GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Pre-Design Investigation Work Plan

Cutoff Wall Interim Remedial Measure Greenpoint Energy Center

Brooklyn, New York
Site No. 224052

Submitted to:
National Grid
287 Maspeth Avenue
Brooklyn, NY 11201

Submitted by:
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Abbreviations and Acronyms

ASTM	American Society for Testing and Materials
CPT	Cone Penetrometer Test
DER-10	NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation
DNAPL	Dense Non-Aqueous Phase Liquid
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
ft	Foot or feet
ft bgs	Feet below ground surface
GEI	GEI Consultants, Inc.
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IRM	Interim Remedial Action
IWP	Investigation Work Plan
LNAPL	Light non-aqueous phase liquid
MGP	Manufactured Gas Plant
MS	Microsoft
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPL	Non-aqueous Phase Liquid
NAD 83	North American Datum 1983
NAVD 88	North American Vertical Datum 1988
NYSDEC	New York State Department of Environmental Conservation
OM&M	Operation Monitoring Maintenance Plan
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance and Quality Control
RAWP	Remedial Action Work Plan
RI	Remedial Investigation
SPT	Standard Penetration Test
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
USDOT	United Sates Department of Transportation
VOC	Volatile Organic Compound

1. Introduction

On behalf of National Grid, GEI Consultants Inc. (GEI) has prepared this Pre-Design Investigation Work Plan (IWP) in support of the development of a Cutoff Wall Interim Remedial Measure (IRM) at the Greenpoint Energy Center at 287 Maspeth Avenue, Brooklyn, New York (**Figure 1**). This investigation is a component of a Remedial Investigation (RI) to be performed in accordance with the requirements set forth in the Consent Order administrated by the New York State Department of Environmental Conservation (NYSDEC). Other components of the RI will be addressed under separate cover. Upon completion of this and subsequent investigations, data findings and evaluation reports will be prepared and submitted to the NYSDEC for review. At the completion of all components of the full RI characterizing the former MGP facility, a comprehensive RI Report will be prepared incorporating the findings from all investigation tasks performed at the site.

The intent of the cutoff wall is to mitigate the potential movement of former manufactured gas plant (MGP) related non-aqueous phase liquid (NAPL) off site and into Newtown Creek and English Kills. For conceptual planning purposes, the proposed wall is assumed to consist of a 2,000 linear foot segment along Newtown Creek, and a 500 linear foot segment along Maspeth Avenue. Actual design dimensions and alignment will be based on the Pre-Design Investigation findings and presented for approval to the NYSDEC in a Remedial Action Work Plan (RAWP). This IWP is the first step in the development of a cutoff wall design, which will be summarized in an Investigation Finding Report. The design program will include the following efforts:

- Implementation of field investigations to gather geotechnical, hydrogeologic and environmental data
- Groundwater modeling and stormwater runoff analysis to define the effects of the proposed cutoff wall on the groundwater regime
- Summation of findings in an Investigation Findings Report
- The cutoff wall design defining alignment, depth and materials of construction
- A RAWP presenting the design for approval to the NYSDEC.

The IWP was developed to focus on details related to cutoff wall design, including NAPL assessment. Analytical sampling for contaminants of concern, although not required for design, will be performed at Pre-Design Investigation locations, to support the RI.

The alignment and depth of the wall will be a function of the NAPL depth encountered along the anticipated cutoff wall, from data obtained through hydrogeologic investigations, and as defined by the hydrogeologic model. Further delineation of subsurface contamination on site is not part of the Pre-Design Investigation.

The remainder of this document is divided into the following sections:

2. **Pre-Design Investigation Work Plan:** defining tasks to be completed in the development of design data and gathering of data for RI purposes.
3. **Cutoff Wall Design:** detailing the components of the design documents.
4. **Schedule:** detailing major milestones within the investigation and design program. A Microsoft (MS) project Gantt timeline of the investigation and design is included in Appendix A.

An electronic version of the approved site-specific Health and Safety Plan (HASP) is included in Appendix B. The HASP is broad in nature and is intended for use in future field investigations at the site in addition to this IWP field activities.

An electronic version of the approved Field Sampling Plan (FSP) detailing soil and sediment sampling, monitoring well installation, development and sampling, test pit excavation and sampling, equipment decontamination, and investigation derived waste handling (IDW) procedures is included in Appendix C.

An electronic version of the approved site specific Quality Assurance Project Plan (QAPP) is included in Appendix D. The QAPP has been developed to address quality control/quality assurance (QA/QC) issues and ensure the integrity of analytical data obtained during all investigations.

