MGP, approximately 0.5 mile to the south.

Glacial deposits in the vicinity of the Site consist of poorly sorted mixtures of clay, silt, sand, gravel, and boulders, and glacio-fluvial outwash deposits consisting of moderately to well-sorted sands and gravels (Cartwright, 2002). The glacial outwash unit generally extended to the top of the Jameco Gravel, which was present between approximately 125 and 145 feet bgs. Isolated layers of glacial till are present within the glacial outwash. The glacial till represents a brown to red-brown, poorly-sorted unit consisting of silt and fine-to-coarse sand. Layers of glacial till were not continuous and were primarily encountered to the northeast of the Site and to the west of the Gowanus Canal. The layers were encountered as deep as 122 feet. The thickness of the glacial till ranged from 0.4 to 34 feet.

Holocene age alluvial/marsh deposits consist of sand, silt, and organic material along stream channels and marshes (Busciolano, 2002). The deposits consist of sub-units of alluvial sand and organic marsh (meadow mat) materials which include fine-grained soils including silt, silt-clay, and clay and peat. Based on historical maps, these deposits are believed to be associated with a former marsh (possibly inter-tidal) located adjacent to the former Gowanus Creek. The alluvial/marsh deposits were encountered throughout the investigation area with the exception of locations near 3rd Avenue and within Parcel I. The alluvial/marsh deposits were found at the approximate elevation (El. -11 feet NAVD88) of the anticipated bottom of the former Gowanus Creek. This elevation is consistent with a former active stream depositional system and an associated lower energy marsh environment. The thickness of the alluvial/marsh deposits ranged from 0.25 feet to 17 feet. The deposits were observed as shallow as 4 feet bgs [El. -1.79 feet NAVD88] and extended to a maximum depth of 39.5 feet bgs [El. -20.08 feet NAVD88] (**Plate 1**).

Fill is defined as soil or rock used to raise the surface of the ground (New York State Geological Survey, 2011). Fill was encountered throughout the Site and primarily consisted of loose, non-cohesive sand and silty-sand with some gravel mixed with brick, concrete, coal fragments, wood, ash, metal fragments, and debris. Fill ranged from approximately 5 feet to 30 feet thick.

2.2 Site Hydrogeology

Two regional groundwater aquifers are present in the vicinity of the Site, the shallower Upper Glacial Aquifer and the deeper Jameco Aquifer. Tidal effects were observed in both the Upper Glacial Aquifer and the Jameco Aquifer during the RI. The Upper Glacial Aquifer has been subdivided into shallow, intermediate, and deep groundwater zones.

The shallow water table zone resides in fill and alluvial/marsh deposits. Elevations of well screen intervals within the shallow zone ranged between approximately 11 and -13 feet NAVD88. Water table elevations ranged from 8.03 feet to -1.76 feet NAVD88 during a RI gauging event conducted on May 19, 2011. Tidal fluctuations ranged from no change to 4.85 feet, with the greatest tidal fluctuations generally observed in monitoring wells located adjacent to the Gowanus Canal bulkhead. The shallow groundwater flows toward the canal. On the east side of the canal, groundwater generally flows westward while shallow groundwater on the west side of the canal flows to the east and south. Overall, the average hydraulic gradient of the shallow groundwater aquifer ranged from 0.0017 to 0.024 feet.

The intermediate groundwater zone resides in glacial outwash deposits. The well screens were installed approximately 5 feet below the elevation of the accumulated sediment/native materials interface within the adjacent Gowanus Canal. Elevations of screen intervals ranged from approximately -17 to -36 feet NAVD88. Intermediate groundwater elevations ranged from 3.06 feet to 1.38 feet NAVD88 during the May 19, 2011, RI gauging event. Under high tide conditions, groundwater in the intermediate zone generally flows toward the Gowanus Canal and converges on a southerly flow path in the vicinity of Parcel I. At low tide conditions, groundwater flow is more southeasterly. Tidal fluctuations within the intermediate zone of the Upper Glacial Aquifer during the May 19, 2011, RI gauging event ranged from 0.04 to 1.03 feet. The average hydraulic gradient of the intermediate groundwater zone ranged between 0.0018 to 0.0020 feet. Upward and downward head potentials were measured. The upward head potentials between the shallow and intermediate zones ranged from 0.001 to 0.097 feet and the downward head potentials ranged from -0.009 to -0.151 feet. The downward vertical head potentials are a result of the meadow mat materials creating a mounded water condition in the shallow zone at Parcel II and potentially in other areas where the meadow mat materials are present.

The deep groundwater zone consists of glacial outwash deposits. Well screens were installed approximately 5 feet above the anticipated elevation of Gardiners Clay. Elevations of screen intervals ranged from -103 to -110 feet NAVD88. Deep groundwater zone elevations ranged from 3.46 feet to 2.51 feet NAVD88 during the May 19, 2011, RI gauging event. Groundwater flow direction in the deep groundwater zone of the Upper Glacial Aquifer was not determined because only two deep wells were installed within the study area; however, flow data from nearby sites and the regional groundwater flow direction suggest that the flow in the deep zone is southwesterly toward Gowanus Bay. There is an upward head potential between the intermediate and deep zones ranging from 0.009 to 0.011 feet.

The Jameco Aquifer zone consists of Jameco gravel. Well screens were installed within the top 5 feet of the Jameco Gravel layer. Elevations of screen intervals ranged from -133 to -145 feet NAVD88. Groundwater elevations within this zone ranged from 3.90 to 2.83 feet NAVD88 during the May 19, 2011, RI gauging event with tidal fluctuations ranging from 0.02 to 0.37 feet. Groundwater flow directions could not be directly determined because only two wells were installed in the Jameco Aquifer; however, flow direction is expected to be southerly based upon regional groundwater flow information. There is an upward head potential between the deep zone of the Upper Glacial Aquifer and the Jameco Aquifer ranging from 0.042 to 0.080 feet.

3. Summary of Site Investigations and Exposure Assessment

The results of the RI and PDI, and the results of the Qualitative Human Health and Exposure Assessment (QHHEA) performed as part of the RI, are summarized below.

3.1 Remedial and Pre-Design Investigation Results Summary

On behalf of National Grid, GEI completed the NYSDEC-approved RI at and adjacent to the Fulton Municipal Works Former MGP Site from May 2008 to May 2011. The RI investigated soil, groundwater, and air impacts on or adjacent to the Site. The RI identified impacted soil and groundwater on properties within and adjacent to the Site and in adjacent street ROWs. In addition to the RI, at the NYSDEC's direction, National Grid completed a PDI to obtain additional information that will be used to support the design of a NAPL barrier wall. The PDI was completed between June and September of 2012.

MPG-related impacts were not found in the top 5 feet of soil on the Site with one exception. Tar staining was noted at 3.7 to 5 feet bgs in boring FW-SB-12, which is located within the holder footprint on Parcel III (as shown in **Plate 2**). Otherwise, MPG-related impacts were encountered below 5 feet bgs and observed impacts generally increase with depth. Petroleum-impacted soils are present across the area of the RI and are generally shallower than the MGP-impacted soils. **Plate 2** depicts physical impacts from 0 to 5, 5 to 10 and 10 to 15 feet bgs. **Plate 3** depicts physical impacts from 15 to 20, 20 to 25, and 25 to 30 feet bgs.

A summary of the environmental findings from the RI and PDI are presented by parcel below.

3.1.1 Parcel I Findings

- Petroleum impacts observed primarily below 10 feet bgs and as deep as 32 feet bgs.
- Residual tar impacts observed primarily between 20 and 50 feet bgs and as deep as 105 feet bgs.
- Tar impacts observed include tar staining, sheen, blebs, coatings, and saturation.
- Data collected during the RI indicate that groundwater at this parcel is impacted with volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), methyl tert-butyl ether (MTBE), pesticides, and metals. NAPL blebs and petroleum odors were also observed in the groundwater during sampling events. The pesticides and MTBE are unrelated to the former MGP operations.
- Soil Vapor/Indoor Air results indicate soil vapor intrusion is not affecting indoor air.
- No exposure to MGP-related impacts under current use.

3.1.2 Parcel II Findings

- Petroleum staining and sheen observed in the top 5 feet bgs.
- Residual tar impacts primarily between 30 and 60 feet bgs and as deep as 105 feet bgs. Tar staining was observed at one location in the top 5 feet bgs.
- Tar impacts observed include tar staining, sheen, blebs, coatings, and saturation.
- Data collected during the RI indicate that groundwater at this parcel is impacted with VOCs, SVOCs, pesticides, and metals. The pesticides are unrelated to the former MGP operations.
- In soil vapor, trace concentrations of VOCs (ethylbenzene, chloroform, trichloroethene [TCE], 1,2,4 trimethylbenzene, 1,3,5 trimethylbezene) were detected. TCE and chloroform are not MGP-related.
- No exposure to MGP-related impacts under current use.

3.1.3 Parcel III Findings

- Petroleum staining observed in top 5 feet bgs.
- Tar sheen observed within the holder at 3.7 feet bgs.
- Residual tar impacts observed primarily between 5 and 20 feet bgs and as deep as 34 feet bgs.
- Tar impacts observed include tar staining, sheen, blebs, coatings and saturation.
- Data collected during the RI indicate that groundwater at this parcel is impacted with VOCs (including chlorinated compounds), SVOCs, pesticides, metals, and cyanide. The chlorinated compounds and the pesticides are unrelated to the former MGP operations.
- In soil vapor/indoor air, detected concentrations of non-MGP VOCs exceed New York State Department of Health guidance values for TCE.
- No exposure to MGP-related impacts under current use.

3.1.4 Parcel IV Findings

- No physical impacts in top 5 feet bgs.
- Petroleum blebs to 17.5 feet bgs outside the holder.
- Residual tar impacts observed primarily between 13 and 19 feet bgs.
- Tar impacts observed include tar staining, coating and saturated lenses.
- Data collected during the RI indicate that groundwater at this parcel is impacted with VOCs, SVOCs, metals, and cyanide. MTBE and associated VOCs, which are not MGP-related, were also detected.
- In soil vapor, low concentrations of VOCs detected, which are likely related to the current site use and/or urban fill.
- No exposure to MGP-related impacts under current use.

3.1.5 Parcel V Findings

- No MGP-related physical impacts observed.

- No further action approved by NYSDEC.

3.1.6 Parcel VI Findings

- Petroleum impacts observed in the top 5 feet bgs.
- Residual tar impacts observed primarily between 30 and 50 feet bgs and as deep as 128 feet bgs.
- Tar impacts observed include tar staining, sheen, coatings, and saturation.
- Data collected during the RI indicate that groundwater at this parcel is impacted with VOCs, SVOCs, pesticides, and metals. The pesticides are unrelated to the former MGP operations.
- No exposure to MGP-related impacts under current use.

3.1.7 Parcel VII Findings

- Petroleum odors observed in the top 5 feet bgs.
- Residual tar impacts observed primarily between 25 and 62 feet bgs at the bulkheads during the PDI.
- Tar impacts observed include tar staining, sheen, coatings, and saturation.
- Data collected during the RI indicate that groundwater at this parcel is impacted with VOCs, SVOCs, and metals.
- No exposure to MGP-related impacts under current use.

3.1.8 Parcel VIII Findings

- Petroleum staining in top 5 feet bgs.
- Residual tar impacts observed primarily between 25 and 100 feet bgs.
- Tar impacts observed include tar staining, sheen, and coating.
- Data collected during the RI indicate that groundwater at this parcel is impacted with VOCs, SVOCs, and metals.
- No exposure to MGP-related impacts under current use.

3.1.9 ROW Findings

- Petroleum staining in top 5 feet bgs.
- Residual tar impacts are present in subsurface soils along portions of Douglass, Degraw, Sackett, and Nevins Streets adjacent to Site Parcels. **Figure 4** presents utility locations in relation to the shallowest residual tar-related impacts. Based on the existing information, it appears that sensitive utilities including the water and gas mains are primarily above the elevation of the residual tar impacts. Sanitary sewers, though, are located at deeper elevations in areas proximate to residual tar impacts on portions of Degraw, Douglass, and Nevins Streets.
- Data collected during the RI indicate that groundwater in the ROWs is impacted with VOCs (including non-MGP-related chlorinated compounds and MTBE), SVOCs,

pesticides, metals, and cyanide. The MTBE, chlorinated compounds and the pesticides are unrelated to the former MGP operations.

- No exposure to MGP-related impacts under current use.

