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New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Western Remedial Action, 11th Floor
625 Broadway
Albany, New York 12233-7010

Re: Remedial Alternative Analysis
Carroll Gardens/Public Place
(Citizens Gas Works Former MGP Site)
AOC Index No. A2-0460-0502
Site No. V00360-2

Dear Mr. Omorogbe:

This letter presents Remedial Alternative Analysis (RAA) for the Carroll Gardens/Public Place Former Citizens Gas Works MGP Site (the Site), located in Brooklyn, New York **(Figure 1)**. KeySpan submitted a conceptual remedy letter on September 22, 2006 that outlined a remedial strategy based on the June 22, 2006 coordination meeting between representatives of the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH), KeySpan Corporation (KeySpan), GEI Consultants, Inc. (GEI), and the New York City Office of Environmental Coordination (NYC OEC) that took place in the NYSDEC offices in Albany, New York. That conceptual remedy included the NYSDEC's minimum requirements for an acceptable remedy at this site in accordance with the requirements set forth in 6 NYCRR 375-1.1(c), *New York State Department of Environmental Conservation (NYSDEC) Technical and Administrative Guidance Memorandum (TAGM) #4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites*, the NYSDEC Draft DER-10 *Technical Guidance For Site Investigation and Remediation* [DER-10], and Administrative Order on Consent (AOC) Index No. A2-0460-0502.

Following the submission of that letter, the NYC OEC has indicated that an agreement may be reached with the owner of Parcel III (warehouse parcel) of the Carroll Gardens/Public Place site and/or a potential developer to allow the Parcel III property to be part of the redevelopment process. If this agreement occurs, the inclusion of Parcel III and subsequent demolition of the existing warehouse would allow for a NYC combined redevelopment plan of Parcels I, II, and III. In addition, the New York State Legislature amended the General Remedial Program Requirements under Subpart 375, Title 6 of the Rules and Regulations of the State of New York (6 NYCRR 375) effective December 14, 2006. In keeping with the agreed upon redevelopment strategy and the amended remedial program requirements, this Remedial Alternative Analysis Scoping letter develops the framework for the remediation of the Parcels I, II, and III in light of the planned redevelopment of the property.

This document outlines the remedial alternatives for the land portion of the site based on the investigations conducted to date. In addition, it provides the outline of a Supplemental Remedial Investigation (SRI) on Parcel III to determine the extent of subsurface impacts once the warehouse is demolished. Finally, this document presents a scope of work for a constructability analysis of various barrier wall types and configurations to ensure that the final remedial wall approach is constructible and will accomplish the remedial goals for the site.

This RAA incorporates the requirements of a Feasibility Study and applicable requirements of a Remedial Action Work Plan (RAWP) under Sections 4.3 and 5.3 of DER-10 and includes the following components.

- Summary of Remedial Investigation and Exposure Assessment
- Future Site Use and Conceptual Remedial Approach
- Remedial Goals and Remedial Action Objectives
- General Response Actions
- Identification and Initial Screening of Technologies
- Proposed Remedial Alternatives for Development and Analysis
- Supplemental Remedial Investigations
- Groundwater Model Development
- Constructability Analysis and Geotechnical Field Data Collection
- Schedule

1.0 Introduction

The Site is divided into four parcels based on ownership and current land usage as depicted on **Figure 2**. Parcels I and II are New York City-owned property. Parcel I is currently a vacant lot and Parcel II is an active concrete plant. Parcels III and IV are privately held. Parcel III is an active clothing distribution warehouse; Parcel IV is an active truck maintenance facility. The area surrounding the Site includes a variety of land uses including residential, commercial, industrial, and recreational.

As of the date of this letter, final decisions on the ultimate land uses of Parcels I, II, and III have not been made. Therefore, the remedial action objectives (RAOs) will be flexible enough to allow for a wide range of future land uses including commercial, mixed commercial/residential, and green space. In addition, depending on the timing of changes in land uses, the remedy may need to be implemented in phases as parcels become accessible.

2.0 Summary of Remedial Investigation and Exposure Assessment

A Remedial Investigation (RI) Report was submitted by KeySpan to NYSDEC in May 2005. The following summary of findings is adapted from the RI Report:

- The chemical constituents detected in soil and groundwater are consistent with those expected for a former MGP site.
- The RI identified the presence of DNAPL tar-saturated soils at depths below the bottom of the Gowanus Canal (elevation –11 ft NAVD). Tar appears to have originated from two areas of the former MGP, which based on process knowledge, were where tar was most intensively handled; in and around Holder Nos. 2 and 3 and the tar separator and tar scrubber on Parcel I and the former tar processing area (tar separators, distillers, dryers, etc.) on Parcel III.
- In the unsaturated soils (elevation 30 ft to –2 ft NAVD), tar is limited to the area adjacent to Holder No. 2 on Parcel I.
- In the shallow zone soils (elevation 16 ft to –24 ft NAVD), tar-saturated conditions are limited to three areas: at Holder No. 3 on Parcel I, and at the northwest and northeast corners of Parcel II.
- The lateral extent of residual tar (blebs, lenses, grain coatings) in the shallow zone covers much of Parcel I, the western half of Parcel II, and the eastern half of Parcel III. Potentially mobile tar was not observed at locations adjacent to the Gowanus Canal at depths above the floor of the canal.
- In the intermediate zone soils (elevation –11 ft to –90 ft NAVD), tar-saturated conditions and inter-bedded zones of tar-saturated soil are present throughout the northeastern portion of Parcel I (near Holder Nos. 2, 3 and the former generator house), throughout nearly all of Parcel II, in the southeastern portion of Parcel III, and on Lots 50 and 138 across the Gowanus Canal.
- The only tar impacts observed in the deep soil zone (elevation –90 ft to –135 ft NAVD) were a layer of tar saturated soil and a zone of inter-bedded tar saturated soil located at the eastern property line of Parcel I near the former boiler and generator houses.
- Based on the distribution of tar and the groundwater flow directions, dissolved phase BTEX and light-end PAHs (e.g., naphthalene) are being transported by groundwater flow into and possibly beneath the Gowanus Canal. Dissolved phase contaminants that enter the canal will likely be mitigated by processes of biodegradation, volatilization, and dilution. Dissolved phase BTEX and light-end PAHs may also migrate to the west and north of the site in the shallow groundwater zone. Dissolved phase contaminants in the intermediate zone likely migrate to the southwest of the site, while deep groundwater impacts are anticipated to be minimal.
- A Qualitative Human Health Exposure Assessment (QHHEA) performed to evaluate contaminants of concern (COCs) in all media (soil, groundwater, soil vapor) at the site determined that current users of each parcel have a very low potential to come into contact with COCs in excess of the screening values. Only NYC employees and possible trespassers at Parcel I may contact COCs in surface soils during routine and intermittent activities on that parcel. Potential future utility and construction workers may come into contact with COCs in subsurface soils and/or shallow groundwater in the course of performing potential utility repairs or potential future construction projects at

all parcels. A summary of each exposure pathway is provided in Appendix A. The complete QHHEA is presented in the May 2005 RI Report.

- A Step I Fish and Wildlife Impact Resource Analysis (FWIRA) indicated that the habitat observed on site provides limited value to mammalian and avian wildlife species, and additional habitat occurring in the surrounding area provides substantially greater habitat availability. Most of the wildlife species utilizing the site are transient, highly mobile populations, and a significant negative impact is not expected. Fisheries resources occurring within the Gowanus Canal are species tolerant of pollution and high levels of nutrients.
- A Step II-B FWIRA was performed for the aquatic resources in the Gowanus Canal. Fish survivability was chosen as the most relevant assessment endpoint in determining potential ecological impact. The results indicate that the site has a de minimis contribution to the anoxic conditions (dissolved oxygen was determined to be the most relevant measurement endpoint) in the canal and so site-related COCs do not impact fish survivability.

3.0 Future Land Use and Conceptual Remedial Approach

As of the date of this letter, the final decision on the ultimate land uses of Parcels I, II, and III has not been made. Therefore, the remedial action objectives (RAOs) will be flexible enough to allow for a wide range of future land uses including commercial, mixed commercial/residential, and green space.

As discussed above, the NYC OEC has indicated that New York City (NYC) will facilitate an agreement with the owner of the Parcel III property (Warehouse parcel) of the Carroll Gardens/Public Place site. Acquisition of Parcel III and demolition of the existing warehouse would allow for a NYC combined redevelopment plan of Parcels I, II, and III. However, depending on the timing of the purchase and the termination of the lease for the concrete plant, the remedy may need to be implemented in phases as parcels become accessible. As discussed below, the remedy will be selected to meet the remedial goals, remedial action objectives, and to be compatible with a potential wide range of future land uses.

4.0 Remedial Goals & Remedial Action Objectives

Remedial Goals

The NYSDEC's Draft DER-10 Technical Guidance for Site Investigation and Remediation – Section 4.1(b) puts forth the following remedial goals for the voluntary cleanup program:

- A remedy shall be protective of public health and the environment, given the intended use of the site.
- Where an identifiable source of contamination exists at a site, it should be removed or mitigated, to the extent feasible, regardless of presumed risk or intended use of the site.

These two goals are the Remedial Goals that will be applied to the site as the site-specific Standards, Criteria and Guidance (SCGs), in accordance with DER-10 Section 4.1 Paragraph e2, 6 NYCRR § 375-1.8(f)(2), and TAGM 4030, for determining success of the final remedy.

Remedial Action Objectives

Remedial Action Objectives (RAOs) are medium-specific or operable-unit specific objectives for the protection of human health and the environment. RAOs are developed based on contaminant-specific Standards, Criteria and Guidelines (SCGs) to the extent practicable in a cost-effective manner. The RAOs are presented below:

GROUNDWATER

- Prevent, to the extent practicable, contact with, or ingestion of contaminated groundwater associated with the site.
- Prevent, to the extent practicable, the migration of contaminated groundwater from the site.
- Remove, to the extent practicable, the source of groundwater contamination.

SOIL

- Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.
- Recover, to the extent practicable, DNAPL tar at the site.

INDOOR AIR

- Prevent, to the extent practicable, inhalation of contaminants volatilizing from soil or groundwater into closed structures.

5.0 General Response Actions

The following general response actions are being considered as means of achieving the RAOs. The media for which each response action is applicable are indicated along with a brief definition and example technologies.

Excavation (soil, groundwater, source): The removal and subsequent treatment or disposal of contaminated soils. This response action includes shallow excavations to remove structures, break exposure pathways, and allow for redevelopment as well as more aggressive excavations to the semi-confining peat/silt/clay unit across the area of DNAPL tar saturation or deeper excavations to the vertical extent of DNAPL saturation.

Removal (groundwater, source): The removal and subsequent treatment or disposal of DNAPL from the subsurface via active or passive recovery wells.

Treatment (soil, groundwater, source): Alteration of the physical and/or chemical nature of the subsurface to cause a change in contaminant mass, mobility, or toxicity (examples: chemical oxidation, stabilization, dynamic underground stripping, thermal treatment, soil flushing).

Containment (groundwater, source): Isolation of contaminant source areas by constructing and maintaining physical barriers that prevent continued migration of contamination into groundwater (examples: caps, sheet pile wall, soil-bentonite cutoff wall, active hydraulic control).

Engineering controls (soil, source): Construction and maintenance of physical barriers to prevent potential exposures to contamination (examples: caps, fencing).

Institutional controls (soil, groundwater, indoor air): Controlling the type and nature of potential exposures through legal or administrative procedures or programs (examples: deed notice, well restrictions, protocols for managing future excavations, Health & Safety Plan for on-site work).

Monitoring (soil, groundwater, source, indoor air, sediment, surface water, biota): Ongoing measurement of contaminant levels as a means of ensuring that potential, but currently incomplete, exposure pathways are not completed (examples: groundwater monitoring, indoor air sampling, sediment sampling, monitored natural attenuation). Monitoring can also be used to confirm that natural attenuation of soil and groundwater constituents is occurring.

The following matrix shows, for each RAO, the general response actions being considered. The response actions are media-specific and the matrix does not explicitly show positive effects on secondary media.