2. Pre-Design Investigation Work Plan

This IWP identifies proposed investigation locations, geotechnical and hydrogeologic investigation approaches and procedures, site surveys, and defines the hydrogeologic modeling approach. Test pit and geophysical assessments may also be included to help define the method of cutoff wall construction, condition of the bulkhead infrastructure, and to identify other subsurface structures of concern. The IWP includes an existing conditions assessment (subsection 2.1), subsurface investigation and laboratory testing (subsection 2.2) and hydrogeologic modeling (subsection 2.3).

The investigation will provide geotechnical, hydrogeologic, and environmental data, an assessment of existing conditions and wall conflicts, and delineation of the vertical and horizontal extent of NAPL along the proposed wall alignment. Review of available site subsurface data, including previous geotechnical and environmental subsurface investigations, bulkhead design documents, utility drawings, and related documents available from agency postings has been performed. However, due to the relative size and history of the site, the availability of additional relevant site records and documentation will require further research. New information may be used to refine parts of this work plan as it becomes available. Specifically, information relating to the historical MGP plant infrastructure footprint and current/former stormwater management systems is being sought for inclusion in the hydrogeologic model of the site.

The cutoff wall design will be partially based on predicted hydraulic performance. Because the proposed wall will cut off groundwater flow, the design may include a groundwater extraction system upgradient of the wall. A hydrogeologic study is proposed to measure groundwater flow gradients, water level elevations, influence of utilities and stormwater infiltration, and tidal influence that may affect or be affected by the cutoff wall. The hydrogeologic study will support a groundwater model for remedial design.

The hydrogeologic study is designed to identify groundwater flow patterns that may influence or be influenced by the proposed cutoff wall. Currently, groundwater flow may be influenced by several conditions that will be investigated under this IWP. The groundwater flow system is likely influenced by many factors as outlined herein. A preliminary review of available groundwater elevations coupled with the proximity of the site to tidal waters and historical marsh indicate that the groundwater table is relatively flat. The former Newtown Creek shoreline was several hundred feet inland to the west of the present-day Newtown Creek, with Mussel Island offshore to the east (**Figure 2**). The historic fill in this area may affect groundwater flow patterns. Pre-MGP topography suggests that shallow groundwater may converge toward the former channel, or along the former Newtown Creek wetlands

complex to the east. There may be a component of flow toward the English Kills, southeasterly from higher ground north and west of the former MGP. Storm drainage systems and process piping may create preferential pathways for shallow groundwater movement and recharge. A low-permeability meadow mat (former wetland surface) and clay layer beneath fill in some locations may serve as a confining unit. Deeper groundwater flow direction may have a westerly or northerly component, due to expected westerly regional flow off Long Island toward the East River, or potential northerly flow along the course of Newtown Creek.

A total of 16 monitoring wells from previous investigations are known to exist on site and appear to be functional (**Table 1**). The existing wells are located in three groupings:

- West of the former MGP, five wells (MW-2 through MW-5, and an unnamed well);
- North of the former MGP, four shallow/deep pairs (MW-1S/D through MW-4S/D); and
- Southeast of the former MGP along Maspeth Avenue, three wells (W-1 through W-3).

The northern well grouping was installed during an IRM investigation completed in March 2005. Installation details for the other two well groupings were not available. Five other wells reportedly existed on site, but could not be found during the June 2008 gauging (MW-5S/D in the northeast grouping, W-4 and GPW-7 along Maspeth Avenue, and MW-1 in the northwest grouping).

GEI gauged the existing wells on June 16, 2008. The measurements indicate a relatively flat gradient; however, an accurate survey is needed to determine groundwater flow direction. A slight downward gradient was observed in the northern well grouping, where well pairs were screened above and below low-permeability soil. However, because the measurements represent one-time readings, additional study is needed to assess the average gradient relative to tide cycles. Due to the limited data available from the existing wells, additional study of the groundwater gradient will be required before a final selection is made on the location of new monitoring wells. This effort is addressed as Task 2 of the subsurface investigation as discussed in subsection 2.2.

2.1 Existing Conditions Assessment

2.1.1 Site Property Survey

A property survey will be performed along the alignment of the proposed cutoff wall to provide a base plan for the design drawings and establish existing conditions and elevations. The survey will consist of a topographic survey, a boundary survey, and a surface and subsurface survey of existing utilities along the alignment. Aerial photography will likely be used to provide the base for the topographic survey with supplemental field locations

obtained in obscured areas. A boundary survey will be performed to locate property lines and corners along the cutoff wall alignment. All locations and elevations will be referenced to the New York State Plane Eastern Zone (3104) North American Datum 1983 (NAD83) and North American Vertical Datum (NAVD 88). An easements search will be performed as part of the utility survey. Available historical infrastructure records including on-site and adjacent historical utility records will be reviewed. This will include a review of plans from local private utility companies, National Grid, and Borough municipal utilities (water, sewer, etc.) as well as applicable county and/or state records. After the records review is complete, a utility markout will be called into the New York City One Call Center. The identified utilities and manhole invert elevations (where accessible) will then be surveyed and documented on the base site map. The existing explorations and historical data will be overlaid as needed. If needed, historical subsurface structures along the proposed wall alignment will be field demarcated based upon the historical plans and records and related to common features that are currently on the site. Following this mark out, test pits may be excavated to verify the presence and locations of the historical features to determine the potential degree of interference with construction of the proposed wall. Because of the size and complex history of the site, not all the site utilities, such as minor branches and connections, will be surveyed.