3.2 Qualitative Human Health and Exposure Assessment

A QHHEA was performed as part of the RI to evaluate potential exposure pathways to Site-related Contaminants of Concern (COCs) in soils, groundwater, and soil vapor. The QHHEA concluded that under current conditions, the environmental impacts do not pose a risk to health for humans. However, potential future utility and construction workers may contact contaminants in subsurface soils or groundwater at each of the parcels, except for Parcel V, and beneath portions of the streets during excavation activities. There is a potential risk to these workers performing utility repairs or future construction activities from exposure to contaminated subsurface soil, groundwater, and soil vapor. In addition, potential risk exists for pedestrians (adults/children), trespassers and construction/utility workers if they come into contact with work-related dust and vapors during intrusive activities within impacted soils and groundwater.

4. Remedial Goals

The objective of this FS is to evaluate and recommend remedial alternatives for Parcels I, II, III, IV, VI, and VII and street ROWs adjacent to these parcels. As discussed above, Parcels V and VIII are not included in this FS.

4.1 Remedial Action Objectives

The RAOs are site-specific goals that address the media of concern, specific contaminants, and the exposure pathways at the Site for the protection of human health and the environment. The media of concern for the Site are soil, groundwater, and tar-like NAPL related to the former MGP operation. The RI did not identify any areas where MGP-impacted soil vapor was adversely affecting indoor air quality and, therefore, soil vapor will not be addressed in this FS.

The specific RAOs identified for the Site are listed below.

Soil

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of contaminants volatilizing from contaminants in soil.
- Remove source material where practicable.

NAPL

- Prevent NAPL migration to the Gowanus Canal, to the extent practicable.
- Prevent NAPL from migrating off-site, to the extent practicable.
- Remove source material where practicable.

Groundwater

- Prevent contact with, ingestion of, or inhalation of volatile contaminants from contaminated groundwater.

4.2 Standards, Criteria, and Guidance

As defined in DER-10, Standards, Criteria, and Guidance (SCGs) are the New York State regulations or statutes that dictate the cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that are generally applicable, consistently applied, officially promulgated, and are directly applicable to a remedial action.

The SCGs that apply to this Site are:

- New York State Code of Rules and Regulations 6(NYCRR) Subpart 375-1: General Remedial Program Requirements
- 6NYCRR§ 375-2: Inactive Hazardous Waste Disposal Site Remedial Program
- 6NYCRR§ 375-6: Remedial Program Soil Cleanup Objectives (SCOs)
- Guidance for Evaluating Soil Vapor Intrusion in New York
- DER-10 Technical Guidance for Site Investigation and Remediation
- DER-31 Green Remediation
- NYSDEC CP-51 Soil Cleanup Guidance (CP-51)

The site-specific cleanup levels for the MGP-related COCs in soil are the SCGs that will be used to define the RAOs and to develop the remedial alternatives. The 6NYCRR Part 375 Commercial Use SCOs were applied to Site parcels due to the current and anticipated future commercial/industrial site use. In addition, a soil cleanup level for total Polycyclic Aromatic Hydrocarbons (PAHs) of 500 milligrams per kilogram (mg/kg), as stated in NYSDEC Soil Cleanup Guidance CP-51, Paragraph H, for areas where the Commercial Use SCOs apply, will be used in lieu of achieving individual COC-specific cleanup levels for PAHs. Consideration will also be given to soils that meet this criterion, but could contribute to a nuisance condition as described in Paragraph G of the CP-51 guidance. Soil analytical data compared to the CP-51 criteria is presented in **Figures 5** and **6**. As presented in **Figure 5**, only two exceedances of the CP-51 criteria were identified in the top 5 feet. Soil analytical data for each of the parcels is presented in Appendix B.

5. General Response Actions

In accordance with the guidance provided in DER-10 regarding the development and evaluation of remedial alternatives, this section describes the development of General Response Actions (GRAs) to address the RAOs identified in Section 4. GRAs are not specific to any single technology, but represent categories or approaches that may be combined and further defined to create remedial alternatives. To meet the RAOs developed for the Site, the following GRAs were identified:

1. **No Action.** There is no exposure to MGP impacts under current site use conditions. However, there is potential for exposure to MGP-impacted soil and groundwater during soil intrusive construction activities, and potential source material is present at some locations. Therefore, due to potential future exposure, no action would result in not meeting the RAOs and is not contemplated for this Site.

2. **Excavation and Off-Site Treatment/Disposal of Soil.** These actions include excavation of impacted soil and NAPL impacts within soil, and off-site treatment/disposal at properly permitted facilities.

3. **In-Situ Treatment of Soil.** This action includes in-situ reduction in the volume, toxicity, and/or mobility of the contaminants in soil and/or of NAPL.

4. **Containment.** Containment actions involve little or no treatment, but provide physical barriers to exposure and/or prevent migration of NAPL. These actions include vertical barriers, and surface caps.

5. **NAPL Recovery.** NAPL recovery involves the installation of recovery wells and/or trenches to collect recoverable NAPL from the subsurface. The collected NAPL can then be removed and treated/disposed of off site.

6. **Institutional Controls**. Institutional controls minimize the potential for contact with the contaminated soil and groundwater, and the implemented remedy. They can include access controls, environmental easements, site management plans, health and safety plans, long-term monitoring, and/or notifications.

6. Identification and Screening of Technologies

This section of the report describes the technologies selected to meet the GRAs identified above. In accordance with DER-10, the technologies are screened to identify those that are technically implementable and can, either alone or in combination with other technologies, meet the RAOs.

Technologies that were screened for the Site include:

- Excavation and off-site treatment or disposal
- In-Situ Treatment
    - In-situ chemical oxidation (ISCO)
    - In-situ solidification (ISS)
- Containment
    - Capping
    - Barrier Wall
        - Structural Cement-Bentonite Slurry Wall
        - ISS
        - Secant Pile Wall
        - Sealed Joint Sheet Pile
- NAPL Recovery
- Institutional Controls, such as site management plans and environmental easements.

Table 1 provides a summary of the initial screening and identifies the technologies retained for use in the alternatives presented in Section 7. The remainder of this section provides descriptions of the technologies and the results of the initial screening.

6.1 Excavation and Off-Site Treatment or Disposal

Technologies for excavation include use of conventional trackhoe equipment for excavation to depths of 20 feet, extended arm trackhoe equipment for excavation to depths of 40 feet, and crane-mounted Kelly bar/clam shell equipment for excavation to depths of 100 feet or more. A combination of conventional trackhoe, extended arm trackhoe, and crane-mounted technologies would be used to complete the excavation work. Control of odors and VOC emissions will be a critical aspect of all excavation scenarios at the Site. Excavation and loading activities would be conducted using odor-controlling foam, temporary plastic covering, and direct load-out to minimize odors and emissions. An air monitoring program would be designed and implemented during excavation activities to ensure emissions are within acceptable levels.

Material management including handling and treatment/disposal of soils, asphalt, debris, and former structures encountered in subsurface fill material is an important part of this alternative. A significant amount of space will be needed to manage the excavated materials. Two other major challenges of potentially deeper excavation at the Site are sidewall support and water management.

Excavated materials would be transported using appropriately permitted trucks or barges. Off-site disposal options include thermal desorption and landfill disposal. While both of these disposal options are carried forward into the detailed description of excavation alternatives, thermal desorption will be given preference where it is technically feasible because the treatment removes the contaminants and the soil can be recycled for beneficial reuse. Large rock and demolition debris would not be accepted by the thermal desorption facilities and would require landfilling.

Excavation will be retained for further consideration. Shallow excavations designed to address source removal and potential exposure under future site use scenarios will be developed as alternatives. The shallow excavation alternatives will be protective of human health and the environment while minimizing disruption to the community, short-term exposure, and implementation challenges associated with deeper excavations.

There are numerous implementation challenges associated with excavation greater than 20 feet at the Site. These challenges include excavation support, dewatering, increased exposure to impacted material, and significant disruption to the community. The deeper the excavation, the larger these challenges grow, with little or no incremental increase in protection of human health and the environment compared to other available technologies. However, excavation to depths of 150 feet bgs to attain Unrestricted Use SCOs is retained as an alternative for further evaluation in accordance with DER-10 Section 4.4 Remedy Selection Reporting Requirements.

6.2 In-situ Treatment

In-situ treatment technologies use chemical, thermal or biological processes to reduce the toxicity or volume of contaminants. In-situ technologies identified for the Site include ISCO and ISS for the treatment of MGP-impacted soil.

6.2.1 In-Situ Chemical Oxidation

ISCO uses various formulations of oxidants to degrade contaminants in the subsurface. The most common oxidants used in ISCO treatment are permanganate (MnO_4^-), Fenton’s (H_2O_2 and Fe^{2+}, or catalyzed hydrogen peroxide), ozone (O_3), and persulfate ($S_2O_8^{2-}$). The technology has been used previously at MGP sites with some limited success, although it had not been effective at treating NAPL source areas. When using ISCO as a remedial technology, the project engineer must have a very thorough understanding of site characteristics such as subsurface geology, hydrologic conditions, and contaminant chemistry.

ISCO will not be effective at reducing the contaminant concentrations in soil to meet the SCGs since there is NAPL present at depth. Therefore, ISCO is eliminated from further evaluation.

6.2.2 In-Situ Solidification

ISS treatment of impacted soil involves the in-place mixing of cementatious reagents, such as Portland cement, with impacted soil to create a solid monolith that substantially decreases the ability of groundwater to come into contact with contaminants. The ISS technology relies on the selection of the appropriate agents and proportions (the “mix design”) as well as the successful delivery system to provide in-situ contact and encapsulation of the impacted soil. The three common delivery systems used for ISS are bucket mixing, auger mixing, and pressure/jet grouting.

ISS results in the formation of a solid monolith of relatively impermeable material in the saturated zone. Groundwater is forced around and under the ISS monolith, thus preventing contact of groundwater with the COC contained in the monolith. However, at some sites, the changed hydrogeologic regime can pose a risk for increased migration of NAPL and COC from areas adjacent to the ISS monolith.

Past industrial use of the Site also presents another implementation challenge to using site-wide ISS. The parcels are currently developed and large aboveground structures as well as numerous underground structures exist in the subsurface. These structures would have to be removed, along with any deep foundations and/or pilings. Removal of these structures would require large excavations to depth and would require substantial excavation support and dewatering, making ISS technically unfeasible.

A related issue is the implementation of ISS adjacent to structures, specifically with shallow foundations. During the installation of the cement mix it is in a flowable state, and as such, provides minimal lateral support to adjacent structures. Therefore, there is the potential for building settlement requiring additional temporary support measures.

Therefore, use of ISS as a major component of the remedy at the Site is not recommended. However, appreciating the limitations of this technology in formerly highly developed and congested sites, ISS could potentially be applicable for some future site use scenarios once properties are redeveloped and subsurface MGP structures have been removed. Therefore, ISS will be retained for alternative development and evaluation on a parcel-specific basis.

6.3 NAPL Recovery

NAPL recovery can reduce the amount of source material in the subsurface by removing the mass of NAPL and also reduce the mobility of residual NAPL by recovering the flowable fraction. Typical recovery systems include specially constructed wells and recovery trenches. Collection may be passive or may require an active pumping system. Several NAPL pumping systems are available, including low-flow NAPL-only pumps. Therefore, NAPL recovery methods are retained for further consideration as a component of the remedial action for the Site.

6.4 Containment Technologies

Containment technologies screened include engineered surface caps and containment barrier walls.

6.4.1 Engineered Caps and Covers

Caps include surface cover soil and impervious caps, which are effective for controlling exposure to impacted surface and shallow subsurface soils. MGP-impacted surface soils are not present in any of the parcels. However, the CP-51 PAH guidance criteria applies to subsurface soil and requires that cover systems such as pavement, permanent structures, or at least 1 foot of surface soil that meets the Commercial Use SCO for the Site be present. Therefore, engineered caps and covers are retained for further consideration as a component of the remedial action for the Site.

6.4.2 Barrier Walls

Barrier walls will be evaluated for two potential applications at the Site. The main purpose of a barrier wall at the Site is to prevent the migration of NAPL into the Gowanus Canal. Upland subsurface NAPL barriers will also be evaluated as a potential technology to contain upland NAPL impacts above the meadow mat, where applicable, to prevent the recontamination of remediated areas.

Soil boring locations with areas of NAPL saturation and potentially mobile NAPL are illustrated in **Figures 7** and **8** and **Plates 1** and **2**. The majority of NAPL saturation was identified on Parcels I, II, III, IV, VI, and VII. The NAPL identified on Parcels I, II, III, and IV in the 10 to 25 feet depth range is primarily associated with subsurface MGP structures. Related NAPL impacts outside of these structures have been identified on Parcel II, in the ROWs (Nevins and Degraw Streets) and on Parcels I, VI, and VII.