	General Response Actions						
Remedial Action Objectives **Carroll Gardens/Public Place Former Citizens Gas Works MGP site**	**Excavation**	**Removal**	**Treatment**	**Containment**	**Eng Controls**	**Inst Controls**	**Monitoring**
▪ Prevent, to the extent practicable, contact with, or ingestion of contaminated groundwater associated with the site.	X	X	X	X	X	X	X
▪ Prevent, to the extent practicable, the migration of contaminated groundwater from the site.	X	X	X	X			X
▪ Remove, to the extent practicable, the source of groundwater contamination..	X	X	X	X			X
▪ Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.	X	X	X	X	X	X	
▪ Recover, to the extent practicable, DNAPL tar at the site.	X	X	X	X			X
▪ Prevent, to the extent practicable, inhalation of contaminants volatilizing from soil or groundwater into closed structures.	X	X	X	X	X	X	X

6.0 Identification and Initial Screening of Technologies

The following components, alone or in combination, are currently being considered for the various parcels of the Carroll Gardens/Public Place site:

- Active or Passive DNAPL Recovery Wells.
- Excavation and treatment/disposal of all source areas to a maximum depth of contamination in the saturated zone to restore site to pre-release conditions.
- Shallow excavation, MGP-era structure removal, and treatment/disposal of DNAPL tar source above the elevation for the former Gowanus Creek clay/peat deposits.
- Shallow excavation, MGP structure removal, and treatment/disposal of DNAPL tar source in the unsaturated zone to a nominal depth of -8 feet below the final property grade based on adjacent side street elevations.
- Deep containment of DNAPL tar source to the maximum depth of observed DNAPL tar in the saturated zone.
- Shallow containment of DNAPL tar source above the elevation for the former Gowanus Creek clay/peat deposit.
- In-situ stabilization of DNAPL tar source in the saturated zone.
- In-situ surfactant flushing of DNAPL tar source in the saturated zone.
- In-situ thermal stripping of DNAPL tar source in the saturated zone.

- Deed Restrictions/Environmental Easements for future uses of the site.
- Establishing institutional controls to manage future ground-intrusive work.

Table 1 (below) presents a summary of the remedial technology screening conducted for each response action being considered. The response actions are judged against likely effectiveness at achieving the RAO's, implementability, and relative cost. Based on the ability of a response action to meet these criteria, the summary table concludes whether the response action was retained for further remedial alternatives development.

Table 1
Summary of Remedial Technology Screening
Carroll Gardens/Public Place (Former Citizens Gas Works MGP Site)
Brooklyn, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
Excavation	Excavation and treatment/disposal of all source areas to a maximum depth of contamination in the saturated zone to restore site to pre-release conditions.	Effective in elimination of exposure pathway and providing long-term protection of human health. Involves removal to an elevation of approximately -120 feet in areas of source material below and downgradient of the former gas holders. While impacts have been identified as deep as elevation -120 feet, impacts to groundwater drop off significantly past elevation -60 feet outside of the DNAPL source areas. RAOs can be met with natural attenuation monitoring for residual groundwater contamination outside the source areas and institutional controls to restrict groundwater use in the immediate area.	Technology proven and readily implemented at shallow depths. Excavation below 40 feet may pose significant technical challenges. Further, hydraulic control necessary to carry out such deep excavation in a tidally influenced aquifer may be insurmountable and quite possibly infeasible.	High relative to other excavation options.	Not Retained.
	Shallow excavation, MGP-era structure removal, and treatment/disposal of DNAPL tar source above the elevation of the former Gowanus Creek clay/peat deposits.	Effective in elimination of exposure pathway via direct contact and providing long-term protection of human health. Involves excavation to the depth of the former Gowanus Creek clay/peat deposits on Parcels I, II, and III. Localized deeper excavations will be required to remove MGP-era structures. Residual contaminants may pose future threat to construction workers depending on site redevelopment plans/usage. Combined with institutional controls to prevent groundwater contact and a site management plan to address potential future deeper excavation for redevelopment, RAOs can be met.	Technology proven and readily implemented. Large scale removal necessary and will require dust, emissions and odor controls as well as significant dewatering in a tidally influenced aquifer.	Medium relative to other excavation options.	Retained for alternative development.

Table 1
Summary of Remedial Technology Screening
Carroll Gardens/Public Place (Former Citizens Gas Works MGP Site)
Brooklyn, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
	Shallow excavation, MGP structure removal, and treatment/disposal of DNAPL tar source in the unsaturated zone to a nominal depth of -8 feet below the final property grade based on adjacent side street elevations.	Effective in elimination of exposure pathway via direct contact and providing long-term protection of human health. Involves excavation of unsaturated soils to accommodate redevelopment. Localized deeper excavations will be required to remove MGP-era structures. Residual contaminants may pose future threat to construction workers depending on site redevelopment plans/usage. Combined with institutional controls to prevent groundwater contact and a site management plan to address potential future deeper excavation for redevelopment, RAOs can be met. Technology is equally effective at meeting the RAOs as deeper excavation technologies and reduces the amount of dewatering, on-site groundwater treatment, transport of contaminated material through neighborhoods, and reduces the time of disturbance to the neighborhood.	Technology proven and readily implemented. Large scale removal necessary and will require dust, emissions and odor controls as well as dewatering/ hydraulic control for removal of MGP era structures.	Low relative to other excavation options.	Retained for alternative development.
Removal	DNAPL Tar Recovery.	Effective at meeting RAO for removal of subsurface DNAPL. DNAPL thickness and recovery observed during the RI indicate that active or passive recovery will be effective in removing large volumes of DNAPL from the subsurface. Active systems may require large scale on-site collection facilities. Combined with other technologies and an OM&M program to remove, transport, and treat, and dispose of recovered DNAPL tar, RAOs can be met.	Technology proven and readily implemented. May require extensive on-site treatment or storage of DNAPL volumes anticipated.	Low installation costs, medium operation and maintenance costs relative to other technologies.	Retained for alternative development.

Table 1
Summary of Remedial Technology Screening
Carroll Gardens/Public Place (Former Citizens Gas Works MGP Site)
Brooklyn, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
Containment	Deep containment of DNAPL tar source to the maximum depth of observed DNAPL tar in the saturated zone	Effective at meeting RAO for preventing shallow to deeper migration and terminating exposure to potential human and ecological receptors. Constructability analysis and geotechnical investigation required to identify barrier installation technology, type of barrier material, and configuration. Modeling required to determine barrier effects on groundwater/DNAPL migration. Continuity of the wall may be limited based on existing natural gas tunnel. Barrier material compatibility testing required based on high styrene content of DNAPL and its impact on grout mixtures. Depth of impacts and lack of deep confining layer may limit effectiveness at depth.	Technology proven and readily implemented. Site constraints and current usage may require extensive disturbance of soils adjacent to Gowanus Canal or barrier installation within the Canal.	Medium to High relative to other containment technologies.	Retained for alternative development.
	Shallow containment of DNAPL tar source above the elevation for the former Gowanus Creek clay/peat deposit.	Effective at meeting RAO for preventing shallow migration and terminating exposure to potential human and ecological receptors. Constructability analysis and geotechnical investigation required to identify barrier installation technology, type of barrier material, and configuration. Modeling required to determine barrier effects on shallow groundwater/DNAPL migration. Continuity of the wall may be limited based on existing natural gas tunnel. Barrier material compatibility testing required based on high styrene content of DNAPL and its impact on grout mixtures. Impacts below shallow confining layer may continue to migrate.	Technology proven and readily implemented. Site constraints and current usage may require extensive disturbance of soils adjacent to Gowanus Canal or barrier installation within the Canal.	Medium relative to other containment technologies.	Retained for alternative development.

Table 1
Summary of Remedial Technology Screening
Carroll Gardens/Public Place (Former Citizens Gas Works MGP Site)
Brooklyn, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
	In-situ stabilization of DNAPL tar source in the saturated zone.	Effective at meeting RAO for preventing migration and terminating exposure. Surface conditions (concrete debris, MGP-era structures, concrete plant subgrade) will restrict shallow implementation and require extensive pre-excavation. Extensive long term monitoring may be required to demonstrate the permanence of the remedy.	Technology proven and readily implemented. Stabilization will limit/restrict redevelopment options	Medium relative to other containment technologies.	Not Retained
In-Situ Treatment	In-situ surfactant flushing of DNAPL tar source in the saturated zone.	Effective in enhancing DNAPL solubility and mobility. Is not effective in soils with low permeability including the peat/clay layer. When combined with other recovery technologies may achieve RAOs. Tidal action and discharging aquifer conditions will make delivery, contact and recovery difficult.	Technology proven in controlled settings. Tidal action will be difficult to control the process.	High capital costs when compared to other alternatives.	Not Retained.
	In-situ thermal stripping of DNAPL tar source in the saturated zone.	Effective on small areas. Injecting steam in the subsurface will have a small radius of influence due to tidal fluctuations and high hydraulic conductivity and thickness of impacted zone >100 feet.	Readily implemented. However, groundwater table and low permeability layers may result in insufficient freeboard to collect vapors or incomplete capture of vapors.	Capital costs may be medium. Operation and maintenance costs may be high when compared to other in situ technologies.	Not Retained.
Engineering Control	Engineered cap/cover system.	Effective at controlling the pathways for future worker and trespasser exposure. Will need to be flexible to include redevelopment plans for the site. May include a visual excavation barrier and clean surface/utility corridor.	Technology proven and readily implemented.	Medium compared to other technologies.	Retained for alternative development.

Table 1
Summary of Remedial Technology Screening
Carroll Gardens/Public Place (Former Citizens Gas Works MGP Site)
Brooklyn, New York

Response Action	Technology	Effectiveness	Implementability	Cost	Status for Alternative Development
Institutional Controls	Access Controls Deed Restrictions Health & Safety Plans Long-Term Monitoring Notifications.	Effective in preventing risks to future construction or utility workers. Not effective in limiting migration.	Readily implemented.	Low. Monitoring to be performed semi-annually.	Retained for alternative development.

7.0 Proposed Remedial Alternatives for Development and Analysis

Remedial Alternative 1

- Excavation and treatment/disposal of all source areas to a maximum depth of contamination in the saturated zone to restore site to pre-release conditions.

Remedial Alternative 2

- Shallow excavation, MGP-era structure removal, and treatment/disposal of DNAPL tar source above the elevation for the former Gowanus Creek clay/peat deposits
- DNAPL Tar Recovery
- Containment Barrier
- Engineered cap/cover system
- Access Controls
- Environmental Land Use Restriction/Deed Restrictions
- Health & Safety Plans
- Long-Term Monitoring
- Notifications

Remedial Alternative 3

- Shallow excavation, MGP structure removal, and treatment/disposal of DNAPL tar source in the unsaturated zone to a nominal depth of -8 feet below the final property grade based on adjacent side street elevations, creation of a clean utility corridor to facilitate potential future development.
- DNAPL Tar Recovery
- Containment Barrier
- Engineered cap/cover system
- Access Controls
- Environmental Land Use Restriction/Deed Restrictions
- Health & Safety Plans
- Long-Term Monitoring
- Notifications

A preliminary analysis of each remedial alternative was conducted. **Figures 2 and 3** depict the locations of the excavation limits and the containment barrier evaluation/location for Parcels I, II and III. Although these figures focus on Remedial Alternative 3, the locations of various excavation and containment scenarios are the same. Each alternative was compared to the eight of the nine Remedy Selection Criteria in 6 NYCRR 375-1.8(f). A cost comparison analysis is

included in Appendix B. In addition, community acceptance will be determined following the public comment period.

1. Overall Protectiveness of the Public Health and the Environment.

- **Remedial Alternative 1:** This alternative will be protective of Public Health and the Environment. All source material will be removed, treated and disposed of off-site.
- **Remedial Alternative 2:** This alternative will be protective of Public Health and the Environment. The potential exposure pathways to impacted soil and groundwater will be broken through excavation, visual excavation barrier, and a containment barrier.
- **Remedial Alternative 3:** This alternative will be protective of Public Health and the Environment. The potential exposure pathways to impacted soil and groundwater will be broken through excavation, visual excavation barrier, and a containment barrier.