6.4.2.1 Canal Barrier Wall

The primary objective of the barrier wall for the Site is to prevent the migration of NAPL from Parcels I, VI and VII into the Gowanus Canal. Containment of the deeper impacts (well below the design dredge line of the canal) on Parcels I, VI, and VII via a barrier wall is not feasible due to the lack of a confining unit in which to seat the wall. An adequate confining unit (competent bedrock) was not identified during the RI in the upper 159 feet of the subsurface. Further, the Gardiners Clay layer was not encountered at the Site, and the underlying Fordham Gneiss bedrock was only encountered at the southwest corner of Parcel I.

Given the physical constraints on the parcels, existing structures, and the Gowanus Canal ROD, which calls for sediment dredging of the Canal adjacent to the Site, the barrier wall must also serve as a retaining structure supporting the adjacent canal properties. Therefore, the barrier wall systems considered for this application must include structural components, such as tiebacks, and be rigid enough to serve as a retaining wall. In addition, to prevent NAPL migration, the barrier wall must achieve a minimum permeability of 1×10^{-6} centimeters per second (cm/s) and prevent

NAPL migration to the canal during varying hydraulic conditions, including groundwater level fluctuations, storm water infiltration, and seepage.

Other Site constraints that factor into the selection of a barrier wall as a remedial action alternative are wetland encroachment, the requirement of wetlands mitigation and replacement, and encroachment into navigable waters.

The following subsections detail the available types of barrier walls that were considered for the Site. The recommended technology for the canal barrier wall is a sealed-joint sheet pile barrier wall, which is discussed in further detail in Section 6.4.2.4. In summary, jet grouting and Deep Soil Mix (DSM) walls were ruled out in the initial stages because they do not meet the structural criteria. The desired barrier wall at the Canal will need to act as a retaining wall. The cement-bentonite slurry wall and the secant pile wall were ruled out because of the requirement to install the wall outboard of the existing bulkhead due to the location of the tar-like source material and the substantial subsurface obstructions including the historical cribbing structure that exists adjacent to the canal.

Structural Cement-Bentonite Slurry Wall

A structural cement-bentonite slurry wall consists of individually poured panels that are spliced together to create a continuous barrier wall. Vertical rectangular shaped “panels” are excavated using specialized equipment. Panel sizes vary in dimensions depending on the equipment, but are typically about 3-feet in width with a length of approximately 8 to 10 feet. An excavation is opened to the required depths using a bentonite slurry to keep vertical excavation walls open during construction of the panel. Once excavated, the panel excavation is tremie-filled using a mixture of cement and bentonite. Excavated soils are not re-used in the construction of the barrier wall, and must be managed and properly disposed of off-site at an appropriately permitted and approved disposal facility.

Since the barrier wall must also serve as a structural element, steel reinforcement would be embedded into each panel. This is in addition to the required structural tiebacks rods that would extend approximately 60 to 70 feet inland of the wall alignment and in many cases beneath existing buildings and structures. Based on case studies and experience, it has been proven that a cement-bentonite slurry wall would typically satisfy the structural and low permeability criteria for this project.

While this technology does satisfy the general criteria for this project, certain conditions and constructability constraints at the Site make this alternative impractical to construct, and it may considerably impact the surrounding community during construction.

In fact, some of the Site conditions and constraints would require all the installation work to be performed from the canal side. This constraint causes several logistical challenges in addition to increased environmental risks due to the potential for accidental spills in the canal. This technology would also require a large staging area for a slurry and cement batching plant, slurry tanks, de-sanding plants and large specialty crane rigs, as well as large staging areas for handling impacted materials generated during construction. Given the limited staging areas on and near to the Site, these staging area requirements would require access agreements for third-party land. Accessing staging areas could create disruptions to the community from traffic congestion, nuisance construction noises and dust, and odors from the handling of impacted materials.

Trench stability is also a constructability issue that should be considered, because both sides of the excavation would need to be confined to contain the slurry fluid used to maintain the excavations. In order to create confinement above the mud line within the canal, a temporary or permanent retaining wall would need to be constructed. In addition, on the land side, the condition of the existing bulkhead is unknown. Risk of fluid losses to the land side of the excavation, and the canal itself, are real considerations that should be evaluated with this alternative. The width of a cement-bentonite slurry wall trench could range from approximately 32 to 48 inches. A wall of this thickness outboard of the existing bulkhead would add to the complications of permitting due to encroachment into navigable water.

In-Situ Soil Stabilization

Two methods of ISS were evaluated for construction of the barrier wall, jet grouting and DSM. A description and evaluation of both of these technologies is provided below.

Jet Grouting

A grout curtain is an in-situ jet grouting process involving drilling to the desired depth and injecting a mixture of high pressure grout and water into the soil to create a thin grout-soil column. Grout columns are spaced so that their zone of influence overlap, thereby creating a continuous wall of grout-soil columns. This system poses some advantages, but many disadvantages for the specific conditions at the Site.

The main advantage to this technology is that the construction technique generally poses less of an impact to the surrounding community; because the equipment is smaller, requires a smaller staging area, and would not necessitate the handling of impacted material. Material handling would be limited to mainly new materials such as dry cement and only minor amounts of impacted materials would be generated through the construction methods. Another advantage is that the method is somewhat conforming to ground conditions and works around certain subsurface obstructions.

However, there are some disadvantages. Creating a cutoff wall without defects and/or verification of overlapping seals would be difficult under the Site conditions. Another disadvantage of using grout curtains alone is that the technique would not meet the structural criteria for the Site, unless it was constructed inland of the existing bulkhead, which is not feasible given the amount of subsurface structures present along the existing bulkhead.

Another concern of the jet grouting barrier wall technology is verification of the permeability criteria (1 x 10^{-6} cm/s). Several factors can prevent the zones of influence between grout-soil columns from overlapping and jeopardize the continuity of the wall. Subsurface obstructions and/or boulders would create gaps along the wall and produce a “shadowing” effect, where the grout-soil mixture migrates around the obstruction leaving un-grouted soil behind it. Since the wall will not be exposed by excavation, it would be very difficult to determine whether such gaps are present or whether the desired zone of influence was achieved. The potential for these gaps, along with the uncertainty of the range of influence resulting from the jet grouting process through variable soil conditions, would make it difficult to determine whether the desired effective permeability is reached. Another consideration is the risk of contamination of grout spilling into the canal through cracks and/or preferential pathways through the existing bulkhead.

Deep Soil Mixing

DSM is an innovative technology that consists of using high-torque specialized drilling rigs that have the capability of mixing soil in-situ while adding admixtures of cement and bentonite in order to modify the strength and permeability of the existing soil. To construct a barrier wall using DSM, soil mixed panels are created using a specialized drilling head. The panels are then interconnected by overlapping the panels by a certain amount to create a continuous wall. Since DSM utilizes in-situ soils as a building material, performance results typically depend greatly on the types of soils being mixed. As a result, structural applications using this technology are usually limited to only lower strength applications. This is a disadvantage for the use of a barrier wall at the Site. Using DSM as the sole barrier wall technology would not meet the structural requirement at the Site.

However, DSM has potential be used elsewhere under non-structural applications. DSM has been used successfully at other heavily NAPL-impacted sites for the construction of low permeable hydraulic barrier wall systems, and verification methods are well accepted. Typically, bench testing and permeability tests on samples are performed to ensure that the proper admixtures and rates are applied to meet the permeability criteria for a site.

Utilizing DSM at the Site would pose moderate impact to the community. A mixing batch plant is required, but it generally would have a much smaller footprint than some of the other barrier wall alternatives addressed above. However, DSM does generate moderate amounts of impacted materials—about 15 to 25 percent of the treated volume—which would need to be handled during construction.

This alternative utilizes in-situ soils, reducing the amount of soil that would need to be removed, handled and disposed of off-site. DSM can be applied to many civil and environmental applications because the cost of construction is relatively low and it utilizes in-situ soils. Overall, this approach results in reducing the amount of soil that would need to be removed, handled and disposed of off site. The batch plant requires only a moderate sized staging area, mainly for the batching of slurry and cement, while the mixing equipment would be operating directly from a barge in the canal.

In order to avoid as many obstructions as possible, the wall would be installed on the canal-side/upland-side of the bulkhead. This would require a temporary support of soils above the canal's mud line. Water behind the temporary support would have to be pumped out so as not to get mixed with the soil-cement-bentonite. As soil is liquefied during the DSM process, a cement-bentonite mixture is added, thus increasing the volume of impacted materials. These impacted materials will need to be managed to prevent them from entering the canal. There would be a risk of contamination from both the impacted spoils and the cement-bentonite mixture that feeds into the DSM rig. An alternate to traditional DSM is Cutter Spoil Mixer (CSM) panels, which can be overlapped easily without excess width and waste produced using standard overlapping DSM columns. The thinnest wall option using the DSM technology would be a CSM, which creates a rectangular shaped soil-mixed panel that can be as thin as 20 inches. Though the wall is relatively thin, it is in excess of what typical permitting allows for navigable encroachment under a national permit. As such, using a DSM, even the thinner CSM, would likely add to the complications of permitting due to encroachment into navigable water at the Canal. DSM will be retained for potential application as a subsurface NAPL barrier at upland site parcels where applicable.

Secant Pile Wall Curtain

A secant pile wall consists of a series of overlapping drilled piles installed to a certain depth using cased shafts, then filled with concrete. The concrete piles are spaced evenly apart so that each new pile is partially drilled through the concrete of the adjacent piles, in order to have an overlap to create a continuous barrier wall. This technology has been used in many applications for structural support and seepage control at dam-related projects. A secant pile wall would meet the structural criteria for the Site and would likely meet the permeability criteria; however, meeting and verifying the joint alignment and required permeability criteria at the joints for an environmental application is a concern.

Construction of the concrete piles along the bulkhead would be difficult because there must be containment around the piles. These types of walls are usually installed prior to an excavation being completed at the wall face. Therefore, to complete construction on the canal side of the existing bulkhead, a temporary retaining wall would need to be constructed, or the wall would need to be constructed inland, which is not feasible. Constructing a temporary retaining wall followed by the secant pile wall would likely pose significant impacts to the canal and the community. A steady flow of construction traffic and the required staging area would cause disruptions to the community. The diameter of the piles required to facilitate sufficient overlap would be approximately 32 to 36 inches. A wall of this thickness outboard of the existing bulkhead would add to the complications of permitting due to encroachment into navigable water.

Another disadvantage is that once the secant pile wall is installed, it would be difficult to validate proper jointing alignment between the piles without excavating to expose the wall face. Therefore, it would not be possible to confirm the effective joint permeability. Installing concrete piles will also require handling and managing impacted materials.

Sealed-Joint Sheet Pile Wall

Sheet pile walls are thin steel panels designed to interlock together to create a continuous wall. Sheet pile walls have many civil applications from temporary excavation shoring systems to permanent bulkhead construction. Sheet pile walls would meet the structural criteria for the Site. However, their interlocking joints will need to be amended with grouted seals to address the Site environmental concerns. Suitable interlocking joint construction methodology and the ability to measure joint permeability are challenging aspects of utilizing sheet piles for this type of environmental applications. National Grid has undertaken a NYSDEC-approved pilot study to evaluate achievement of the permeability requirements and construction methods as part of the Former Citizens Gas Works MGP (Former Citizens MGP) remedial program. The Former Citizens MGP is adjacent to the Gowanus Canal, south of the former Fulton Municipal Works MGP. The results of the pilot study at the Former Citizens MGP will be incorporated into the design of a sealed-joint, sheet pile wall, if selected as a remedy for the Site. Specifically related to the Fulton Site, the Former Citizens MGP pilot study includes:

- Laboratory testing of barrier wall sealant materials for compatibility with Dense Non-Aqueous Phase Liquid and of determination of resulting permeabilities. These tests will evaluate sealant material that will be installed in the joint interlocks as a primary seal and grouts for the secondary seal in the sheet pile wall.
- Evaluation of chemical corrosivity of steel sheet pile systems when exposed to DNAPL.
- Bench-scale tests on the grouted barrier wall interlock seal systems to measure the permeability/hydraulic permittivity of the seals using water and DNAPL as the permeants. Three types of custom made/welded groutable seal systems will be evaluated.
- Field-scale constructability testing of the three types of seal systems.
- Evaluation of vibration and off-site noise levels during sheet pile installations.

Installation of sheet pile walls along the Gowanus Canal is common, and construction impact to the community is generally minimal. This barrier wall alternative also offers a minimal staging footprint and has the lowest risk of spreading or causing contamination, as no existing soils need to be removed or handled.

Steel sheet piles would be either driven or vibrated into place in front of the existing bulkhead by equipment working from within the canal or from onshore. The construction of sheet pile walls does produce some noise and vibrations that may be of concern to some of the surrounding properties; mitigative measures will be evaluated during the Former Citizens MGP pilot study. Sheeting above the design dredge line would be held in place by tieback rods to concrete anchors, or by soil anchors grouted in place. Installation of anchors will be complicated by the presence of existing structures. However, similar installations along urban waterways have been successfully performed. Permitting for construction of the wall would be under the Federal nationwide permit program since the approach is consistent with normal bulkhead repair and maintenance programs as well as environmental remedial programs.

6.4.2.2 Upland Subsurface NAPL Barriers

Subsurface NAPL barriers will be retained as a potential technology to contain the NAPL impacts identified above the meadow mat on Parcel II (and potentially Parcel III). The construction details of the subsurface NAPL barriers will be determined based on the future redevelopment and/or remediation design specified on a parcel-by-parcel basis. Subsurface NAPL barriers will also be included as a component of the remedy evaluation and design to prevent recontamination of previously remediated areas located adjacent to non-remediated NAPL impacts. The subsurface NAPL barriers for these purposes will likely consist of leaving sheeting required for excavation support in-place. However, in certain circumstances, it may be necessary to modify the sheeting joints as required to prevent NAPL migration or use ISS or grout barriers, as appropriate. The detailed design of these NAPL barriers will be completed during the remedial design for each parcel as required.

Containment of the deeper NAPL impacts on Parcel II with a barrier wall is not feasible due to the depth of the impacts and the lack of a confining unit in which to seat the wall. An adequate confining unit (competent bedrock) was not identified during the RI in the upper 159 feet of the subsurface. Further, the Gardiners Clay layer was not encountered at the Site, and the underlying Fordham Gneiss bedrock was only encountered at the southwest corner of Parcel I.

6.5 Institutional Controls

Institutional controls can effectively prevent exposures for potential receptors. They do not involve direct management of the impacted materials and, therefore, they are not effective in limiting subsurface migration, reducing volume, or treatment of contaminants. Institutional controls, such as environmental easements, site management plans, and groundwater use restrictions, are required when using a restricted SCO.

An environmental easement is a legal instrument that would serve to notify any potential future property owners of the environmental conditions and any use restrictions placed on a property. An important component of any institutional control program is ongoing monitoring of the effectiveness of the controls. This includes annually certifying that the controls are in place and are effective.

There is no exposure to impacted material under current property uses at the Site. However, there is potential exposure to impacted material during intrusive construction work. As a result, institutional controls are required to prevent and/or reduce exposure and will be retained for alternative development.

A site management plan will be required for managing intrusive work and will include establishing a protocol for overseeing worker and public health and safety, having a plan for managing any contaminated soil or groundwater removed during the work, and establishing a mechanism, such as including the Site area in the “one-call” system, to notify people who may otherwise be unaware of conditions at the Site prior to conducting intrusive work in potentially impacted areas.

It is anticipated that long-term agreements can be used between the remedial party and a third party property owner to ensure compliance with site management plans and that National Grid is notified of planned redevelopment activities and/or major renovations so that National Grid can address remedial issues consistent with the final remedial selection.

7. Development and Analysis of Alternatives

The most applicable technologies, as determined by the detailed analysis in Section 6, have been carried forward for development of the remedial alternatives to achieve the desired RAOs under the current site use and a future site use scenario. The following technologies are included in the development of remedial alternatives:

- Excavation and off-site treatment or disposal
- ISS
- Construction of a Barrier Wall for NAPL Containment
- NAPL Recovery
- Cap or Surface Cover
- Institutional Controls

Each alternative is discussed in detail below. A no action alternative was evaluated in Section 5 and was not carried forward because it would not achieve the RAOs identified for the Site.

7.1 Development of Alternatives

Under current conditions, the environmental impacts present at and near the Site do not pose a risk to human health. There is a potential risk to potential future utility and construction workers, but only if they participate in excavation activities and come into direct contact with the contaminants. Even then, risks can be mitigated through institutional controls such as site management plans.

Each of the parcels is currently developed and owned by third parties. NYSDEC required that remedial alternatives for future site use be developed and evaluated as part of this FS. Accordingly, two categories of alternatives are presented: (1) Actions that could be implemented to meet the RAOs under current site use and (2) Actions that could possibly be implemented under future use scenarios if a parcel undergoes major redevelopment. Although this FS refers to potential technologies for use if parcels undergo redevelopment, actual technologies implemented will be evaluated on a parcel-by-parcel basis considering factors such as soil conditions, site constraints, and the nature of the disturbance/redevelopment, and as a result is subject to change when/if redevelopment occurs.

A detailed description of each element of the remedial alternatives and how they would be applied to each parcel is provided below both for the current site use scenario and for the future site use scenario.

7.1.1 Current Site Use

The site-wide remedial alternative for current parcel uses is as follows:

- Construction of a Barrier Wall at the Canal for NAPL Containment (Parcels I, VI, and VII only)
- NAPL Recovery
- Institutional Controls
- Investigation to delineate potential shallow source material in ROW at the intersection of Degraw and Nevins Streets

7.1.1.1 Barrier Wall

The recommended technology for the barrier wall is a sealed-joint sheet pile wall. A sheet pile barrier wall meets the strength and permeability requirements for the Site conditions and will have the least impact to the community during construction. This alternative should also present the smallest construction footprint, as work could potentially be completed from barges within the Gowanus Canal.

The proposed extent of the barrier wall along the eastern bulkhead is shown in **Figure 9**. The barrier wall extends from the head of the Gowanus Canal to the southern edge of Parcel I. Tar saturated soils were observed in borings within Parcels I, VI, and VII along the Gowanus Canal. The northern limit of the wall was determined from the tar saturation observed within soil borings FW-SB-128 and FW-SB-114. The southern limit of the barrier wall was determined from the tar-coated soils observed within soil boring FW-SB-111, and because tar saturation and tar coatings were not observed in borings (FW-SB-121/121A and FW-SB-127) south of Sackett Street above El.-32 feet NAVD88 (approximately 42 feet bgs). The primary tar-like impacts observed in FW-SB-121/121A were blebs and globs, not saturated conditions. The final alignment and primarily the need for wing walls at the end of the alignment will be determined during the design phase based on hydraulic modeling. The model will also identify the potential for groundwater mounding behind the wall and will be used to evaluate alternative groundwater management approaches.

There are two primary factors that drive the design depth of the barrier wall. First, the barrier wall will need to reach a target elevation to adequately prevent potentially mobile tar from migrating into the canal from the Site. Secondly, it will need to act as a structural retaining wall with support considerations, taking into account the proposed dredging and capping described in the EPA ROD for the canal and future operating conditions. As such, the present EPA target dredging elevations are approximately El. -18 feet NAVD88 (approximately 28 feet bgs) to native sediment. To accommodate the EPA dredge depth, the walls structural requirement dictates the final design depth to be to approximately 50 feet bgs (El. -40 feet NAVD88). This is approximately 22 feet below the surface elevation of native sediment in the canal. This proposed depth will prevent migration of NAPL into the canal, based on observed impacts along the Parcels I, VI, and VII bulkheads. The final barrier wall depth will be determined in the design phase and will be designed in conjunction with the EPA's remedy for the canal.

The sheeting above the EPA design dredge line would be held in place by tieback rods attached to anchors, or by soil anchors grouted in place. Installation of the anchors will be complicated by the presence of existing structures. Permitting of the wall would be under the United States Army Corps of Engineers (USACE) nationwide general permit program since the approach is consistent with normal bulkhead repair and maintenance programs as well as environmental remedial programs. The design of the barrier wall will need to accommodate the Combined Sewer Overflows (CSO) discharge pipes and additional undefined pipes that discharge into the canal.

The barrier wall will be designed for a permeability requirement for the sheeting joints of 1 x 10^{-6} cm/s, similar as what is being designed at the Former Citizens Gas Works MGP Site. As discussed, a NYSDEC-approved pilot study program at the Former Citizens Gas Works MGP site is scheduled for early to mid-2014, and includes study of joint seals, sheet pile wall components and construction techniques. This pilot study will evaluate the permeability limits and constructability of several modified joint designs on steel sheet pile systems. The pilot study program will evaluate barrier wall sealant materials for compatibility with DNAPL, evaluate the chemical corrosivity of steel sheet pile systems when exposed to DNAPL, measure the permeability and hydraulic permittivity of grouted seals using water and DNAPL as the permeants, and include field tests on the constructability of three types of sheeting seal systems.

The results of the pilot study will be taken into consideration when designing the barrier wall for the Site. As a result, the design of the barrier wall may or may not include a modified joint system. The barrier wall for the Site will be designed to meet the permeability requirement of 1 x 10^{-6} cm/s, and ideally the pilot study results will provide valuable data to be used in the design.

Steel sheet piles would be either driven or vibrated into place in front of the existing bulkhead from within canal. The construction of sheet pile walls will produce some noise and vibrations that may be of concern to some of the surrounding properties; mitigative measures will be evaluated and implemented as appropriate. Results of the Former Citizens Gas Works MGP pilot study on construction techniques, and resulting noise, vibrations, and odors, will be incorporated into the design for the Site.

7.1.1.2 NAPL Recovery

NAPL recovery will be evaluated for areas immediately inland of the barrier wall and on parcels where potentially recoverable NAPL has been identified. Borings with tar saturated intervals and lenses are identified in **Figures 7** and **8**. Because NAPL impacts were observed to depths greater than 20 feet bgs in most locations, the NAPL recovery system will most likely be composed of a series of recovery wells targeting depths greater than 20 feet bgs. Additional design data needs to be collected to determine recovery rates, recovery well spacing, and scope and design of the system (i.e., NAPL storage, type of system enclosure, operation schedule, etc.).

A PDI will be performed in which borings will be installed in potential NAPL recovery locations based on previous investigative borings. Should NAPL-saturated soil be considered to have a potential for recovery, wells will be installed. Once installed, the NAPL recovery wells will be gauged periodically for NAPL accumulation. If sufficient NAPL accumulates, NAPL drawdown and recovery rate tests will be performed to determine potential NAPL recovery rates at each well. The PDI, and any subsequent potential recovery well installations, will determine the final NAPL recovery system scope, design, recovery logistics (e.g., manual or automated), instrumentation, and product recovery strategy.

As illustrated in **Figures 7, 8,** and **9,** zones of tar saturation have been identified immediately upgradient of the proposed barrier wall location on Parcels I, VI, and VII; on Parcel II; and on the Douglass, Nevins, and Degraw Streets ROWs. Zones of tar saturation were not detected in soil borings performed at the perimeter of Parcel III. As discussed, the shallow NAPL impacts identified on Parcels II, III and IV are considered associated with former structures and will be removed when the structures are excavated once the properties become redeveloped as discussed in Section 7.1.2.

The exact location and number of the potential NAPL recovery wells will not be determined until the barrier wall design and the NAPL recovery PDI are complete. The following potential NAPL recovery well locations and depths are provided based on currently available information and will likely be modified following the PDI.

- Adjacent to the proposed barrier wall (Parcels I, VI, and VII and Degraw Street) the majority of tar saturated zones were identified at depths between approximately 25 and 50 feet bgs. Deeper impacts between approximately 60 and 70 feet bgs were identified on Parcel VII and on the southern portion of Parcel I, adjacent to the former Sackett Street ROW. Impacts as deep as 98 feet bgs were detected on Parcel VI. Borings will be installed targeting each of these zones for evaluation of potential NAPL recovery.

- Parcel II is currently used as a public park. NAPL recovery on Parcel II will be difficult to implement due to potential exposure issues associated with the recovery, temporary storage, and transportation of NAPL at the Site. Therefore, potential NAPL recovery systems will be evaluated once redevelopment is planned for a property. Accommodations to address future potential exposure issues for NAPL recovery systems may be incorporated into future redevelopment of this property.

- Tar saturated intervals were also detected in the Douglass, Nevins Street and Streets ROWs, as illustrated in **Figures 7** and **8**. Two potential NAPL recovery borings would be installed within the ROWs, one to approximately 60 feet bgs in Douglass Street north of Parcel II, and one in Degraw Street south of Parcel VI to a depth of approximately 80 feet bgs. Potential exposure issues associated with NAPL recovery within the ROWs will also need to be addressed. However, the site use is not anticipated to change for the

ROWs and, therefore, NAPL recovery for the ROWs will be evaluated under current site use.