2. Standards, criteria and guidance.

- **Remedial Alternative 1:** This alternative will comply with the site specific SCGs as described in Section 4.0 above. The alternative is protective of human health and the environment and will excavate all source material from the site.
- **Remedial Alternative 2:** This alternative will comply with the site specific SCGs as described in Section 4.0 above. The alternative is protective of human health and the environment and will excavate shallow source material, contain deeper source material, and recover DNAPL source material from the site.
- **Remedial Alternative 3:** This alternative will comply with the site specific SCGs as described in Section 4.0 above. The alternative is protective of human health and the environment and will excavate shallow source material, contain deeper source material, and recover DNAPL source material from the site.

3. Long-term effectiveness and permanence.

- **Remedial Alternative 1:** This alternative will achieve long term effectiveness through excavation of all source material.
- **Remedial Alternative 2:** This alternative will achieve a measure of long term effectiveness through shallow soil excavation and long term operations of the DNAPL recovery program.
- **Remedial Alternative 3:** This alternative will achieve a measure of long term effectiveness through shallow soil excavation and long term operations of the DNAPL recovery program.

4. Reduction in toxicity, mobility, or volume of contamination through treatment.

- **Remedial Alternative 1:** Excavated soils and DNAPL will be destroyed off-site.
- **Remedial Alternative 2:** Excavated soils and recovered DNAPL will be destroyed off-site. DNAPL recovery program will enhance on-site control of DNAPL migration. The barrier wall will provide isolation of the impacted materials.
- **Remedial Alternative 3:** Excavated soils and recovered DNAPL will be destroyed off-site. DNAPL recovery program will enhance on-site control of DNAPL migration. The barrier wall will provide isolation of the impacted materials.

5. Short-term impacts and effectiveness.

- **Remedial Alternative 1:** Short term impacts for the excavation will be excessive to the surrounding community. The total excavation of all source material to the maximum depth of observed source material would include the excavation and transport of approximately 1.5 million cubic yards of soil. At an average rate of twenty 20-yard trucks per day, it would take approximately 14.5 years to complete the remediation. Community impacts would be mitigated through a CAMP and site controls.
- **Remedial Alternative 2:** Short term impacts for the excavation and DNAPL recovery program would be no greater than a standard urban construction project. Community impacts would be mitigated through a CAMP and site controls. The remedy would be effective in breaking exposure pathways in the short term. The barrier wall effectiveness and short term impacts will be further evaluated once the final configuration is determined.
- **Remedial Alternative 3:** Short term impacts for the excavation and DNAPL recovery program would be no greater than a standard urban construction project. Community impacts would be mitigated through a CAMP and site controls. The remedy would be effective in breaking exposure pathways in the short term. The barrier wall effectiveness and short term impacts will be further evaluated once the final configuration is determined.

6. Implementability.

- **Remedial Alternative 1:** Implementability of an excavation to a nominal depth of 90 feet below ground surface at the site is unlikely. Extensive earth support structures would have to be installed to support the surrounding infrastructure. The deteriorating condition of the elevated subway line adjacent to the site would require repair and protection prior to beginning an excavation of this size. Construction dewatering for the excavation could require an on-site treatment facility capable of treating hundreds and thousands of gallons of water per day. Assuming an average porosity of 30%, the storativity of the aquifer within the proposed bounds of the excavation is over 91 million

gallons of groundwater that would require treatment and disposal. Based on the size and depth of the excavation, the impacts on the local infrastructure, and the scale of dewatering, this alternative is likely technically impracticable.

- **Remedial Alternative 2:** The excavation and DNAPL recovery portions of the remedy are readily implementable with standard construction equipment. Construction dewatering would be required to achieve the target depths. Implementability of the barrier wall will be dependant on the final configuration, site usage, and site access.
- **Remedial Alternative 3:** The excavation and DNAPL recovery portions of the remedy are readily implementable with standard construction equipment. Construction dewatering will be limited to areas where the groundwater table intersects the excavation limits. Specifically in the areas of localized deeper excavations to remove the former MGP-era structures. Implementability of the barrier wall will be dependant on the final configuration, site usage, and site access.

7. Cost-effectiveness, including capital costs and annual site maintenance plan costs.

- An estimate of remedial costs is include in Appendix B.

8. Community acceptance.

- Community acceptance will be addressed following NYSDEC approval of the RAWP and a public meeting.

9. Land use, provided the Department determines that there is reasonable certainty associated with such use.

- The redevelopment for this property will be based on NYC plans. Once finalized, then the certainty of the land use will be addressed.

8.0 Conceptual Remedy Selection

A conceptual remedy was developed and presented to the NYSDEC in the September 22, 2006 conceptual remedy letter. This conceptual remedy has been further developed based on the analysis presented below, potential changes in Parcel ownership, and discussions with the NYSDEC.

KeySpan intends the remedy to be compatible with future redevelopment plans for Parcels I, II, and III and with current use or potential future redevelopment at Parcel IV. Although it is likely that Parcels I, II, and III will be available for remediation and redevelopment, the current uses of Parcels II and III may continue for an unspecified time, therefore implementation of the conceptual remedy for these parcels may be performed in a phased approach as the properties

become available for redevelopment. However, components of the remedy at these parcels (such as DNAPL recovery) may be possible to implement under current conditions combined with institutional controls. The selected conceptual remedy is discussed below by parcel. In general, the remedy includes shallow excavation (nominal 8 feet below the redevelopment grade) coupled with a containment barrier, DNAPL recovery, and engineering and institutional controls. The selected 8-ft nominal depth excavation is equally as effective at meeting the RAOs as deeper excavation technologies when combined with the other components of the remedy and will result in reduced dewatering and on-site groundwater treatment, reduced transport of contaminated material through neighborhoods, and a reduced time of disturbance to the neighborhood.

Parcel I

Following NYC removal of the surface debris and concrete wash located on the parcel, the conceptual remedy for Parcel I will include the excavation of unsaturated soils on Parcel I to a maximum depth of 8 feet below the final proposed grade. Where accessible, subsurface MGP-era structures and their contents will be removed. This will include the removal of the three gas holders, purifier houses, and gas house foundations observed during the Remedial Investigation. The localized deeper excavation at the location of the former holders will be used to create a clean utility corridor to support site redevelopment. The clean utility corridor will extend form Smith Street to the center of the parcel. A visual excavation barrier will be installed to demarcate the limits of the excavation performed during the remediation and to prevent inadvertent future disturbance of deeper impacted soils. MGP-impacted excavated soils will be transported off-site for treatment by thermal desorption. The excavated soils will be replaced by clean backfill. A DNAPL recovery system will be designed and installed so that it is compatible with the redevelopment plans for the site.

The final grade of the site will be determined based on the NYC redevelopment plan but will at a minimum match the grade of the adjacent streets and properties. An environmental easement will be placed on the parcel to limit site usage. The easement will include restriction on 1st floor residential property, subsurface parking structures, and groundwater use at the site. A soil management plan will be implemented and require notification of any potential future soil excavation on the parcel, which if extending beneath the visual exaction barrier would have to be conducted by OSHA HAZWOPER trained personnel. An operations, maintenance, and monitoring plan will be implemented to monitor groundwater quality at the site, operate, maintain and monitor the DNAPL recovery system, and ensure maintenance of the visual excavation barrier.

Parcels II and III

The conceptual remedy for Parcels II and III will include a barrier wall and DNAPL recovery. The location, depth, and orientation of the proposed barrier wall will be dependant on the

barrier's potential effects on groundwater flow conditions. The existing groundwater flow conditions at the site will be modeled so that an evaluation of the barrier wall can be conducted. The groundwater model will be based on hydraulic conductivity, hydraulic head, and tidal study data collected during the Remedial Investigation. The Gowanus Canal is a tidally influenced water body and the shallow groundwater at the site flows toward and discharges to the canal. Installation of a barrier wall would alter this flow pattern and could exacerbate the natural mounding that occurs in the shallow zone between Parcels I and II. In the deep and intermediate zones, groundwater flow is parallel to the canal. This may necessitate the installation of wing walls and DNAPL recovery trenches/wells at the edges of the wall to prevent migration of DNAPL parallel to the canal. Modeling of the groundwater flow will be used to determine the most efficient orientation of the barrier wall. The results of the model and final barrier wall configuration will be presented in the RAWP and will be based on a configuration that will effectively mitigate impacted groundwater and DNAPL migration off-site. The evaluation will include an assessment of groundwater mounding behind the barrier wall, DNAPL transport, and the potential mitigation measures, including in-situ/ex-situ groundwater treatment (if necessary), or active DNAPL recovery. Given that the objective of the barrier wall is to mitigate potential on-going migration of DNAPL tar, the final design of the wall will include DNAPL collection systems and/or wing walls sufficient to prevent potential migration around the barrier wall system. If the modeling suggests that contaminated groundwater may migrate toward the canal, then the final design will also account for treatment of groundwater.

Current site usage will have to be considered in developing the plans for constructing the barrier wall if the wall installation were to occur prior to removal of the concrete plant on Parcel II and the warehouse on Parcel III. The wall construction means and methods will have to address these physical structures as well as other subsurface obstructions if the areas cannot be cleared and accessed prior to wall construction. Based on these restrictions, it is preferable that construction of the barrier wall occur after the current usage of these parcels changes.

The specific mode of DNAPL recovery will be dependant on the site usage as well as the type and configuration of the barrier wall installed as described above. DNAPL recovery may include vertical or horizontal collection wells, passive recovery/active pumping, and a collection system. All components of the system will be designed and constructed to be chemically compatible with the DNAPL observed at the Site (including high styrene concentrations, low flashpoint). It is anticipated that all components in contact with DNAPL from the site will be stainless steel; all electrical systems will be explosive proof; and the collection system will be housed in a permanent structure with appropriate heating, ventilation, and air conditioning controls to maintain temperatures well below the 90 degree Fahrenheit flashpoint of the DNAPL. A pilot study of DNAPL collection technologies will be conducted prior to completion of the RAWP. The results of the pilot study will be used to develop the final design of the DNAPL recovery and collection system.

Following a change in site usage of either Parcel, further remedial efforts will commence. On Parcel III, additional subsurface investigation will be conducted. This investigation will focus on identifying any additional remnant structures from the former MGP operations and determining the vertical and horizontal extent of MGP related impacts below the footprint of the existing warehouse. The results of this investigation will be used to further evaluate the configuration of the barrier wall on Parcel III.

In addition to the subsurface investigation on Parcel III, following a change in site usage the remedy will include the excavation of unsaturated soils on Parcels II and III to a maximum depth of 8 feet below the final proposed grade. Where accessible, subsurface MGP-era structures and their contents will be removed. Localized deeper excavations may be used as a clean utility corridor to support site redevelopment and will likely extend from the intersection of Fifth and Bond Streets to the center of Parcel II and from Smith Street to the center of the Parcel III. A visual excavation barrier will be installed to demarcate the limits of the remedial excavation and to prevent future inadvertent contact with deeper soils. MGP-impacted excavated soils will be transported off-site for thermal desorption. The excavated soils will be replaced by clean backfill. The final grade of the site will be determined based on the NYC redevelopment plan but will at a minimum match the grade of the adjacent streets and properties. An environmental easement will be placed on the parcel to limit site usage. The easement will include restriction on 1st floor residential property, subsurface parking structures, and groundwater use at the site. A soil management plan will be implemented and require notification of any potential future soil excavation on the parcel, which if extending beneath the visual exaction barrier would have to be conducted by OSHA HAZWOPER trained personnel. An operations, maintenance, and monitoring plan will be implemented to address the DNAPL recovery system, monitor groundwater quality at the site, and ensure maintenance of the visual excavation barrier.

Parcel IV

The conceptual remedy for Parcel IV will include excavation of shallow impacted soils at the southeast corner of Parcel IV. The excavated soils will be transported off-site for thermal desorption. The excavated soils will be replaced by clean backfill and the asphalt surface will be replaced to pre-excavation conditions. As there will be no other shallow MGP-impacted material remaining on the parcel, this will represent the extent of the remedy for Parcel IV. There is no current negotiated access to the site for the purposes of remediation. Therefore, access to the property may the affect the timing and scope of the remedy.

9.0 Conceptual Remedy Evaluation of Regulatory Compliance

An evaluation of the conceptual remedy was conducted to ensure that the planned remedial action meets the standards for remedial action selection required in DER-10 and 6 NYCRR 375-

1.8. Table 2 (below) presents a summary of the conceptual remedy components compliance with the RAOs.

Table 2
Remedy Compliance with Remedial Action Objectives
Carroll Gardens/Public Place
Former Citizens Gas Works MGP Site

Remedial Action Objectives	Common Remedial Components by Parcel		
	Parcels I, II, & III	**Parcel II & III**	**Parcel IV**
	Unsaturated Soil Excavation to 8 feet, MGP-Structure Removal, Visual Excavation Barrier, Environmental Easement; DNAPL Recovery	**Barrier Wall and DNAPL Recovery**	**Shallow Soil Excavation**
▪ Prevent, to the extent practicable, contact with, or ingestion of contaminated groundwater associated with the site.	Clean surface cover and Easement will prevent direct contact with groundwater	NA	NA
▪ Prevent, to the extent practicable, the migration of contaminated groundwater from the site.	NA	Barrier will prevent/limit groundwater discharge to the Gowanus Canal	NA
▪ Remove, to the extent practicable, the source of ground water contamination.	Structure removal and DNAPL recovery will remove source material	DNAPL recovery will remove source material	NA
▪ Prevent, to the extent practicable, ingestion/direct contact with contaminated soil.	Clean Soil Cover and Easement will prevent direct contact with soils	NA	Removal of all impacted soil
▪ Recover, to the extent practicable, DNAPL tar at the site.	DNAPL Recovery Program will remove DNAPL	DNAPL Recovery Program will remove DNAPL	NA
▪ Prevent, to the extent practicable, inhalation of contaminants volatilizing from soil or groundwater into closed structures.	Clean surface cover will reduce exposure to impacted soils, Easement will limit exposure by restricting site usage	NA	NA

10.0 Supplemental Remedial Investigation

The RI did not determine the vertical extent of MGP-related impacts below the current warehouse property. Borings within the warehouse were limited to 20 feet below the floor to determine potential points of exposure. DNAPL observed in borings and monitoring wells installed in Huntington Avenue indicate that the extent of MGP-related impacts extends under the existing warehouse; however, the vertical limit and exact horizontal limit of that extent has not been established.

Assuming that the warehouse on Parcel III is demolished, a supplemental investigation work plan will be submitted to the NYSDEC to investigate and bound the vertical and horizontal limits of the MGP-related impacts.

11.0 Containment Barrier Constructability Analysis

Prior to finalizing the conceptual remedy, a constructability analysis of the containment barrier must be completed. This analysis will include the collection of field data and geotechnical parameters required to design and construct the barrier wall. In addition, a groundwater model will be created using data collected during the tidal study performed during the remedial investigation. This model will be utilized to determine the optimum wall configuration to reduce surface mounding of groundwater behind the wall and prevent discharge of impacted groundwater around the barrier.

The following field investigations will be conduced to determine the constructability of the barrier along the existing boundary of Parcels II and III with the Gowanus Canal.

- Geotechnical Borings along the axis of the barrier. These will be installed to collect grain size distribution, blow counts, and soil strength of the discrete soil layers where the barrier will be installed. Monitoring wells may be installed in several borings with discrete screen intervals installed to determine the hydraulic conductivity of the various soil layers.
- Test Pits and Ground Penetrating Radar Survey along axis of the barrier. There are significant obstructions along the Gowanus Canal that were observed or documented during the RI. These include but are not limited to: former MGP structures; two active high pressure natural gas mains; a combined sewer line; tiebacks, deadmen, and bracing from the original construction of the Gowanus Canal; and concrete wash pits as deep as eighteen feet which are present on the active concrete plant. Where observed, these wash pits can contain up to 18 feet of solidified concrete wash. The locations and extent of these obstructions will impact the type of wall that can be installed in this area, or force the installation of a barrier from the canal along side the existing bulkhead.

- Material Compatibility Testing. The DNAPL observed during the RI has a low flashpoint (90 degrees Fahrenheit) and high styrene content. The high styrene content contributed to the DNAPL dissolving the PVC monitoring wells that were installed at the site. The compromised wells were abandoned to avoid downward migration of shallow DNAPL within the monitoring wells. The shallow DNAPL entered these wells in areas where the PVC well casing was encased in a Portland cement/bentonite grout mixture. It is not know whether the grout failed from the styrene or the DNAPL migrated along cracks or fractures in the grout to contact the PVC wells. Therefore, material compatibility testing is required to determine if the DNAPL at the site could cause a failure of a barrier based on chemical incompatibility.
- Pilot Testing. It is recommended that pilot testing of the various technologies be implemented at the site prior to the final determination of the barrier materials. This is to confirm that the barrier material type can be installed at the site.

Summary

In accordance with Section 5.3 of DER-10 this letter presents the conceptual remedy and remedial alternatives analysis (RAA). KeySpan is prepared to begin groundwater modeling and the constructability analysis for the Site in accordance with the NYC OES conceptual redevelopment plans. KeySpan requests regulatory approval of this conceptual remedy so that work may commence. Also, a draft schedule of remedial action components, milestones, and submittals will be prepared and submitted once regulatory approval of this conceptual remedy is issued.

If you have any questions, feel free to contact me at (718) 403-3053

Sincerely,

Tracey Bell
Project Manager

cc: L. Liebs, KeySpan
L. Eckhaus, NYSDEC
L. Oliva, NYSDEC
G. Litwin, NYSDOH
R. Kulikowski, NYCOEC
G. Lacetti, NYSDOH
C. Doroski, NYSDOH

Figures

SOURCE: Map created with TOPO! ® ©2001 National Geographic (www.nationalgeographic.com/topo)

0 2000 4000

SCALE, FEET

CARROLL GARDENS/PUBLIC PLACE
BOROUGH OF BROOKLYN, NEW YORK

KEYSPAN CORPORATION

GEI Consultants

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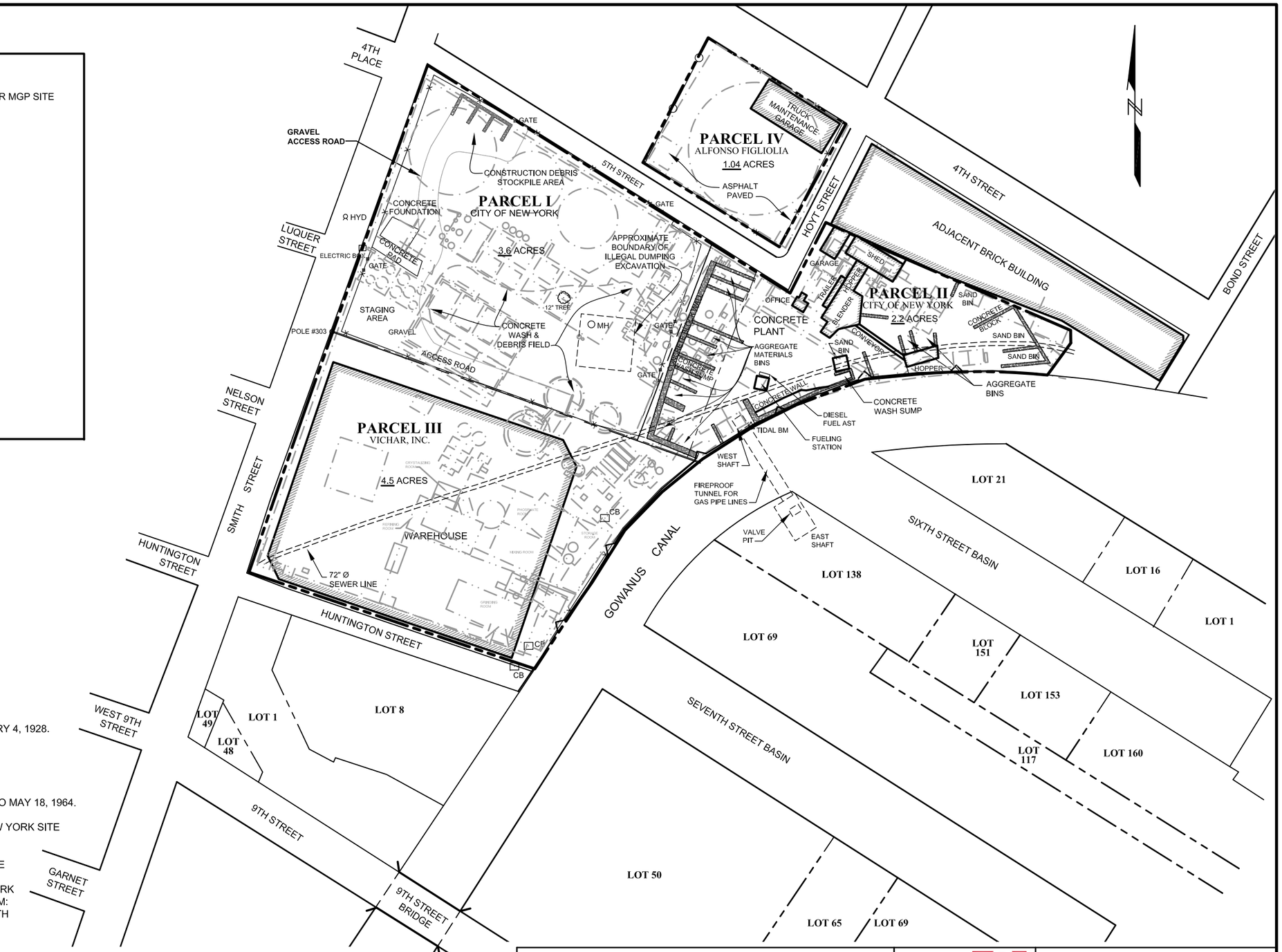
SITE LOCATION MAP

March 2007 Figure 1

KEYSPAN\CITIZENS\RA\FIGS\Citizens-LOCATION MAP.CDR

LEGEND

- APPROXIMATE BOUNDARY OF FORMER MGP SITE
- SEA WALL
- CURRENT STRUCTURE
- HISTORICAL STRUCTURE
- EXISTING CHAIN LINK FENCE
- EXISTING WOOD FENCE
- CB — EXISTING CATCH BASIN
- MH — EXISTING MANHOLE
- POLE #303 — EXISTING UTILITY POLE
- HYD — EXISTING HYDRANT
- TAX ASSESSOR'S BOUNDARIES
- PARCEL BOUNDARIES
- **PARCEL I** — KEYSPAN PARCEL NUMBER
- CITY OF NEW YORK — OWNER



SOURCES:

1. CITIZENS WORKS SURVEY, JOHNSON AND HIGGENS, N.Y., FEBRUARY 4, 1928.
2. SANBORN MAPS (1886 THROUGH 1996)
3. TECHNICAL SCOPE OF WORK, DVIRKA AND BARTILUCCI, 2000.
4. CITIZENS WORKS PROPERTY PLAN, OCTOBER 1937, CORRECTED TO MAY 18, 1964.
5. CARROLL GARDENS/PUBLIC PLACE, BOROUGH OF BROOKLYN, NEW YORK SITE PLAN, METCALF & EDDY, DECEMBER 2004.
6. SURVEY OF SITE BOUNDARIES, EXISTING CONDITIONS, AND SAMPLE LOCATIONS CONDUCTED BY GEI CONSULTANTS, INC. ON 12/3-4/02, 3/4/03, 6/4-6/03, 7/10/03, 2/08/05, AND 4/04/05. SURVEYED BY NEW YORK STATE-LICENSED LAND SURVEYOR NO. 050146. HORIZONTAL DATUM: NEW YORK STATE PLANE COORDINATE SYSTEM (EAST ZONE, NORTH AMERICAN DATUM (NAD) 83). VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM (NAVD) 88.
7. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM http://www.oasisnyc.net, ACCESSED AUGUST 2004.

NOTE:

PARCELS I-IV OCCUPY APPROXIMATELY 11.5 ACRES..