The volume and frequency of collection of NAPL will dictate the collection approach. For low recovery locations, NAPL will be collected manually at an appropriate frequency. Automated NAPL pumping systems may be installed at recovery well locations where sufficient NAPL accumulation and recharge rates are observed. These systems may be enclosed in sub-surface vaults, sheds, and/or trailers and consist of NAPL recovery pumps, controls, monitoring equipment, and temporary NAPL storage systems. Location and public access to the well areas will be a consideration in collection approach and equipment.

7.1.1.3 Institutional Controls

Institutional controls will be used under the current site use scenario to prevent potential exposure to impacted soil and groundwater during intrusive construction activities. As an initial matter, a site management plan would be developed for each parcel to manage intrusive work and establish a protocol for worker and public health and safety, to manage any contaminated soil or groundwater removed during the work, and establishing a mechanism, such as including the Site area in the New York City one-call system, to notify people who may otherwise be unaware of conditions at the Site prior to conducting soil intrusive work. National Grid has identified the Site on its internal gas maps and National Grid Site will be contacted prior to any non-emergency work on gas lines adjacent to the site. The interim site management plan will include provisions to monitor the effectiveness of the controls via annual certification that the controls are in place and are effective.

National Grid anticipates using long-term agreements, as appropriate, to notify any current and future property owners of the environmental conditions and any use restrictions placed on the Site in the Site Management Plan (SMP). These long-term agreements would be required to obtain access for operation, maintenance, and monitoring of any remediation systems on all parcels (such as the barrier wall and NAPL recovery systems) and would require the property owners to notify National Grid of planned redevelopment activities and/or major renovations so that National Grid can address remedial issues consistent with the final remedial selection. Other institutional control tools that may be used depending on site conditions include environmental easements (Parcels I, II, III, and IV) and groundwater use restrictions.

7.1.1.4 Investigation to Delineate Potential Source Material Adjacent to Utilities

Under normal circumstances, when utility work can be planned in advance, institutional controls including site management plans, are effective at preventing potential utility worker exposure. However, in an emergency scenario as in a gas main break, utility workers may not have time to adequately plan or follow the institutional controls. Shallow utilities within 8 feet bgs would be considered accessible in this emergency scenario. Sewers adjacent to the Site are located at depths greater than 12 feet bgs and would not fall into an emergency scenario. The depth of excavation and the presence of the shallow utilities above the sewers dictate that any work on the sewers would need to be planned in advance, and could be completed under the site management plan.

Shallow Utilities

Information collected during the RI indicates that residual tar impacts are present in the vicinity of the shallow utility zone in a limited area at the intersection of Nevins and Degraw Streets (**Figure 9**). A subsurface investigation is required to determine impacts adjacent to the shallow utilities in this area. **Figure 4** presents utility locations in relation to the shallowest residual tar-related impacts. Based on the existing information, sensitive utilities including the water and gas mains are primarily above the elevation of the residual tar impacts, with the possible exception of a limited area at the intersection of Nevins and Degraw Streets. The water line is present at a depth of approximately 4 feet bgs and gas lines are present at depths ranging from 2 to 6 feet bgs. The shallowest NAPL impacts in the ROWs were detected in the vicinity of Nevins and Degraw Streets at depths of 5 and 6.5 feet bgs. In addition to water and gas mains, electric and telecom lines are present within the ROWs at the Site. The location and depth of these additional utilities within the area of potential impacts will also be identified as part of this investigation, which will include the sewer regulator station located on Nevins Street.

A work plan will be developed to investigate the shallow soil conditions in this limited area. The first step will be to identify all of the utilities and gather any available information on the size, location, and depth. Once this information is known, a field investigation would be completed likely including soft-dig test pits to visibly inspect the utilities in this area and determine whether tar-impacted soil is present. If tar-impacted soil is identified within 1 foot of the bottom of shallow utilities (water, gas, electric, telecom, etc.), a plan will be developed to address these impacts.

This approach will take into consideration ROW modifications required by the Gowanus Canal ROD related to the installation of a CSO tank system in the area. As noted, sewers are located beneath the shallow utilities on Degraw, Douglass and Nevins Streets. As such, the final design and location of the CSO tank and appurtenances may dictate relocation/ renovation of the sewers and could require temporary relocation or replacement of shallow utilities in some areas. Therefore, any remedial actions potentially required to address shallow utilities will be deferred until the City's plan for the CSO tank system is finalized. The EPA's Statement of Work specifies that the City will provide a CSO tank location plan to the EPA by October 1, 2014.

If a remedy is implemented to address the shallow utilities prior to remediation of adjacent parcels, installation of a subsurface NAPL barrier to prevent recontamination of remediated areas will be evaluated. The subsurface NAPL barrier may consist of leaving sheeting used for excavation support in-place and potentially modifying the sheeting joints, as required, to prevent NAPL migration.

Deep Utilities

NAPL is also present adjacent to deeper sewers, primarily along Degraw and Nevins Streets (**Figure 4** and **Figure 9**). Due to their depth, a sewer repair or upgrade would need to be planned in advance to provide adequate time to implement the site management plan and mitigate the exposure risk to the utility worker.

Potential migration of NAPL to the canal through bedding material adjacent to the sewers will be addressed by the barrier wall installation. To date, there is no data that suggests mobile NAPL is entering into the sewers.

As noted above, the fate of the sewers in the vicinity of the Site is unknown. The Gowanus Canal ROD mandated that a CSO tank be installed as part of the remedy. Parcel II was cited as potential location for this tank. The sewers are an integral part the EPAs proposed CSO tank system and are subject to the City's design plan. According to the EPA's Statement of Work, the City is to provide to the EPA a CSO tank location plan by October 1, 2014. As such, further investigation regarding the sewers will be deferred until the final plan for the CSO tank and associated plumbing upgrades are known.

7.1.2 Future Site Use

Three site-wide remedial alternatives have been developed and evaluated for a potential future site use/redevelopment scenario. As noted above, the QHHEA concluded that current conditions do not pose a risk to human health. The only potential risk would be from intrusive activities, which are not currently contemplated. In addition there are no redevelopment plans for the parcels. Under these circumstances, if/when a parcel is to be redeveloped, an appropriate remedy will be designed at that time, following pre-design work, including sampling, to define excavation areas and depths, design excavation support and dewatering systems, confirm the presence and depth of former MGP structures, and potentially pre-characterization sampling for waste management. Since it is expected that each parcel will be redeveloped independently, all of these activities will require a parcel-specific design and remediation of each of the parcel will be implemented independently.

The three alternatives for a potential future site use/redevelopment scenario are set forth below. These alternatives would be implemented once redevelopment is planned for a property and the specified redevelopment allows access to subsurface impacts (i.e., redevelopment specifies demolition of existing structures and/or surface features to be completed by others).

- Excavation of Soil to meet the Unrestricted Use SCOs
- Excavation of Former MGP Subsurface Structures
- Excavation of Former MGP Subsurface Structures and Remediation of Potentially Mobile NAPL above the Meadow Mat

A description of how each of these alternatives may be implemented for each parcel and the ROW is provided below. The applicability of each alternative for a given parcel will be evaluated case-by-case, considering factors such as soil conditions, site constraints, and the nature of the disturbance/redevelopment.

7.1.2.1 Excavation of Soil to Meet the Unrestricted Use SCOs

The area surrounding the Site has supported industrial and commercial activities for approximately 150 years. As presented in Section 7.2 below, there are numerous implementation challenges associated with excavation to the total depth of impacts at this Site with little or no incremental increase in protection of human health and the environment compared to other available technologies. A description of the excavation required to attain Unrestricted Use SCOs is presented as an alternative and further description of the implementation challenges are discussed below in accordance with DER-10 Section 4.4 Remedy Selection Reporting Requirements.

The extent of impacted soil requiring excavation to meet the Unrestricted Use SCOs at the Site is illustrated in **Figure 10**. The current data indicate the depth of excavation required to attain this criteria would range from approximately 20 to 150 feet bgs. Excavation support to depth; dewatering; water treatment facilities; material handling facilities; and odor and emissions controls would be required for implementation of this alternative. Containment measures would be required to prevent recontamination of remediated areas from adjacent areas. Due to space restrictions on the parcels, this alternative would be implemented in stages to allow for on-site placement of the required support facilities. The duration for implementation of this alternative is estimated to be approximately 21 years if the parcels were remediated sequentially. The average duration required for a parcel remediation to meet the unrestricted use criteria is estimated to be approximately 3 years.

7.1.2.2 Excavation of Former MGP Subsurface Structures

Parcels I, II, III, and IV are within the footprint of the former Fulton Municipal Works MGP. Former MGP subsurface structures will be excavated, as illustrated in **Figure 11**. Information on the structures is provided in **Table 2**. Excavation support; dewatering; water treatment facilities; material handling facilities; and odor and emissions controls would be required for implementation of this alternative.

Subsurface NAPL barriers will be evaluated as required to prevent the recontamination of remediated areas from adjacent impacted areas. The design of the NAPL barriers will be dependent upon the nature and extent of adjacent impacts and the future redevelopment specified for each parcel.

In areas outside of the subsurface structure excavation, where future development specifies subsurface disturbance, soils that exceed CP-51 criteria (total PAHs greater than 500 mg/kg) due to MGP-related impacts will be excavated to a depth required by redevelopment activities. Prior to the subsurface activity, soil analytical sampling will be performed, as needed, to ensure the

CP-51 criteria are met for MGP-related impacts, taking into account the nature of the activities and the redevelopment plans.

A cap or cover system such as pavement, a permanent structure, or 1-foot of clean fill will be evaluated and, if appropriate, installed following subsurface work where the remaining soil is within the CP-51 criteria but exceeds the Commercial Use SCOs for PAHs.

NAPL recovery is included in this alternative to address the remaining potentially mobile NAPL not removed during excavations. NAPL recovery for Parcels I, VI, and VII will be performed as part of the current site use remedy in conjunction with the canal barrier wall NAPL recovery described above in Section 7.1.1. It is assumed that NAPL recovery (if found feasible) will remain in place on Parcels I, VI, and VII during and after redevelopment and will not be included in the alternative evaluation for future use on these parcels. NAPL recovery within the ROWs is also evaluated as part of the current site use remedy presented in Section 7.1.1.

Recoverable NAPL has not been identified outside of the proposed excavation extents on Parcel IV. Therefore, based on currently available data, NAPL recovery evaluation under this alternative is limited to application on Parcel II and potentially Parcel III. On Parcel III, current data indicate that recoverable NAPL is not present outside of structure excavation area. However, limited data is available for this parcel due to the presence of current structures.

The institutional controls in place for current site use for each of the parcels and the ROWs will be re-evaluated to determine if they remain applicable or need modification if additional remedial activities are performed.

A summary of how this alternative could be applied at each parcel and the ROWs is provided below.

- **Parcel I**:
    - The property is currently used as a filming studio and under current conditions the MGP-related impacts pose no risk to human health. This alternative would be implemented once redevelopment is planned for the property and the specified redevelopment allows access to subsurface impacts via demolition of current site structures, by others.
    - Potentially, up to four subsurface former MGP structures are located on the northwestern corner of Parcel I. The estimated depth of these structures and/or their foundations is approximately 10 feet bgs.
    - The canal barrier wall and associated NAPL recovery wells specified under the current site use alternative would be in place on this parcel.
    - Current data indicate there are no exceedances of the CP-51 criteria to a depth of 10 feet bgs outside of structure excavation area.
    - Surface caps and institutional controls, as described above, could be implemented with this alternative.

- **Parcel II**:
  - The property is currently the location of Thomas Greene Playground and the Douglass and Degraw Pool. Under current conditions the MGP-related impacts do not pose risk to human health. This alternative would be implemented once redevelopment is planned for the property and the specified redevelopment allows access to subsurface impacts via demolition of park features, by others, including the swimming pools, handball courts and basketball courts.
  - Five former MGP subsurface structures have been identified on the south-central portion of Parcel II. The depths of these structures and/or their foundations range from approximately 5 to 20 feet bgs.
  - Current data indicate there is one exceedance of the CP-51 criteria within a 5 foot depth interval outside of the structure excavation area. Data will be collected to delineate the soil requiring excavation to meet the CP-51 criteria as dictated by future redevelopment.
  - NAPL recovery, if any, will be evaluated for this parcel at the time of redevelopment. Tar saturated impacts have been identified at depths between approximately 10 and 95 feet bgs. A PDI will be performed in which borings will be installed at potential NAPL recovery well locations targeting these areas and depths. Should NAPL-saturated soil be considered to have a potential for recovery, wells will be installed and NAPL recovery rates will be evaluated to determine the final NAPL recovery system scope, design, recovery logistics (e.g., manual or automated), instrumentation, and product recovery strategy.
  - Surface caps and institutional controls, as described above, could be implemented with this alternative.