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SITE MAP AND PARCEL BOUNDARIES

March 2007 Figure 2

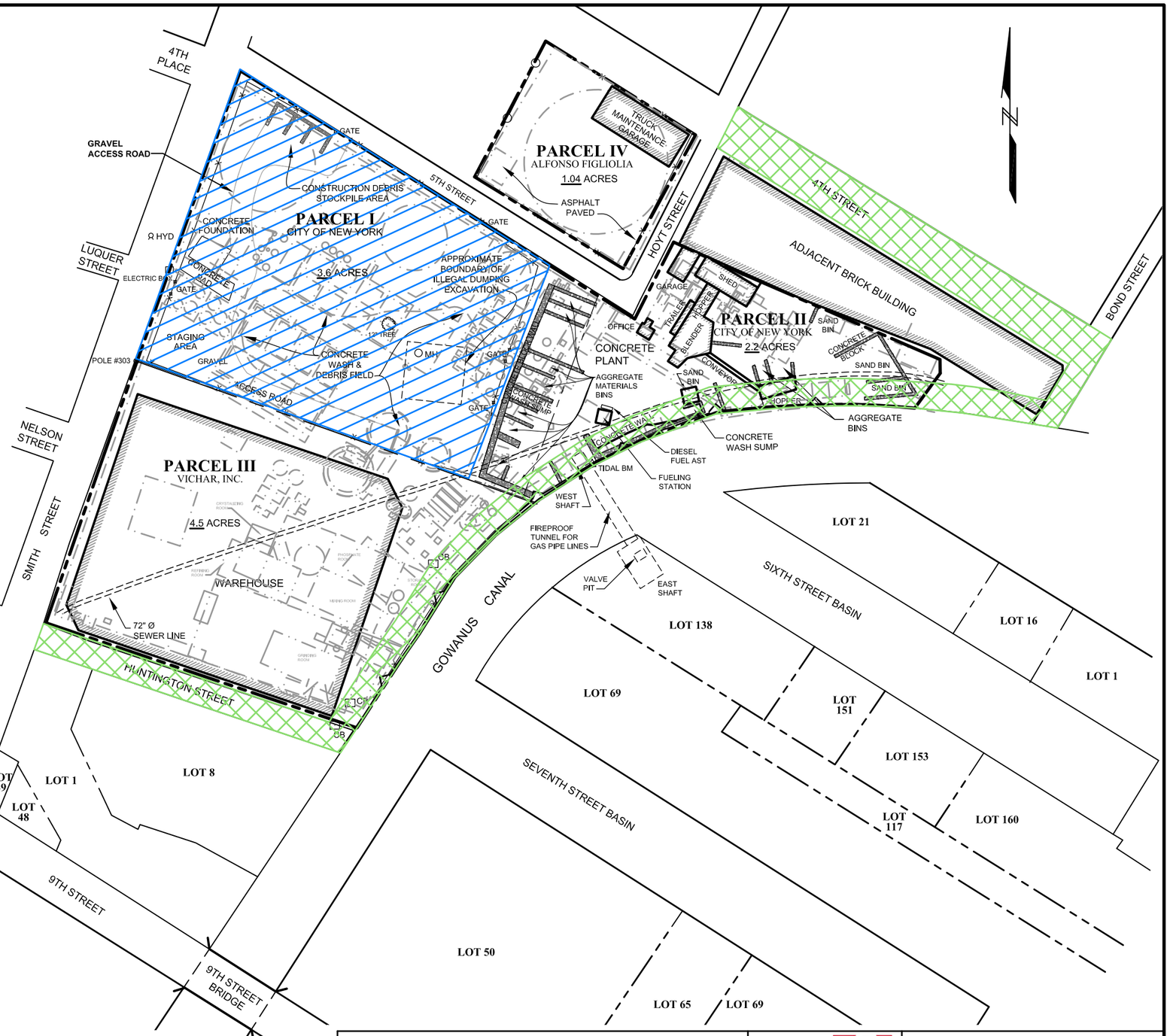
KEYSPAN\CITIZENS\RA\FIGURES\CITIZENS CONCEPTUAL RA.dwg

EXCAVATION NOTES:

1. EXCAVATE TO 8' BELOW ADJACENT STREET ELEVATIONS.
2. REMOVE MGP-ERA STRUCTURES TO MAXIMUM EXTENT OF STRUCTURES.
3. INSTALL VISUAL EXCAVATION BARRIER.
4. BACKFILL AND GRADE EVEN WITH ADJACENT STREET ELEVATIONS.
5. DNAPL RECOVERY.

LEGEND

- AREA TO BE EXCAVATED
- AREA TO BE EVALUATED FOR CONTAINMENT BARRIER AND ACTIVE DNAPL RECOVERY COLLECTION
- APPROXIMATE BOUNDARY OF FORMER MGP SITE
- SEA WALL
- CURRENT STRUCTURE
- HISTORICAL STRUCTURE
- EXISTING CHAIN LINK FENCE
- EXISTING WOOD FENCE
- CB — EXISTING CATCH BASIN
- MH — EXISTING MANHOLE
- POLE #303 — EXISTING UTILITY POLE
- HYD — EXISTING HYDRANT
- TAX ASSESSOR'S BOUNDARIES
- PARCEL BOUNDARIES
- **PARCEL I** — KEYSPAN PARCEL NUMBER
- CITY OF NEW YORK — OWNER



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NOTE:

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CONCEPTUAL REMEDIAL ALTERNATIVE PARCEL I

Project 061140-2-1103 | March 2007 | Figure 3

KEYSPAN\CITIZENS\RA\FIGURES\CITIZENS CONCEPTUAL RA.dwg

EXCAVATION NOTES:

1. DEMOLITION OF EXISTING STRUCTURES.
2. REMEDIAL INVESTIGATION BELOW STRUCTURES TO BOUND IMPACTS.
3. EXCAVATE TO 8' BELOW ADJACENT STREET ELEVATIONS.
4. REMOVE MGP-ERA STRUCTURES TO MAXIMUM EXTENT OF STRUCTURES.
5. INSTALL VISUAL EXCAVATION BARRIER.
6. BACKFILL AND GRADE EVEN WITH ADJACENT STREET ELEVATIONS.
7. DNAPL RECOVERY.

LEGEND

- AREA TO BE EXCAVATED
- AREA TO BE EVALUATED FOR CONTAINMENT BARRIER AND ACTIVE DNAPL RECOVERY COLLECTION
- APPROXIMATE BOUNDARY OF FORMER MGP SITE
- SEA WALL
- CURRENT STRUCTURE
- HISTORICAL STRUCTURE
- EXISTING CHAIN LINK FENCE
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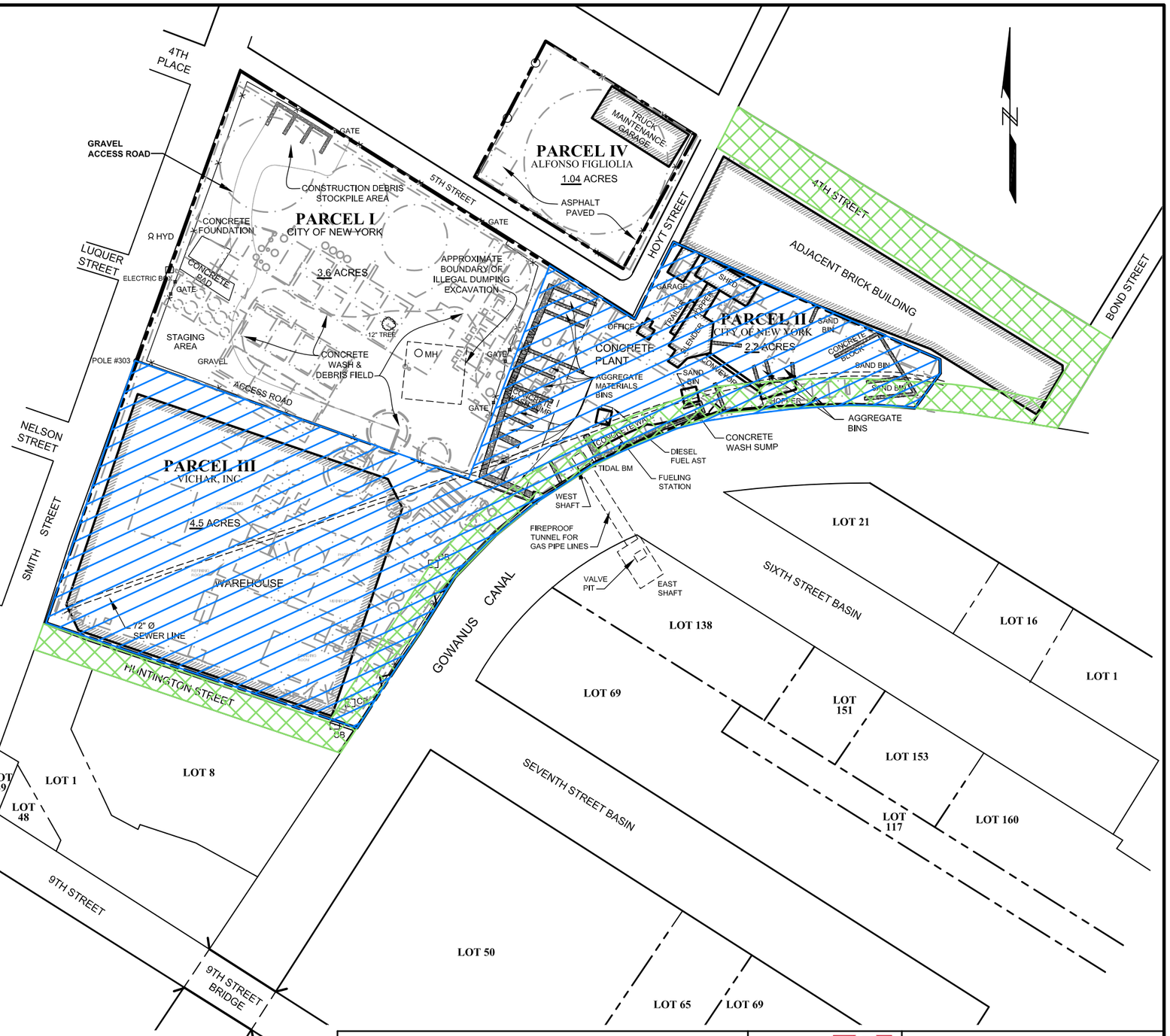
- HYD — EXISTING HYDRANT
- TAX ASSESSOR'S BOUNDARIES
- PARCEL BOUNDARIES
- **PARCEL I** — KEYSPAN PARCEL NUMBER
- CITY OF NEW YORK — OWNER



SOURCES:

1. CITIZENS WORKS SURVEY, JOHNSON AND HIGGENS, N.Y., FEBRUARY 4, 1928.
2. SANBORN MAPS (1886 THROUGH 1996)
3. TECHNICAL SCOPE OF WORK, DVIRKA AND BARTILUCCI, 2000.
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NOTE:

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CONCEPTUAL REMEDIAL ALTERNATIVE PARCELS II AND III

Project 061140-2-1103 | March 2007 | Figure 4

KEYSPAN\CITIZENS\RA\FIGURES\CITIZENS CONCEPTUAL RA.dwg

EXCAVATION NOTES:

1. EXCAVATE TO 8' BELOW ADJACENT STREET ELEVATIONS.
2. INSTALL VISUAL EXCAVATION BARRIER.
3. BACKFILL AND GRADE EVEN WITH EXISTING ELEVATIONS.

LEGEND

- AREA TO BE EXCAVATED
- APPROXIMATE BOUNDARY OF FORMER MGP SITE
- SEA WALL
- CURRENT STRUCTURE
- HISTORICAL STRUCTURE
- EXISTING CHAIN LINK FENCE
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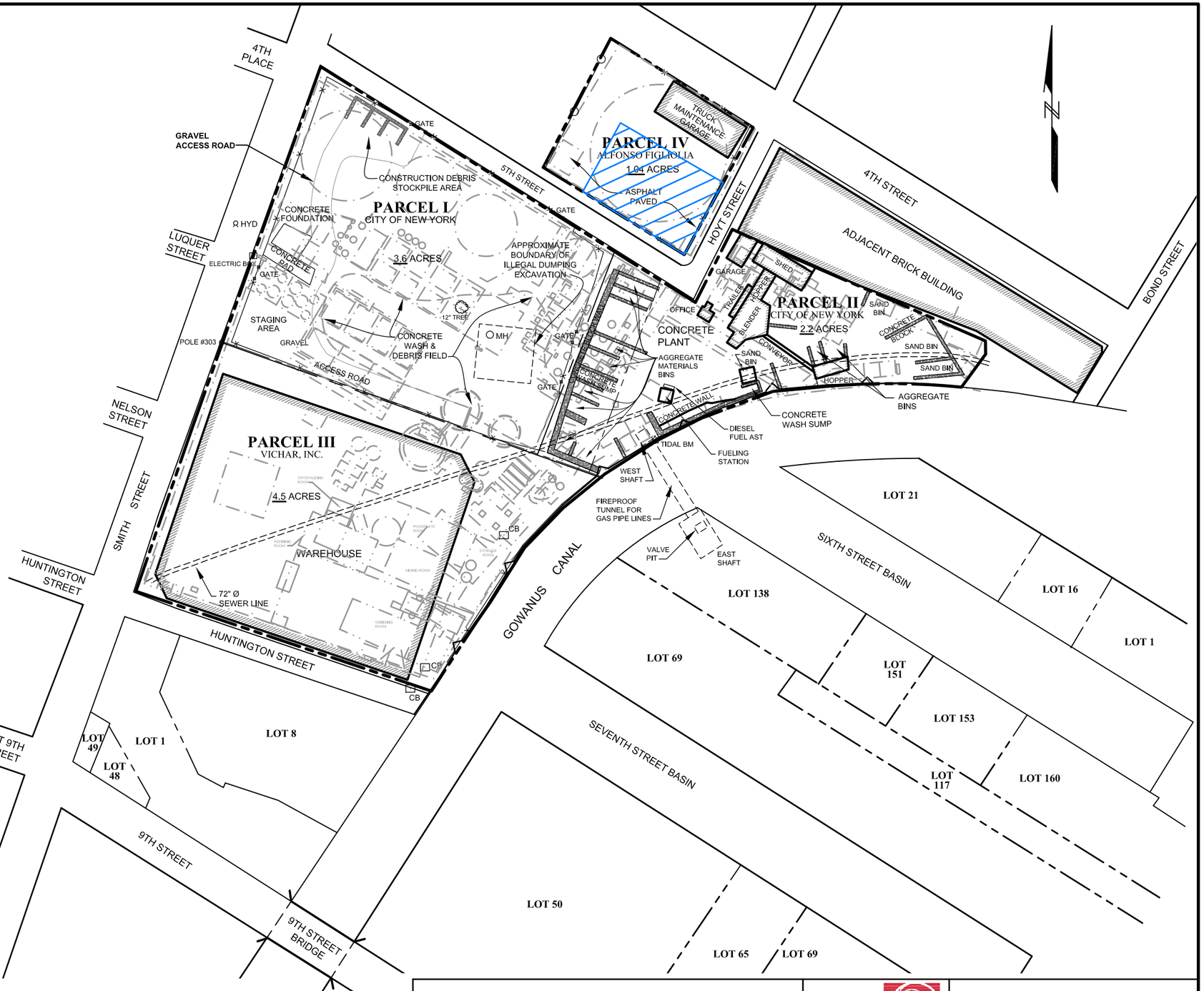

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CONCEPTUAL REMEDIAL ALTERNATIVE PARCEL IV

March 2007 Figure 5

KEYSPAN\CITIZENS\RA\FIGURES\CITIZENS CONCEPTUAL RA.dwg

Appendix A:
Qualitative Human Health Exposure Assessment Summary

Appendix A
Qualitative Human Exposure Assessment Summary

Qualitative Human Exposure Assessment - Human Exposure Pathway Overview

A qualitative human exposure assessment is included in the December 2005 RI Report for the Carroll Garden/Public Place site. Based on the assessment, the following existing or potential exposure pathways are significant and require remedial action for their elimination or mitigation:

- A complete exposure pathway to PAHs and lead contained in surface soils at Parcel I exists for NYC DCAS and Department of Sanitation workers, utility workers, trespassers, and potential future construction workers. The majority of the parcel is debris or grass covered, thereby limiting the potential for inhalation of fugitive dust by the potential receptors. NYC DCAS and Department of Sanitation workers have been informed that the site is a former MGP site and that they are to wear appropriate personal protective equipment (PPE) if soils must be disturbed on the site. The use of such precautions will mitigate potential exposure to surface soils and should continue until a final remedy for the site is in place.
- A complete exposure pathway to BTEX, PAHs, cadmium, lead, and mercury in subsurface soils exists on Parcel I for the NYC DCAS and Department of Sanitation workers, utility workers, and potential future construction workers. Exposure to subsurface soils (up to 16 feet bgs) is only possible if the soils are disturbed. A potential exposure pathway to subsurface soils exists for the NYC DCAS and Department of Sanitation workers because these individuals may be responsible for removal of debris and concrete wash on the site, thereby disturbing subsurface soils. Exposure through inhalation, dermal contact, and incidental ingestion for these receptors would only be possible if excavation activities occurred on the parcel.
- A complete exposure pathway to BTEX, non-carcinogenic PAHs, and arsenic in groundwater exists on Parcel I for the NYC DCAS and Department of Sanitation workers, utility workers, and potential future construction workers. Exposure to groundwater through inhalation, dermal contact, and incidental ingestion is only possible if excavation to or below 16 feet bgs and below the water table occurs (approximately 36 feet bgs in the northwest corner of the Site and approximately 4 feet bgs along the eastern boundary of the Site). A complete exposure pathway for groundwater exists for the NYC DCAS and Department of Sanitation workers because these individuals may be responsible for removal of debris and concrete wash on the site; such activities could bring these workers into contact with shallow groundwater.
- A potentially complete exposure pathway for toluene exists on Parcel I for the NYC DCAS and Department of Sanitation workers, utility workers, and potential future construction workers. Toluene, the only COC identified in soil gas, would likely be present in ambient air at far lower concentrations within the breathing zone due to dilution, but is included as a potentially complete exposure pathway as a measure of conservatism. Receptors at excavation depths (utility workers and potential future construction workers) would be more likely to have a complete exposure pathway to toluene, given the intrusive nature of their work in areas where soil gas was measured.

Appendix A
Qualitative Human Exposure Assessment Summary

- A complete exposure pathway to BTEX, PAHs, cadmium, and selenium in subsurface soils exists on Parcel II for utility workers and potential future construction workers. Any future construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to BTEX-, PAH-, cadmium-, and selenium-containing soils. The use of such precautions will mitigate potential exposure to the impacted soils and should continue until a final remedy for the site is in place.
- A complete exposure pathway to BTEX and non-carcinogenic PAH compounds in groundwater exists on Parcel II for utility workers and potential future construction workers. Exposure to groundwater through inhalation, dermal contact, and incidental ingestion is only possible if excavation to or below the water table occurs (approximately 10 feet bgs along the bulkhead and 6 feet bgs in the vicinity of the concrete plant's control house). Any future construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to BTEX- and PAH-containing groundwater. The use of such precautions will mitigate potential exposure to impacted groundwater and should continue until a final remedy for the site is in place.
- A potentially complete exposure pathway to PAHs and lead contained in surface soils underlying the asphalt parking lot at Parcel III exists for utility workers and potential future construction workers. A majority of the parcel is covered by the footprint of the existing warehouse, and the remainder of the site is paved with asphalt. Any future utility workers or construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to PAH- and lead-containing surface soils. The use of such precautions will mitigate potential exposure to the PAH- and lead-containing surface soils and should continue until a final remedy for the site is in place.
- A complete exposure pathway to BTEX, PAHs, and metals (arsenic, cadmium, lead, mercury, and selenium) in subsurface soils exists on Parcel III for utility and construction workers. The shallowest observed evidence of tar impacts on Parcel III was directly below the asphalt pavement. Exposure through inhalation, dermal contact, and incidental ingestion for these receptors is possible if excavation activities are conducted on the parcel. Any future utility workers or potential construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to BTEX-, PAH-, and metal-containing soils. The use of such precautions will mitigate potential exposure to impacted soils and should continue until a final remedy for the site is in place.
- A complete exposure pathway to BTEX, non-carcinogenic PAHs, and cyanide in groundwater exists on Parcel III for the utility workers and potential future construction workers. Soil gas data obtained from samples collected beneath the warehouse building show that benzene concentrations exceeded occupational thresholds for workers. The depth to the sewer line on this parcel is unknown; therefore a potentially complete pathway to BTEX, PAHs, and cyanide in groundwater exists for utility workers who may

perform repairs on the sewer line. Similarly, a complete pathway for groundwater would exist for a future construction worker conducting tasks below the water table. Therefore, any utility workers and future construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to BTEX-, PAH-, and cyanide-containing groundwater. The use of such precautions will mitigate potential exposure to impacted groundwater and should continue until a final remedy for the site is in place.

- A complete exposure pathway for benzene may exist for warehouse workers on Parcel III. Benzene was the only compound detected above the OSHA PEL of 1,000 parts per billion per unit volume (ppbv) at 2,000 ppbv (CGSV-06). While concentrations of benzene within the warehouse originating from soil gas are unlikely to be above the OSHA PEL due to dilution in indoor air and a low infiltration rate, exposure to minor concentrations of benzene are possible for indoor workers. Utility workers and future construction workers that breach the foundation of the building may also come into contact with benzene concentrations in soil gas migrating to ambient air.
- A potentially complete exposure pathway to PAHs, cadmium, and lead contained in surface soils at Parcel IV exists for utility workers and potential future construction workers. The parcel is paved with asphalt with the exception of the footprint of the truck maintenance facility. Any future utility workers or potential construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to PAH-, cadmium-, and lead-containing surface soils. The use of such precautions will mitigate potential exposure to the PAH- and lead-containing surface soils and should continue until a final remedy for the site is in place.
- A complete exposure pathway to BTEX, PAHs, and lead in subsurface soils exists for utility and construction workers on Parcel IV. The shallowest observed evidence of tar impacts on the parcel was at 11 feet bgs. Exposure through inhalation, dermal contact, and incidental ingestion for these receptors is only possible if the soils are excavated to 11 feet bgs or deeper. Any future utility workers or potential construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to BTEX-, PAH-, or lead-containing surface soils. The use of such precautions will mitigate potential exposure to impacted soils and should continue until a final remedy for the site is in place.
- A complete exposure pathway to some PAHs and selenium in subsurface soils exists for utility and construction workers. The shallowest observed impacts on the adjacent parcels was at 7.5 feet bgs (CGSB-49 at Lot 65). Exposure through inhalation, dermal contact, and incidental ingestion for these receptors is only possible if the soils are excavated to 7.5 feet bgs or deeper. Any future utility workers or potential construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to PAH-, or selenium-containing surface soils.

Appendix A
Qualitative Human Exposure Assessment Summary

- A complete exposure pathway to BTEX and naphthalene in shallow groundwater exists for the utility workers and potential future construction workers on adjacent properties. Any utility workers and future construction workers would have to wear PPE and monitoring of their work zone would have to be conducted to ensure that they are not exposed to groundwater.

Refer to the exposure assessment in the RI Report for a more detailed discussion of the potentially exposed populations.

Appendix B:
Remedial Alternative Cost Analysis

Table B-1
Opinion of Cost for Remedial Alternative 1
Carroll Gardens/Public Place (Citizens Gas Works Former MGP Site)
Brooklyn, New York

GEI Consultants, Inc. (GEI) has prepared this opinion of probable cost to perform the scope of work described in the Remedial Alternatives Analysis for the Carroll Gardens/Public Place Site (Citizens Gas Works Former MGP Site) prepared by GEI. GEI's opinion is based on published RS Means Cost Data and on GEI's project experience. In order to prepare this Opinion of Cost, GEI made assumptions on the constructability of the barrier wall based on relavant project experience and the data presented in the Remedial Investigation Report. GEI made basic assumptions as to actual site conditions that should be encountered; specific decisions and costs by other design professionals to be engaged by the contractor; the means, materials, methods of construction, and schedule the contractor will use/determine; and various other factors (see Attached Assumptions). An actual contractor's bid price to perform this work may vary from this opinion of cost based on variances in the above-mentioned assumptions.