- **Parcel III:**
  - The property is currently used as a textbook warehouse. Under current conditions the MGP-related impacts pose no risk to human health. This remedial alternative would be implemented once redevelopment is planned for the property and the specified redevelopment allows access to subsurface impacts via demolition of current site structures, by others.
  - A former gas holder foundation is present on the northeastern portion of Parcel III and a portion of a gas holder that is primarily located on Parcel IV is located within the northeastern corner of Parcel III. The gas holder foundations extend to approximately 20 feet bgs.
  - Current data indicate there are no exceedances of the CP-51 criteria outside of structure excavation area. However, limited data is available for this parcel due to the presence of current structures. Additional data will be collected as required based on future redevelopment to determine if soil is present within the proposed limits of future redevelopment that exceeds the CP-51 criteria. If there is soil that exceeds the CP-51 criteria, it will be excavated and disposed of off site.
  - NAPL recovery, if any, will be evaluated for this parcel at the time of redevelopment. Current on-site data indicate there is no potentially mobile NAPL

present outside of the area identified for structure excavation. However, limited data is available for this parcel due to the presence of current structures. Additional data will be collected as required based on future redevelopment to determine if recoverable NAPL is present.
  - Surface caps and institutional controls, as described above, could be implemented with this alternative.

- **Parcel IV:**
  - This property is currently used for storage of roll-off bins, truck maintenance equipment, and construction materials; as a parking lot; and for miscellaneous commercial uses. Under current conditions, the MGP-related impacts do not pose risk to human health. This remedial alternative would be implemented once redevelopment is planned for the property and the specified redevelopment allows access to subsurface impacts.
  - A gas holder foundation is present primarily on the northwestern portion of Parcel IV and extends onto Parcel III. Structural analysis would be required to ensure the integrity of the building on Parcel III in the event the gas holder foundation must be removed. The depth of the gas holder foundation is also approximately 20 feet bgs.
  - There are no exceedances of the CP-51 criteria outside of the area identified for former MGP structure excavation.
  - No NAPL was identified outside of the area identified for former MGP structure excavation.
  - Surface caps and institutional controls, as described above, could be implemented with this alternative.

- **Parcels VI and VII:**
  - Not part of the former MGP Site. No exposure to MGP-related impacts under current use.
  - No MGP-related impacts were detected in the top 20 feet bgs on either parcel with the exception of solid tar encountered at one boring in the central portion of Parcel VI at a depth of 6 to 6.9 feet-bgs. NAPL impacts were detected at approximately 10 feet bgs immediately adjacent to the western property line of Parcel VI along Nevins Street.
  - Deep NAPL recovery and containment will be evaluated as part of the barrier wall and NAPL recovery system under the current site use alternative.
  - Institutional controls as described above will be in place.

- **ROWs:**
  - An investigation performed and a plan will be developed to address any impacts observed as described in section 7.1.1.3 under current site use.
  - Institutional controls as described above will be in place.

7.1.2.3 Excavation of Former MGP Subsurface Structures and Remediation of Potentially Mobile NAPL above the Meadow Mat

This alternative includes all of the remedial actions and limitations specified for the above alternative, Excavation of Former MGP Subsurface Structures (Section 7.1.2.2), with the addition of remediation of potentially mobile NAPL above the meadow mat, where applicable. The objective of this alternative is to perform a PDI at locations where potentially mobile NAPL may be present above the meadow mat and evaluate a range of technologies that could be used to remediate these potential impacts in conjunction with the future redevelopment plan. The location of the proposed investigation areas are provided in **Figure 12**. Parcels would be investigated and remedial actions would be evaluated and performed when redevelopment plans are in place for a specific parcel, the redevelopment plans specifying demolition of current site structures, by others, so that the MGP-related structures and impacts would be accessible.

As described in Section 2.1, the meadow mat is a subset of the alluvial/marsh deposits and consists of fine-grained sand, silt, and organic material encountered throughout the investigation area with the exception of locations within Parcel I and near 3rd Avenue. The thickness of the alluvial/marsh deposits ranged from 0.25 feet to 17 feet. The locations and thickness of the meadow mat, where encountered during the RI, are identified in **Plate 1**.

This alternative is not applicable to Parcel I as the meadow mat is not present at this location. In addition, NAPL impacts were not encountered in the top 10 feet bgs and the barrier wall and NAPL recovery systems will be in place at this parcel to prevent further migration of deeper NAPL impacts.

The meadow mat was encountered at the majority of boring locations on Parcel II at a depth of approximately 20 feet bgs. NAPL impacts were not identified above the meadow mat on the western portion of Parcel II. NAPL impacts detected to a depth of 20 feet bgs in soil borings performed during the RI are identified in **Figure 12**. Based on this data it is assumed that approximately 75 percent of the investigation area could require remediation under this alternative.

The meadow mat was not encountered on Parcel III. However, investigation on this parcel has been limited due to the presence of the current building structure. Therefore, the investigation area identified to determine if NAPL is present above the meadow mat consists of the entire parcel outside of the area identified for MGP structure excavation. NAPL impacts were not detected to 20 feet bgs in soil borings performed immediately adjacent to the western, southern and southeast property boundaries of Parcel III (**Figure 12**). Based on this data, it is assumed that approximately 30 percent of the investigation area will require remediation under this alternative.

NAPL impacts were not identified outside of the area identified for excavation of subsurface MGP structures above the meadow mat on Parcel IV; therefore, this alternative does not apply to Parcel IV.

NAPL impacts were detected above the meadow mat at one location on the western property boundary of Parcel VI along Nevins Street. The area of investigation identified in **Figure 12** for Parcel VI was identified to determine if the impacts along Nevins Street extend onto Parcel VI. Three RI soil borings were performed in the vicinity of the proposed investigation area on Parcel II. NAPL impacts and the meadow mat were only encountered in one of these locations. Therefore, for the purpose of this evaluation it is assumed that approximately 30% of the investigation area could require remediation under this alternative.

NAPL impacts were not identified above the meadow mat on Parcel VII; therefore, this alternative does not apply to Parcel VII.

Shallow NAPL impacts in the ROWs will be addressed under the current site use scenario described in section 7.1.1.3.

Three remedial technologies have been identified as potentially applicable to address the shallow NAPL above the meadow mat, if identified on Parcels II, III and VI during the PDI. At this time, a specific technology cannot be selected because the remedy will be dependent upon the nature and extent of NAPL impacts above the meadow mat and the nature and extent of future redevelopment at each parcel, neither of which has been defined. However, for comparison purposes, the following three technologies have been identified as potentially applicable to address shallow NAPL above the meadow mat and will be evaluated at the conclusion of the PDI in conjunction with the future redevelopment plans.

1. **Excavation of impacts to the meadow mat.** This would include excavation to approximately 20 feet bgs. Excavation support; dewatering; water treatment facilities; material handling facilities; and odor and emissions controls would be required for implementation of this alternative. It is assumed this excavation would be performed concurrent with the excavation of subsurface MGP structures on the parcel.

2. **ISS of impacts to the meadow mat**. It is assumed that the ISS method implemented would be DSM using large diameter augers. Surface obstructions and subsurface soils to a depth of approximately 5 feet bgs within the identified ISS area would be excavated prior to implementation. This depth would account for volume increase due to the addition of stabilization agents and would also allow for placement of a surface cap upon completion. The exact volume of material requiring excavation would be determined during the design phase. ISS treatability studies will be performed to determine the appropriate stabilization mixture. The exact scope of the ISS would also be dependent upon the future redevelopment plans for the parcel.

3. **Containment.** Containment would consist of the installation of sealed joint sheet piles or an ISS barrier, keyed into the meadow mat, if present, to prevent further lateral migration of NAPL outside of the identified area. NAPL recovery would likely be incorporated behind the containment barrier.

7.2 Analysis of Alternatives

The alternatives evaluated for the Site include one alternative that addresses remedial activities to meet the RAOs under current site use scenario and three alternatives under the future use scenario. As noted above, the QHHEA concluded that current conditions do not pose a risk to human health. The only potential risk would be from intrusive activities, which are not currently contemplated. In addition there are no redevelopment plans for the parcels. However, remedial alternatives for future site use were required to be developed and evaluated as part of this FS. Each of the alternatives consists of various GRAs and technologies selected to address each of the RAOs. The alternatives have been evaluated based on the following criteria in accordance with Section 4.2 of DER-10:

- Overall protectiveness of the public health and the environment
- Conformance with SCGs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume of contamination through treatment
- Short-term impact and effectiveness
- Implementability
- Cost effectiveness
- Land use

7.2.1 Current Site Use

The site-wide alternative evaluated for current site use scenario is described in detail in Section 7.1.1 and consists of construction of a barrier wall at the canal for NAPL containment (Parcels I, VI and VII only); NAPL recovery at the barrier wall and within the ROWs, as appropriate; institutional controls; and an investigation to determine if source material is present adjacent to shallow utilities in an area of potential impacts identified at the intersection of Nevins and Degraw Streets. This alternative meets each of the evaluation criteria. A summary of this remedial alternative is presented in **Table 3**.

Overall protectiveness of the public health and the environment
The barrier wall and NAPL recovery will protect public health and the environment by preventing NAPL migration to the canal and removing NAPL from the subsurface. The identification of source material adjacent to shallow utilities will allow for remedial plans and/or controls to be developed to prevent the exposure to emergency response utility workers performing emergency repairs on these utilities. Institutional controls, as outlined previously, will be developed to ensure the protection of public health.

Conformance with SCGs
The barrier wall and NAPL recovery conforms with the SCGs by preventing the migration of NAPL and removing source material where practicable. Containment of deep NAPL (greater than 50 feet bgs) cannot be achieved by the barrier wall due to implementability issues associated with the installation of the barrier wall to a depth of a suitable confining unit at the

Site. However, NAPL recovery wells will be installed where recoverable NAPL is identified to recover deep NAPL, thereby, reducing the potential for further migration. Thus, the barrier wall and NAPL recovery system work together to achieve the SCGs.

Institutional controls will be implemented to prevent potential exposures to soil and groundwater impacts that exceed the SCGs. The CP-51 SCOs of 500 mg/kg total PAHs are not currently met at two locations above 5 feet bgs and groundwater impacts above NYSDEC standards are present. However, there is no exposure under current site use. There is potential exposure to impacted soil and groundwater during intrusive construction activities; however, work-specific remedial programs, engineering and institutional controls will be implemented to mitigate these exposures.

Long-term effectiveness and permanence

The barrier wall will provide a long-term solution to prevent the migration of NAPL to the Gowanus Canal. The NAPL recovery system will be effective at permanently removing mobile NAPL from the subsurface. If source material is identified adjacent to shallow utilities in the ROW, a plan will be developed to prevent exposure to these impacts in the long-term. Institutional controls can be maintained to be effective in the prevention of long-term exposure to remaining impacts at the Site.

Reduction of toxicity, mobility, or volume of contamination

The barrier wall and NAPL recovery will reduce the mobility and volume of NAPL at the Site. NAPL recovery will reduce the mobility of deep NAPL impacts and will reduce the volume of NAPL in the subsurface. If source material is identified adjacent to shallow utilities in the ROW, a plan will be developed to reduce the toxicity, mobility or volume of these impacts. Institutional controls will not reduce the toxicity, mobility or volume of impacts at the Site.

Short-term impact and effectiveness

Installation of the barrier wall could cause short-term impacts to the community associated with noise and vibrations during construction. The NAPL recovery systems would increase the potential short-term exposure to NAPL during recovery, temporary storage, and transportation. The short-term impacts during installation of the recovery wells and systems will be negligible. Both the barrier wall and the NAPL recovery system will immediately be effective at reducing MGP impacts following construction. As soon as the barrier wall is installed, NAPL will be prevented from migrating into the canal and the volume of NAPL in the subsurface will be reduced during NAPL recovery operations.