Remedial Component	Unit	Unit Price	Remedial Alternative 1 Quantity	Remedial Alternative 1 Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 473,000	1	$ 473,000
2 Permitting and Regulatory submittals	Lump Sum	$ 245,000	1	$ 245,000
3 Constuctability Investgation	Lump Sum	$ 300,000	1	$ 300,000
			Subtotal	$ 1,018,000
			% Total Costs	0%
Construction Management				
1 Construction Oversight	Day	$ 1,044	2800	$ 2,923,200
2 Air Monitoring during construction	Day	$ 780	2800	$ 2,184,000
3 Air Monitoring System	Month	$ 30,000	136	$ 4,080,000
4 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	11.2	$ 56,000
			Subtotal	$ 9,243,200
			% Total Costs	1%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 200,000	1	$ 200,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 25,000	1	$ 25,000
3 Temporary Offices for construction period +3 months	Month	$ 3,000	139	$ 417,000
4 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 667,000
			% Total Costs	0%
REMEDIAL COMPONENTS				
Parcel I				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	692,000	$ 14,359,000
2 Import and Place Backfill	Tons	$ 16	1,038,000	$ 16,089,000
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	1,012,050	$ 90,730,283
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	15	$ 7,875
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	51,900	$ 5,784,255
6 Hazardous Waste Disposal	Tons	$ 209	25,950	$ 5,423,550
7 Dewatering System Operation and Maintenance	100 CF	$ 23	3,990,000	$ 89,775,000
8 Excavation Support System	SF	$ 50	220,000	$ 11,000,000
Parcels II & III				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	994,000	$ 20,625,500
2 Import and Place Backfill	Tons	$ 16	1,491,000	$ 23,110,500
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	1,453,725	$ 130,326,446
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	15	$ 7,875
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	74,550	$ 8,308,598
6 Hazardous Waste Disposal	Tons	$ 209	37,275	$ 7,790,475
7 Dewatering System Operation and Maintenance	100 CF	$ 23	4,290,090	$ 96,527,025
8 Excavation Support System	SF	$ 50	389,000	$ 19,450,000
Parcel IV				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	35,000	$ 726,250
2 Import and Place Backfill	Tons	$ 16	52,500	$ 813,750
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	51,188	$ 4,588,959
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	15	$ 7,875
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	2,625	$ 292,556
6 Hazardous Waste Disposal	Tons	$ 209	1,313	$ 274,313
7 Dewatering System Operation and Maintenance	100 CF	$ 23	8,552	$ 192,420
8 Excavation Support System	SF	$ 50	26,000	$ 1,300,000
			Subtotal	$ 547,511,504
			% Total Costs	78%
Long term monitoring and maintenance				
1 Periodic Monitoring, Reporting, Disposal and Maintenance	Year	$ 66,000	30	$ 1,014,582
assume I=5%			**Subtotal**	$1,014,582
			% Total Costs	0%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 558,439,704
Total O & M costs				$ 1,014,582
Total Capital and O&M costs without contingency				$ 559,454,286
Contingency (25%)			25%	$ 139,863,572
			% TOTAL COSTS	20%
			TOTAL COST	**$ 699,317,858**

Remedial Alternative 1 Summary and Cost Estimate Assumptions
Carroll Gardens/Public Place (Citizens Gas Works Former MGP Site)
Brooklyn, New York

Alternative 1 Summary:

Remedial Alternative 1 includes excavation and treatment/disposal of all source areas to a maximum depth of contamination in the saturated zone to restore site to pre-release conditions.

- Excavation of soil and debris to depths ranging from 40' to 120' will produce over 1.7 million cubic yards of material for offsite treatment and disposal.
- Excavation support cells will be created with approximately 640,000 square feet of steel sheeting.
- Dewatering of excavation volumes will generate of roughly 62 billion gallons of wastewater that will be treated onsite and discharged into the Gowanus Canal.
- Long term periodic monitoring, reporting, and maintenance are included in this remedial alternative.
- It is expected this remedial alternative can be completed over 11.5 years.

Cost Estimate Assumptions:

Unit Rates for Labor

- GEI unit rates from the 9/8/05 RFB submittal were used as typical costs for report preparation and oversight costs. These rates are intended to reflect industry rates and not those of a specific consultant.

Constructability Investigation

Boring and Test Pits:

- Sonic Rotary Drilling Rig will be used to core through obstructions within the top 20 feet of overburden.
- A total of ten sonic borings at a rate of two borings completed per day. Boring depth of approximately 20 feet per boring. Plan on 5 days of sonic drilling plus 2 days contingency for a total of 7 days.
- Mud rotary borings to be advanced 125 feet below surface elevation.
- Assume a mud rotary drilling rate of 50 feet per day, approximately 3 days per boring. Plan on 30 days of mud rotary drilling plus 5 days contingency for a total of 35 days.
- After a depth of 20 feet, the remainder of the boring is to be completed using mud rotary drilling.
- Assume 1 hour of equipment decontamination and fluid handling per day.
- Assume 1 hour of overtime per day
- Assume sequence of 10 days of sonic drilling (Day 0 through Day 10)
- Assume mud rotary drilling overlaps by 6 days (Day 4 through Day 34)
- Assume test pit investigations begin after completion of sonic drilling (Day 11 through Day 31)

Analytical Laboratory Sampling/Analysis:

- Assume two chemical samples per location. 10 borings x 2 samples/boring = 20 samples.
- Assume four geotechnical samples per location. 10 borings x 4 samples/boring = 40 samples.
- Assume 0.5 hours per analysis per sample for data validation.
- Assume 20 chemical samples at 5 analyses per sample for a total of 100 analyses for validation.
- Data validation estimated to take approximately 50 hours.

Construction Management:

- One construction oversight person on site during all construction activities. (12hrs/day)
- One air monitoring oversight person on site during all remedial activities. (10hrs/day)

Remedial Components

- Assume and average depth to groundwater of 10 feet below surface.
- Assume 35 trucks per day at 18 cubic yards per truck. Total of 630 cubic yards/day.
- Costs based on similar MGP remediation project in Bronx, NY from 2006-2007.
- Assume 5% of the excavation consists of bulk solid waste and construction debris.
- Assume a total of 45 drums of Non-Hazardous aqueous waste generated.
- Assume 2.5% of material to be disposed of as Hazardous waste.
- Excavation support system consists of sheet piles driven to a depth of 20 feet beyond maximum excavation depth.
- Excavation support systems for each parcel will be independent of one another.
- Excavation support is not limited to the outer boundaries of the parcel. Parcel sectioning may be necessary to manage the excavations.
- Assume sheet piles driven at a rate of 360 square feet/day (approximately 3 piles).
- For dewatering calculations, assume 30% soil porosity for storativity and 5% leakage per day.

Long Term Monitoring Costs

- Rates based on GEI MSA with STL of Connecticut
- Assume a total of 12 monitoring wells consisting of 4 sampling rounds per year.
- For data validation, assume 0.5 hours per analysis per sample.
- Assuming 12 sample locations and 4 analyses per location, therefore 48 samples at 4 samples per analysis totals 192 analyses.
- The data validation is estimated to take approximately 96 hours per year.

Table B-2
Opinion of Cost for Remedial Alternative 2
Carroll Gardens/Public Place (Citizens Gas Works Former MGP Site)
Brooklyn, New York

GEI Consultants, Inc. (GEI) has prepared this opinion of probable cost to perform the scope of work described in the Remedial Alternatives Analysis for the Carroll Gardens/Public Place Site (Citizens Gas Works Former MGP Site) prepared by GEI. GEI's opinion is based on published RS Means Cost Data and on GEI's project experience. In order to prepare this Opinion of Cost, GEI made assumptions on the constructability of the barrier wall based on relavant project experience and the data presented in the Remedial Investigation Report. GEI made basic assumptions as to actual site conditions that should be encountered; specific decisions and costs by other design professionals to be engaged by the contractor; the means, materials, methods of construction, and schedule the contractor will use/determine; and various other factors (see Attached Assumptions). An actual contractor's bid price to perform this work may vary from this opinion of cost based on variances in the above-mentioned assumptions.

Remedial Component	Unit	Unit Price	Remedial Alternative 2 Quantity	Remedial Alternative 2 Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 473,000	1	$ 473,000
2 Permitting and Regulatory submittals	Lump Sum	$ 245,000	1	$ 245,000
3 Constuctability Investgation	Lump Sum	$ 300,000	1	$ 300,000
			Subtotal	$ 1,018,000
			% Total Costs	1%
Construction Management				
1 Construction Oversight	Day	$ 1,044	600	$ 626,400
2 Air Monitoring during construction	Day	$ 780	600	$ 468,000
3 Air Monitoring System	Month	$ 30,000	27	$ 810,000
4 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	11.2	$ 56,000
			Subtotal	$ 1,960,400
			% Total Costs	2%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 200,000	1	$ 200,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 25,000	1	$ 25,000
3 Temporary Offices for construction period +3 months	Month	$ 3,000	30	$ 90,000
4 Temporary Utilities	Lump Sum	$ 25,000	1	$ 25,000
			Subtotal	$ 340,000
			% Total Costs	0%
REMEDIAL COMPONENTS				
Parcel I				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	116,000	$ 2,407,000
2 Import and Place Backfill	Tons	$ 16	174,000	$ 2,697,000
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	169,650	$ 15,209,123
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	10	$ 5,250
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	8,700	$ 969,615
6 Hazardous Waste Disposal	Tons	$ 209	4,350	$ 909,150
7 Dewatering System Operation and Maintenance	100 CF	$ 23	37,180	$ 836,550
8 Excavation Support System	SF	$ 50	63,000	$ 3,150,000
Parcels II & III				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	207,000	$ 4,295,250
2 Import and Place Backfill	Tons	$ 16	310,500	$ 4,812,750
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	302,738	$ 27,140,417
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	10	$ 5,250
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	15,525	$ 1,730,261
6 Hazardous Waste Disposal	Tons	$ 209	7,763	$ 1,622,363
7 Dewatering System Operation and Maintenance	100 CF	$ 23	63,555	$ 1,429,988
8 Excavation Support System	SF	$ 50	85,000	$ 4,250,000
9 Barrier Wall & DNAPL Collection System (Unknown Configuration)	Lump Sum	$ 4,100,000	1	$ 4,100,000
Parcel IV				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	18,000	$ 373,500
2 Import and Place Backfill	Tons	$ 16	27,000	$ 418,500
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	26,325	$ 2,360,036
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	10	$ 5,250
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	1,350	$ 150,458
6 Hazardous Waste Disposal	Tons	$ 209	675	$ 141,075
7 Dewatering System Operation and Maintenance	100 CF	$ 23	1,413	$ 31,793
8 Excavation Support System	SF	$ 50	17,000	$ 850,000
			Subtotal	$ 79,050,577
			% Total Costs	75%
Long term monitoring and maintenance				
1 Periodic Operations, Maintenance, Monitoring, Reporting, and Disposal	Year	$ 150,000	30	$ 2,305,868
assume I=5%			**Subtotal**	$2,305,868
			% Total Costs	2%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 82,368,977
Total O & M costs				$ 2,305,868
Total Capital and O&M costs without contingency				$ 84,674,845
Contingency (25%)			25%	$ 21,168,711
			% TOTAL COSTS	20%
			TOTAL COST	**$ 105,843,556**

Remedial Alternative 2 Summary and Cost Estimate Assumptions
Carroll Gardens/Public Place (Citizens Gas Works Former MGP Site)
Brooklyn, New York

Remedial Alternative 2

Remedial Alternative 2 includes shallow excavation, MGP-era structure removal, and treatment/disposal of DNAPL tar source above the elevation for the former Gowanus Creek clay/peat deposits, installation and operation of a DNAPL recovery system, construction of a containment barrier, and implementation of an engineered cap/cover system.

- Approximately 1,000' of containment barrier wall will be constructed with materials to be determined by constructability analysis.
- Excavation of soil and debris to depths of roughly 20' will produce nearly 340,000 cubic yards of material for offsite treatment and disposal.
- Excavation support cells will be created with approximately 170,000 square feet of steel sheeting.
- Dewatering of excavation volumes will generate of roughly 76 million gallons of wastewater that will be treated onsite and discharged into the Gowanus Canal.
- Access controls and Environmental Land Use Restriction and/or Deed Restrictions will be implemented.
- Long term periodic monitoring, reporting, and maintenance are included in this remedial alternative.

It is expected this remedial alternative can be completed over 2.5 years.

Cost Estimate Assumptions:

Unit Rates for Labor

- GEI unit rates from the 9/8/05 RFB submittal were used as typical costs for report preparation and oversight costs. These rates are intended to reflect industry rates and not those of a specific consultant.

Constructability Investigation

Boring and Test Pits:

- Sonic Rotary Drilling Rig will be used to core through obstructions within the top 20 feet of overburden.
- A total of ten sonic borings at a rate of two borings completed per day. Boring depth of approximately 20 feet per boring. Plan on 5 days of sonic drilling plus 2 days contingency for a total of 7 days.
- Mud rotary borings to be advanced 125 feet below surface elevation.
- Assume a mud rotary drilling rate of 50 feet per day, approximately 3 days per boring. Plan on 30 days of mud rotary drilling plus 5 days contingency for a total of 35 days.

- After a depth of 20 feet, the remainder of the boring is to be completed using mud rotary drilling.
- Assume 1 hour of equipment decontamination and fluid handling per day.
- Assume 1 hour of overtime per day
- Assume sequence of 10 days of sonic drilling (Day 0 through Day 10)
- Assume mud rotary drilling overlaps by 6 days (Day 4 through Day 34)
- Assume test pit investigations begin after completion of sonic drilling (Day 11 through Day 31)

Analytical Laboratory Sampling/Analysis:

- Assume two chemical samples per location. 10 borings x 2 samples/boring = 20 samples.
- Assume four geotechnical samples per location. 10 borings x 4 samples/boring = 40 samples.
- Assume 0.5 hours per analysis per sample for data validation.
- Assume 20 chemical samples at 5 analyses per sample for a total of 100 analyses for validation.
- Data validation estimated to take approximately 50 hours.

Construction Management:

- One construction oversight person on site during all construction activities. (12hrs/day)
- One air monitoring oversight person on site during all remedial activities. (10hrs/day)

Remedial Components

- Assume and average depth to groundwater of 10 feet below surface.
- Assume 35 trucks per day at 18 cubic yards per truck. Total of 630 cubic yards/day.
- Costs based on similar MGP remediation project in Bronx, NY from 2006-2007.
- Assume 5% of the excavation consists of bulk solid waste and construction debris.
- Assume a total of 30 drums of Non-Hazardous aqueous waste generated.
- Assume 2.5% of material to be disposed of as Hazardous waste.
- Excavation support system consists of sheet piles driven to a depth of 20 feet beyond maximum excavation depth.
- Excavation support systems for each parcel will be independent of one another.
- Excavation support not anticipated for parcel limits adjacent to barrier wall to be installed along the Gowanus Canal.
- Excavation support is not limited to the outer boundaries of the parcel. Parcel sectioning may be necessary to manage the excavations.
- Assume sheet piles driven at a rate of 360 square feet/day (approximately 3 piles).
- For dewatering calculations, assume 30% soil porosity for storativity and 5% leakage per day.

Long Term Monitoring Costs

- Rates based on GEI MSA with STL of Connecticut
- Assume a total of 12 monitoring wells consisting of 4 sampling rounds.
- For data validation, assume 0.5 hours per analysis per sample.
- Assuming 12 sample locations and 4 analyses per location, therefore 48 samples at 4 samples per analysis totals 192 analyses.
- The data validation is estimated to take approximately 96 hours.

Table B-3
Opinion of Cost for Remedial Alternative 3
Carroll Gardens/Public Place (Citizens Gas Works Former MGP Site)
Brooklyn, New York

GEI Consultants, Inc. (GEI) has prepared this opinion of probable cost to perform the scope of work described in the Remedial Alternatives Analysis for the Carroll Gardens/Public Place Site (Citizens Gas Works Former MGP Site) prepared by GEI. GEI's opinion is based on published RS Means Cost Data and on GEI's project experience. In order to prepare this Opinion of Cost, GEI made assumptions on the constructability of the barrier wall based on relavant project experience and the data presented in the Remedial Investigation Report. GEI made basic assumptions as to actual site conditions that should be encountered; specific decisions and costs by other design professionals to be engaged by the contractor; the means, materials, methods of construction, and schedule the contractor will use/determine; and various other factors (see Attached Assumptions). An actual contractor's bid price to perform this work may vary from this opinion of cost based on variances in the above-mentioned assumptions.

Remedial Component	Unit	Unit Price	Remedial Alternative 3	
			Quantity	Total Cost
COMMON COST COMPONENTS				
Preconstruction				
1 Engineering Design, Plans, Specs, Bid	Lump Sum	$ 473,000	1	$ 473,000
2 Permitting and Regulatory submittals	Lump Sum	$ 193,000	1	$ 193,000
3 Constuctability Investgation	Lump Sum	$ 300,000	1	$ 300,000
			Subtotal	$ 966,000
			% Total Costs	2%
Construction Management				
1 Construction Oversight	Day	$ 1,044	400	$ 417,600
2 Air Monitoring during construction	Day	$ 780	400	$ 312,000
3 Air Monitoring System	Month	$ 30,000	15	$ 450,000
4 Site Survey (Preconstruction and Post-Remediation)	Acre	$ 5,000	11.2	$ 56,000
			Subtotal	$ 1,235,600
			% Total Costs	2%
General Conditions				
1 Mobilization/Demobilization	Lump Sum	$ 200,000	1	$ 200,000
2 Site Preparation (fence and shrub removal)	Lump Sum	$ 25,000	1	$ 25,000
3 Temporary Offices for construction period +3 months	Month	$ 3,000	18	$ 54,000
4 Temporary Utilities	Lump Sum	$ 25,000	11.2	$ 280,000
			Subtotal	$ 559,000
			% Total Costs	1%
REMEDIAL COMPONENTS				
Parcel I				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	104,000	$ 2,158,000
2 Import and Place Backfill	Tons	$ 16	156,000	$ 2,418,000
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	152,100	$ 13,635,765
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	10	$ 5,250
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	7,800	$ 869,310
6 Hazardous Waste Disposal	Tons	$ 209	3,900	$ 815,100
7 Dewatering System Operation and Maintenance	100 CF	$ 23	0	$ -
8 Excavation Support System	SF	$ 50	28,000	$ 1,400,000
Parcels II & III				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	82,000	$ 1,701,500
2 Import and Place Backfill	Tons	$ 16	123,000	$ 1,906,500
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	119,925	$ 10,751,276
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	10	$ 5,250
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	6,150	$ 685,418
6 Hazardous Waste Disposal	Tons	$ 209	3,075	$ 642,675
7 Dewatering System Operation and Maintenance	100 CF	$ 23	0	$ -
8 Excavation Support System (Excludes Canal Boundary)	SF	$ 50	38,000	$ 1,900,000
9 Barrier Wall & DNAPL Collection System (Unknown Configuration)	Lump Sum	$ 4,100,000	1	$ 4,100,000
Parcel IV				
1 Soil Excavation Handling and Stockpiling Soil	In Place CY	$ 21	9,400	$ 195,050
2 Import and Place Backfill	Tons	$ 16	14,100	$ 218,550
3 Non-Hazardous Waste (Landfill or Thermal treatment)	Tons	$ 90	13,748	$ 1,232,463
4 Non-Hazardous Aqueous Waste	55 Gal Drum	$ 525	10	$ 5,250
5 Bulk Solid Waste and Construction Debris	Tons	$ 111	705	$ 78,572
6 Hazardous Waste Disposal	Tons	$ 209	353	$ 73,673
7 Dewatering System Operation and Maintenance	100 CF	$ 23	0	$ -
8 Excavation Support System	SF	$ 50	9,000	$ 450,000
			Subtotal	$ 44,797,602
			% Total Costs	72%
Long term monitoring and maintenance				
1 Periodic Operations, Maintenance, Monitoring, Reporting, and Disposal	Year	$ 150,000	30	$ 2,305,868
assume I=5%			**Subtotal**	$2,305,868
			% Total Costs	4%
REMEDIAL COST SUMMARY				
Total Capital costs without contingency				$ 47,558,202
Total O & M costs				$ 2,305,868
Total Capital and O&M costs without contingency				$ 49,864,070
Contingency (25%)			25%	$ 12,466,017
			% TOTAL COSTS	20%
			TOTAL COST	**$ 62,330,087**

Remedial Alternative 3 Summary and Cost Estimate Assumptions
Carroll Gardens/Public Place (Citizens Gas Works Former MGP Site)
Brooklyn, New York

Remedial Alternative 3

Remedial Alternative 3 includes shallow excavation, MGP structure removal, and treatment/disposal of DNAPL tar source in the unsaturated zone to a nominal depth of 8 feet below the final property grade based on adjacent side street elevations, creation of a clean utility corridor to facilitate potential future development, installation and operation of a DNAPL recovery system, construction of a containment barrier, and implementation of an engineered cap/cover system.

- Approximately 1,000' of containment barrier wall will be constructed with materials to be determined by constructability analysis.
- Excavation to 8' below grade surface in Parcels I, II, and III and 11' below grade surface in the southeast portion of Parcel IV will produce nearly 200,000 cubic yards of material for offsite treatment and disposal.
- Excavation support cells will be created with approximately 75,000 square feet of steel sheeting.
- Access controls and Environmental Land Use Restriction and/or Deed Restrictions will be implemented.
- Environmental Land Use Restriction/Deed Restrictions
- Long term periodic monitoring, reporting, and maintenance are included in this remedial alternative.

It is expected this remedial alternative can be completed over 1.5 years.

Cost Estimate Assumptions:

Unit Rates for Labor

- GEI unit rates from the 9/8/05 RFB submittal were used as typical costs for report preparation and oversight costs. These rates are intended to reflect industry rates and not those of a specific consultant.

Constructability Investigation

Boring and Test Pits:

- Sonic Rotary Drilling Rig will be used to core through obstructions within the top 20 feet of overburden.
- A total of ten sonic borings at a rate of two borings completed per day. Boring depth of approximately 20 feet per boring. Plan on 5 days of sonic drilling plus 2 days contingency for a total of 7 days.
- Mud rotary borings to be advanced 125 feet below surface elevation.

- Assume a mud rotary drilling rate of 50 feet per day, approximately 3 days per boring. Plan on 30 days of mud rotary drilling plus 5 days contingency for a total of 35 days.
- After a depth of 20 feet, the remainder of the boring is to be completed using mud rotary drilling.
- Assume 1 hour of equipment decontamination and fluid handling per day.
- Assume 1 hour of overtime per day
- Assume sequence of 10 days of sonic drilling (Day 0 through Day 10)
- Assume mud rotary drilling overlaps by 6 days (Day 4 through Day 34)
- Assume test pit investigations begin after completion of sonic drilling (Day 11 through Day 31)

Analytical Laboratory Sampling/Analysis:

- Assume two chemical samples per location. 10 borings x 2 samples/boring = 20 samples.
- Assume four geotechnical samples per location. 10 borings x 4 samples/boring = 40 samples.
- Assume 0.5 hours per analysis per sample for data validation.
- Assume 20 chemical samples at 5 analyses per sample for a total of 100 analyses for validation.
- Data validation estimated to take approximately 50 hours.

Construction Management:

- One construction oversight person on site during all construction activities. (12hrs/day)
- One air monitoring oversight person on site during all remedial activities. (10hrs/day)

Remedial Components

- Assume and average depth to groundwater of 10 feet below surface.
- Assume 35 trucks per day at 18 cubic yards per truck. Total of 630 cubic yards/day.
- Costs based on similar MGP remediation project in Bronx, NY from 2006-2007.
- Assume 5% of the excavation consists of bulk solid waste and construction debris.
- Assume a total of 30 drums of Non-Hazardous aqueous waste generated.
- Assume 2.5% of material to be disposed of as Hazardous waste.
- Excavation support system consists of sheet piles driven to a depth of 10 feet beyond maximum excavation depth.
- Excavation support systems for each parcel will be independent of one another.
- Excavation support not anticipated for parcel limits adjacent to barrier wall to be installed along the Gowanus Canal.
- Excavation support is not limited to the outer boundaries of the parcel. Parcel sectioning may be necessary to manage the excavations.
- Assume sheet piles driven at a rate of 360 square feet/day (approximately 3 piles).

Long Term Monitoring Costs

- Rates based on GEI MSA with STL of Connecticut
- Assume a total of 12 monitoring wells consisting of 4 sampling rounds.
- For data validation, assume 0.5 hours per analysis per sample.
- Assuming 12 sample locations and 4 analyses per location, therefore 48 samples at 4 samples per analysis totals 192 analyses.
- The data validation is estimated to take approximately 96 hours.