Implementability

Implementation issues associated with installation of the barrier wall include access to third-party properties for the installation of sheeting, tie backs, and anchors, installation of which will be complicated by the presence of existing structures. Permitting of the wall would be required under the USACE nationwide permit program. The design of the barrier wall will need to accommodate the EPA remedy for the Gowanus Canal, CSO discharge pipes, and additional undefined pipes that discharge into the canal.

The primary implementation issues for the NAPL recovery systems will be access to third-party properties and preventing exposure to recovered NAPL. Access to third-party properties will be required for installation of recovery wells, placement of recovery systems, and long-term operation and maintenance of the systems. The parcels where NAPL recovery is proposed are currently zoned for industrial/commercial use. Therefore, location of a NAPL recovery system at these locations is feasible. NAPL recovery in the ROWs will be difficult due to potential exposure issues. The recovery wells could be installed and monitored within the ROWs. However, if the NAPL recharge rate at these locations is sufficient to justify an automated NAPL recovery system, the system would have to be located on an adjacent third-party property or in a subgrade vault to limit potential exposure to the community.

There are numerous implementation issues associated with investigation and potential remediation of source material adjacent to shallow utilities in the ROW. Shallow utilities in the ROW include gas mains, water lines, telecom lines, and electric lines that service a large number of residences and businesses. The exact number, type and location of utilities within the area identified for investigation is currently unknown. Coordination of the protection and/or temporary replacement of these utilities during investigation and potential mitigation of impacts will be complicated. There are also significant permitting and logistical challenges involves with working with New York City and the individual utilities.

Institutional controls are implementable as they would be consistent with the current and potential futures site use.

Cost effectiveness

The cost for this alternative is estimated to be approximately $16.3 million. Details of this cost estimate are presented in **Appendix C**. The majority of the costs are associated with the design and installation of the barrier wall and operation, maintenance and monitoring of the NAPL recovery systems. The operation maintenance and monitoring costs for implementation of the site management plan are also included in this cost. It is assumed that an average annual cost of $100,000 will be required to perform construction oversight, material handling, and annual certification in compliance with the site management plan.

Land use

This remedial alternative is consistent with and supports the current commercial and industrial land use at the Site. This remedial alternative was selected to be protective of public health and the environment while being the least disruptive to the community and allowing continued industrial and commercial land use.

7.2.2 Future Site Use

Three remedial alternatives have been selected for evaluation under the future site use scenario:

- Excavation of Soil to meet the Unrestricted Use SCOs
- Excavation of Former MGP Subsurface Structures
- Excavation of Former MGP Subsurface Structures and Remediation of Potentially Mobile NAPL above the Meadow Mat

Each of these alternatives has been described in detail in Section 7.1.2. A description of how each alternative applies to the evaluation criteria is provided below. A comparison of the future site use scenario alternatives is presented in **Table 4**.

7.2.2.1 Excavation of Soil to Meet the Unrestricted Use SCOs

This alternative consists of the excavation of all soil impacts in exceedance of the Unrestricted Use SCOs as described in section 7.1.2.2 and illustrated in **Figure 10**.

Overall protectiveness of the public health and the environment
Once the implementation of this alternative is complete it would be protective of the public health and the environment. However, there will be a significant increase in the short term exposure risks during implementation of this alternative. The Site is located in a densely populated area and the risk of exposure to impacted material will increase during excavation and transportation activities. The estimated duration required for the excavation of all MGP impacted soil is approximately 21 years.

Conformance with SCGs
Excavation of soil to meet the Unrestricted Use SCOs conforms to the SCGs. However, the area surrounding the Site has supported industrial and commercial activities for approximately 150 years and the anticipated future site use is industrial and/or commercial. Excavation to the total depth of impacts at this Site to meet the Unrestricted Use SCOs provides little or no incremental increase in protection of human health and the environment.

Long-term effectiveness and permanence
The excavation of soil to meet the Unrestricted Use SCOs will provide a long-term solution to prevent exposure to impacts and reduce the potential migration of NAPL by eliminating source areas. However, due to the long history of urban and industrial use in the area surrounding the Site, adjacent soil as well as the groundwater likely contain impacts that are not MGP related and that likely exceed unrestricted use SCOs. These impacts could recontaminate remediated areas to concentrations above the unrestricted use SCOs.

Reduction of toxicity, mobility, or volume of contamination
The excavation of soil impacts will permanently reduce the toxicity, mobility and volume of these impacts through off-site treatment and/or disposal.

Short-term impact and effectiveness

There will be a significant increase in the short term public health exposure risk during the implementation of this alternative due to the highly populated location of the Site and the size and scope of the remedy. There will be a significant disturbance to the community during the excavation and transportation of impacted material, which has been estimated to take approximately 21 years to complete. Excavated material would need to be transported through highly congested roadways for treatment and disposal off site. Approximately 250,000 one way truck movements would be required to remove the excavated material and bring in clean fill. Controls, such as covered excavations and the use of odor suppressant foam, would be utilized to minimize exposures during excavation at each parcel.

Implementability

There are numerous implementation challenges associated with this alternative. Construction support and dewatering would be required to depths up to 150 feet bgs; extended odor and emissions controls; space restrictions for material handling, dewatering and waste water treatment facilities due to implementation on a parcel by parcel basis and disruption to the community.

Cost effectiveness

The estimated cost for this alternative is approximately $590 million.

Land Use

This remedial alternative is not necessary to be protective of the current and anticipated future commercial and industrial land use at the Site.

7.2.2.2 Excavation of Former MGP Subsurface Structures

This alternative consists of the excavation of former MGP subsurface structures on Parcels I, II, III, and IV; excavation of impacted soil in exceedance of CP-51 criteria to a depth as required to support future redevelopment; NAPL recovery, if any, on Parcel II; and institutional controls. Details of this alternative are described in section 7.1.2.2 and illustrated in **Figure 11**.

Overall protectiveness of the public health and the environment

The combination of remediation technologies included in this alternative, in conjunction with the current site use remedy, will be protective of public health and the environment. Excavation of soil that exceeds the CP-51 criteria (total PAHs greater than 500 mg/kg) as required for future redevelopment will mitigate potential exposure risk during intrusive activities. Excavation of subsurface structures and NAPL recovery, if needed, will result in the removal of source material from the subsurface, which further protects public health and the environment from exposure to these impacts. Institutional controls will be developed to ensure the protection of public health to any remaining impacts.

Conformance with SCGs

The excavation of subsurface structures and NAPL recovery, if needed, conforms to the SCGs by reducing the potential for the migration of NAPL and removing source material where practicable. Excavation of soil that exceeds the CP-51 criteria (total PAHs greater than 500 mg/kg) as required for future redevelopment will result in meeting the SCGs in areas of future intrusive work. Institutional controls will be implemented to prevent potential exposures to soil and groundwater impacts that exceed the SCGs.

Long-term effectiveness and permanence

The removal of subsurface MGP structures will provide a long-term solution to prevent exposure to these impacts and reduce the potential migration of NAPL by eliminating source areas. The NAPL recovery system will be effective at permanently reducing the quantity of mobile NAPL in the subsurface. Excavation of soil that exceed the CP-51 criteria where required for future redevelopment and implementation of institutional controls for remaining impacts will mitigate potential exposures during any intrusive activities at the Site.

Reduction of toxicity, mobility, or volume of contamination

The excavation of soil impacts coupled with off-Site disposal will permanently reduce the toxicity, mobility, and volume of on-Site impacts. NAPL recovery will reduce the mobility and the overall volume of NAPL at the Site.

Short-term impact and effectiveness

Minimal additional short-term impacts will be realized during the excavation of soil for general improvements and utility-related depths. The excavations are shallow and material will be directly loaded into trucks or barges and transported off site for treatment and disposal. The excavations will be deeper for removal of subsurface MGP structures and impacts could be more significant. Therefore, excavation of these structures may increase the short-term potential exposure to the community. However, controls, such as covered excavations, will be utilized to minimize these exposures. The NAPL recovery systems would increase the potential short-term exposure to NAPL during recovery, temporary storage, and transportation of NAPL. The short-term impacts during installation of the recovery wells and systems are anticipated to be negligible.

Although the excavations may take some time to complete, they will immediately and effectively reduce MGP impacts at the Site. If required, NAPL recovery systems will be effective at reducing the mobility and volume of NAPL.

Implementability

There are minimal implementation issues associated with the excavation of soil to meet CP-51 criteria or the removal of subsurface former MGP structures. These excavation activities will be coordinated with site redevelopment activities. The primary implementation issues for the NAPL recovery systems will be access to third-party properties and preventing exposure to recovered NAPL. Steps will be taken to mitigate these implementation issues. The installation of NAPL recovery systems on Parcel II will be coordinated with the site redevelopment to minimize these potential exposure issues.

Institutional controls are implementable as they would be consistent with the current and potential futures site use.

Cost effectiveness

Of all the future use remedial alternatives, this alternative has the highest cost effectiveness. There is a high cost benefit as it will remove former MGP structures that contain source material and adjacent source material for an estimated cost of $19.8 million. The cost estimate is presented in **Appendix C**.

This cost estimate is based on limited available information regarding the anticipated scope of this alternative and no information about any potential redevelopment of the parcel. Changes in the estimated costs are likely to occur when information becomes available and data is collected during the PDI and during the engineering design.

Land Use

This remedial alternative is consistent with and supports the current and anticipated future commercial and industrial land use at the Site. This remedial alternative is protective of public health and the environment while being the least disruptive to the community and allowing continued industrial and commercial land use.

7.2.2.3 Excavation of Former MGP Subsurface Structures and Remediation of Potentially Mobile NAPL above the Meadow Mat

This alternative consists of the excavation of former MGP subsurface structures on Parcels I, II, III, and IV; investigation and potential remediation of mobile NAPL above the meadow mat on Parcels II, III, and VI; excavation of soil impacts in exceedance of CP-51 criteria to a depth as required to support future redevelopment; possible NAPL recovery on Parcel II; and institutional controls. Details of this alternative are described in section 7.1.2.3 and illustrated in **Figure 12**.

Overall protectiveness of the public health and the environment

Excavation of soil that exceeds the CP-51 criteria (total PAHs greater than 500 mg/kg) to a depth as required to support future redevelopment will mitigate risk to the public and environment. Excavation of subsurface structures, remediation of mobile NAPL, if any, above the meadow mat, and NAPL recovery will result in the removal and/or treatment of source material from the subsurface, which further protects public health and the environment from exposure to these impacts. Institutional controls will be developed to ensure the protection of public health to any remaining impacts.

Conformance with SCGs

The excavation of subsurface structures, remediation of NAPL, if any, above the meadow mat; and NAPL recovery conform with the SCGs by reducing the potential for NAPL migration, if any, and removing source material where practicable. Excavation of soil that exceeds the CP-51 criteria (total PAHs greater than 500 mg/kg) as required for future redevelopment will result in meeting the SCGs in areas of future intrusive work. Institutional controls will be implemented to prevent potential exposures to soil and groundwater impacts that exceed the SCGs.

Long-term effectiveness and permanence

Removal of subsurface MGP structures will provide a long-term solution to prevent exposure to these impacts and reduce the potential migration of NAPL, if any, by eliminating source areas. If a NAPL recovery system is required, it will be effective at permanently removing mobile NAPL from the subsurface. The excavation of NAPL, if any, above the meadow mat is a more permanent solution than ISS or containment of these impacts. However, properly designed and maintained containment and ISS remedies are effective in the long-term. Institutional controls will mitigate potential exposures during any intrusive activities at the Site.

Reduction of toxicity, mobility, or volume of contamination

The excavation of impacts within and immediately adjacent to former subsurface MGP structures will permanently reduce the mobility and volume of these impacts through off-site treatment and/or disposal. NAPL recovery will reduce the mobility and the overall volume of NAPL at the Site. The excavation of NAPL, if any, above the meadow mat will reduce the toxicity, mobility and volume of these impacts; ISS of NAPL, if any, above the meadow mat will reduce the toxicity and mobility; and containment combined with NAPL recovery will reduce the mobility and volume of these impacts.

Short-term impact and effectiveness

Minimal additional short-term impacts will be realized during the excavation of soil in exceedance of CP-51 criteria for general improvements and utility-related depths. The excavations are shallow and material will be directly loaded into trucks or barges and transported off site for treatment and disposal. The excavations will be deeper for removal of subsurface MGP structures and NAPL present above the meadow mat and impacts could be more significant. Therefore, excavation of these structures may increase the short-term potential exposure to the community. However, controls, such as covered excavations and odor suppressant foam, will be utilized to minimize these exposures. The NAPL recovery systems could increase the potential short-term exposure to NAPL during recovery, temporary storage, and transportation of NAPL. The short-term impacts during installation of the recovery wells and systems are anticipated to be negligible.

Although the excavations may take some time to complete, they will immediately and effectively reduce MGP impacts at the Site. If required, NAPL recovery and containment systems will be effective at reducing the mobility and volume of NAPL.

Implementability

There are minimal implementation issues associated with the excavation of soil to meet CP-51 criteria or the removal of subsurface former MGP structures. These excavation activities will be coordinated with site redevelopment activities. The primary implementation issues for the

NAPL recovery systems will be access to third-party properties and preventing exposure to recovered NAPL. Steps will be taken to mitigate these implementation issues. The installation of NAPL recovery systems on Parcel II and potentially Parcel III (depending in further investigation) will be coordinated with the site redevelopment to minimize these potential exposure issues.

The implementation issues associated with ISS of NAPL impacts above the meadow mat potentially include subsurface obstructions, space restrictions for staging of ISS support systems, and restrictions associated with subsurface infrastructure required for future redevelopment. The implementation issues associated with containment of NAPL impacts, if any, above the meadow mat potentially include subsurface obstructions and the presence of a consistent and sufficient meadow mat unit to key the NAPL barrier into to provide confinement. Institutional controls are implementable as they would be consistent with the current and potential futures site use.

Cost effectiveness

A potential cost range for this remedial alternative is estimated to be between $23.9 and $38.9 million. This remedial alternative is moderately cost effective when compared to the other alternatives. This cost range was developed based on numerous assumptions with limited information regarding the scope of the remedy and no information regarding future redevelopment plans. Assumptions were made regarding the depth and location of the future redevelopment for each parcel, the redevelopment of potential minimum and maximum remedial areas, the selected remedial technology, the amount of soil that could potentially be re-used on-site, and the requirement and type of excavation support, dewatering systems, and odor control. Accordingly, the estimated cost range represents a projection that will likely change if/when information and data are obtained from a PDI, engineering design, and redevelopment plan. The high and low range cost estimates presented in **Appendix C** were developed using each of the three remedial technologies presented in this FS (Excavation, Containment, ISS). The low range cost estimates were developed using the remedial areas shown in **Figure C1.** The high range cost estimates were developed using the remedial areas shown in **Figure C2**.

In the event there is future redevelopment of a parcel that requires excavation of MGP-impacted material above the CP-51 criteria (total PAHs greater than 500 mg/kg), National Grid will work with the property owner to establish a plan to address that impacted material in accordance with the SMP and the NYSDEC-approved FS for the Site. The property owner must contact National Grid when a plan is created and before undertaking any work. National Grid is responsible for MGP-impacted material only. Any activities associated with standard redevelopment, construction, and/or urban or historic fill is the responsibility of the property owner.

Land Use

This alternative is consistent with and supports the current and anticipated future commercial and industrial land use at the Site. This alternative was developed to be protective of public health and the environment while being less disruptive to the community and allowing continued industrial and commercial land use.

7.2.2.4 Summary of Future Use Alternatives Evaluation

A summary of the evaluation of the future site use remedial alternatives is provided in **Table 4**. Each of the alternatives was scored for the individual criteria based on the following scale:

- 0 – Does not meet criteria
- 1 – Poor conformance with criteria
- 2 – Acceptable conformance with criteria
- 3 – Good conformance with criteria
- 4 – Excellent conformance with criteria

The sum of the scores was then used to rank the alternatives.

The Unrestricted use alternative scored the lowest with a total score of 12. This alternative scored poorly due to the increased short term risks, implementability issues, high costs, and non-conformance with current and anticipated future land use.

The Excavation of Former MGP Subsurface Structures alternative and the Excavation of Former MGP Subsurface MGP Structures and Remediation of NAPL above the Meadow Mat alternative received scores of 22 and 23, respectively. The additional remediation of NAPL, if any, above the meadow mat resulted in slightly higher scores for meeting the SCGs and the reduction of toxicity, mobility or volume of contaminants. However, it is difficult to fully evaluate the alternative that includes remediation of NAPL, if any, above the meadow mat because the nature and extent of these impacts has not been fully defined. In addition, the remedial technology selected to address these impacts will be dependent upon redevelopment plans, the scope of which, for each of the parcels, has not been defined.

8. Recommended Remedy

Under current conditions, the MGP-related impacts present at and near to the Site pose no risk to human health. Each parcel evaluated is currently developed and not owned by National Grid. Therefore, two remedial alternatives are recommended for the Site. The first, or current use, alternative addresses remedial actions that could be implemented to meet the RAOs under the current property uses. The second, or future use, alternative would be implemented on a case-by-case basis as each parcel is redeveloped. The parcel redevelopment would need to allow access to the subsurface impacts (i.e., redevelopment specifies demolition of existing structures and/or surface features to be completed by others). The future use alternative recommended for the Site is the Excavation of Former MGP Surface Structures and Remediation of Potentially Mobile NAPL above the Meadow Mat.

8.1 Recommended Remedy for Current Site Use

The site-wide alternative recommended for current parcel uses is as follows:

- Construction of a Barrier Wall: A sealed-joint steel sheet pile barrier wall will be installed at the boundary of the Gowanus Canal and Parcels I, VI, and VII to a depth of approximately 50 feet bgs to prevent NAPL migration to the canal.
- NAPL Recovery: NAPL recovery wells, as appropriate, will be installed, immediately upgradient of the barrier wall on Parcels I, VI, and VII and on the Degraw Street ROW to reduce the volume of source material. A PDI will be performed to identify potential NAPL recovery locations with wells installed at select locations. The wells will be monitored to determine potential NAPL collection volume and recharge rates. A NAPL recovery program will be developed for wells with sufficient NAPL recharge capacity.
- Institutional Controls: Institutional controls will be required for Parcels I, II, III, IV, VI, VII, and on select adjacent ROWs to prevent potential exposure to impacted soil and groundwater during soil intrusive activities. It is anticipated that institutional controls will include long term agreements with property owners requiring compliance with site-specific SMPs for each parcel, as appropriate. These agreements will provide notice to the property owners of the SMP requirements and will also require the property owners to notify National Grid of planned redevelopment activities and/or major renovations so that National Grid can address remedial issues consistent with the final remedial selection. Other institutional control tools that may be used depending on site conditions include environmental easements (Parcels I, II, III, and IV), interim SMPs (see **Figure 9**), and groundwater use restrictions.
- Investigation to delineate potential shallow source material in ROWs: An investigation will be performed to determine if source material is present adjacent to shallow utilities in an area of potential impacts identified at the intersection of Nevins and Degraw Streets (**Figure 9**).

Details of this alternative are illustrated in **Figure 9**. The barrier wall will follow a formal remedial design process. Additional pre-design work will be required to design both the barrier wall and NAPL recovery well network and potential recovery system. Additional information required includes data on the foundations of buildings and bulkheads adjacent to the proposed barrier wall, a refined hydraulic model, and New York City infrastructure data related to the Flushing Tunnel, CSOs and other outfalls proximate to the proposed barrier wall. The final design will be completed in conjunction with the design of the remedy for the Gowanus Canal. The EPA Gowanus Canal ROD presents a remedy for the canal that includes dredging, ISS and capping with related requirements for the improvements of bulkheads to implement the remedy. Given the interrelated nature of the barrier wall and the Gowanus Canal remedy, the final design must be developed in conjunction with the Gowanus Canal remedy. Design of the barrier wall will also rely upon data generated from the completion of the Former Citizens MGP Pilot Study.

The cost for this alternative is estimated to be approximately $16.3 million.

8.2 Recommended Remedy Future Use/Redevelopment

The site-wide alternative recommended for remediation of parcels in conjunction with future redevelopment is the Excavation of Former MGP Subsurface Structures and the Investigation and Potential Remediation of Potentially Mobile NAPL above the Meadow Mat, where applicable. In order for the future use remedy to be implemented, the parcel redevelopment would have to allow for access to the subsurface impacts (i.e., redevelopment specifies demolition of existing structures and/or surface features to be completed by others). A detailed description of how this alternative would be applied to each parcel is provided in section 7.1.2.2 and 7.1.2.3 and is illustrated in **Figure 12**. For each parcel this alternative includes some or all of the following, based on parcel conditions and the extent of redevelopment:

- Excavation of former MGP subsurface structures containing source material: Former structures identified in **Table 2** and **Figure 12** will be excavated. Parcels I, II, III and IV were part of the Site footprint and subsurface structures on these parcels and impacted material immediately adjacent to these structures will be excavated to remove potential source material.
- A PDI will be performed on Parcels II, III, and VI to define the presence or nature and extent of potentially mobile NAPL above the meadow mat. The proposed limits of the investigation are illustrated in **Figure 12**. A specific remedy to address these impacts will be developed based on the findings and using the screened technologies, as appropriate, with NYSDEC approval.
- In other areas, where future subsurface activities occur, soils in those areas that exceed CP-51 criteria (total PAHs greater than 500 mg/kg) due to MGP-related impacts, if any, will be excavated to a depth required for subsurface repair, maintenance or redevelopment activities. Prior to subsurface repair, maintenance or redevelopment activities, soil analytical sampling will be performed, as needed, to ensure the CP-51 criteria are met for MGP-related impacts, taking into account the nature of the activities and the redevelopment plans.

- Cap or Surface Cover: A cap or cover system such as pavement, a permanent structure, or 1-foot of clean fill will be evaluated on a case-by-case basis, and where necessary, installed during future redevelopment of a parcel to prevent exposure to shallow soil that meets the CP-51 criteria, but exceeds the Commercial use SCOs for PAHs.
- Subsurface NAPL Barriers: Subsurface NAPL barriers will be evaluated to prevent the recontamination of previously remediated areas if adjacent NAPL impacts are present.
- NAPL Recovery: The need for NAPL recovery systems, if any, will be evaluated for Parcel II and potentially Parcel III when the properties are available for redevelopment. NAPL recovery wells will not be installed on Parcel II while it remains a public park.
- Institutional Controls: Institutional controls are generally required to prevent potential exposure to impacted soil and groundwater during intrusive activities. It is anticipated that institutional controls will be needed for Parcels I, II, III, IV, VI, VII, and on the adjacent ROWs, include long term agreements with property owners requiring compliance with site-specific SMPs (see area illustrated in **Figure 12**) for each parcel, as appropriate. These agreements will provide notice to the property owners of the SMP requirements and will also require the property owners to notify National Grid of planned redevelopment activities and/or major renovations so that National Grid can address remedial issues consistent with the final remedial selection. Other institutional control tools that may be used depending on site conditions include environmental easements (Parcels I, II, III, and IV), interim SMPs, and groundwater use restrictions.

The final remedy for each parcel will be designed at the time of redevelopment. Pre-design work, including sampling, will be needed to further define excavation areas, design excavation support and dewatering systems, and confirm the presence and depth of former MGP structures. In addition, the design of the NAPL recovery well networks and potential recovery systems will require a PDI to determine NAPL mobility and recovery rates. The schedule for remedial actions under this alternative will be dictated by parcel redevelopment. It is likely that each parcel will be redeveloped independently from one another and will require a parcel-specific design. Institutional controls will be implemented in the interim.

A potential cost range is provided for evaluation purposes in this FS and is estimated to be between $23.9 and $38.9 million. This cost estimate is based on limited available information regarding the anticipated scope of the remedial alternative and without information about any potential redevelopment of the parcel. Minimum and maximum remedial areas were calculated based on the existing data. Costs estimates using each of the three remedial technologies presented in this FS (Excavation, Containment, ISS) were developed for each of these areas. Cost estimates are presented in **Appendix C**.

Additional data will be needed to close data gaps and better refine the remedy costs. Changes in the costs are likely to occur when future information and data collected during the PDI and engineering design. The plan for any redevelopment will have a great effect on the remedy scope and cost and will be a factor in determining the appropriate remedial technology used.

Furthermore, if there is future redevelopment of a parcel that requires excavation of MGP-impacted material that is above the CP-51 criteria (total PAHs greater than 500 mg/kg), National Grid will work with the property owner to establish a plan to address that impacted material in accordance with the SMP and the NYSDEC-approved FS for the Site. The property owner will need to contact National Grid before undertaking any work. National Grid will only have responsibility for MGP-impacted material. Any activities associated with standard redevelopment, construction, and/or urban or historic fill will continue to be the responsibility of the property owner.

9. References

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Tables

Figures

Plates

Appendix A (electronic only)

1928 Survey

Appendix B (electronic only)

Soil Analytical Results

Appendix C

Cost Estimates