2.1.2 Utility Geophysical Survey

A utility documentation and geophysical survey may be appropriate to identify investigation and construction subsurface conflicts with existing utilities and structures that could not be validated under the utility markout effort noted above, or requiring more precise delineation due to potential conflicts with the proposed cutoff wall. The utilities would be located on site using ground penetrating radar and electro-magnetic pipe, cable and box locators. Once the utilities are located, the horizontal and vertical location of each utility will be surveyed and documented on the site basemap.

2.1.3 Stormwater System Evaluation

A document review and site reconnaissance will be performed to assess locations of current and possible historical subsurface drainage features that may affect the groundwater flow direction and serve as potential preferential flow conduits. This information will also be used for drainage design calculations and associated permitting for the cutoff wall. Topography, drainage utilities, and former production piping will be mapped to confirm or refine monitoring well locations. Ground cover type and topographic low points will be mapped to identify potential surficial influences on the water table. Geophysics and confirmation of historical features through test pits, may be necessary to confirm the location, depth, and interconnectedness of historical drainage systems.

2.2 Subsurface Investigations and Laboratory Testing

Field investigations will be conducted to acquire hydrogeologic, geotechnical, and environmental data. An aquifer pumping test will also be performed to acquire aquifer yield data and to assess the potential presence of hydrogeologic boundary conditions related to the heterogeneity of the former creek channel, wetland complex, and historical infrastructure beneath the site. These data will be necessary to adequately estimate the potential volume of groundwater collection and/or treatment related to installation of the proposed containment wall. The field investigation will consist of two tasks:

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- Task 1 (Hydrogeologic Study) will consist of an initial groundwater elevation survey of existing wells, installing new monitoring wells located to define potential flow gradients, NAPL assessment, stormwater evaluation, and an aquifer pumping test.
- Task 2 (Geotechnical Study) will consist of cone penetrometer and/or conventional borings, geotechnical laboratory testing, and if necessary, piezometer installation and test pit excavations.

Both tasks will include analytical chemical testing for contaminants of concern in associated borings and monitoring wells, in support of the RI. Figure 2 shows approximate proposed boring and well locations, subject to change based on initial findings and accessibility. Supplemental locations will be determined based on preliminary findings.

2.2.1 Task 1 - Hydrogeologic Study

An attempt will be made to verify the existence of unfound wells. The condition of the existing wells will be evaluated and the wells will be redeveloped if necessary. In the event well construction details and/or associated boring logs are not available, a video survey of existing wells will be performed to identify screen depth intervals, and borings may be advanced during subsequent phases adjacent to existing well clusters to assess the localized geologic setting. The existing wells and a tidal gauging point will be surveyed by a licensed surveyor relative to the datum established under subsection 2.1. Groundwater elevations will be measured at existing wells to form a preliminary groundwater contour map. Gauging for the presence of NAPL will be performed at all monitoring well locations. Tidal fluctuations will be measured in select monitoring wells and in Newtown Creek.

To gather hydrogeologic data for the groundwater model, installation of monitoring wells at 13 locations is proposed (**Figure 2**). The five monitoring well borings closest to Newtown Creek will be extended to a minimum of 100 feet below ground surface (ft bgs) and at least 10-feet below the deepest MGP-related contaminant observed in the borehole, based on field screening described in the FSP. The remainder of the monitoring wells will be advanced to a minimum of 50 ft bgs, and at least 10-feet below the deepest MGP-related contaminant observed in the borehole. Upon completion of the soil borings, monitoring wells will be

installed to depths appropriate to gather hydrogeologic data as detailed below and the remainder of the boring will be tremie grouted to depth using a cement/bentonite slurry mixture. Following installation, groundwater elevations will be measured at all monitoring wells. Aquifer parameter tests will be performed including slug tests, infiltration tests, and aquifer pumping tests. The aquifer testing is described below in subsection 2.2.2.4.

Note that the five monitoring well borings to be advanced to a minimum of 100 ft below ground surface are located inboard of the bulkhead-dock structure along the creek. The structure consists of a pile-supported timber dock 40-feet wide capped with about 7-feet of soil fill. Rip-rap has been placed along the inboard edge of the dock, which slopes inland below grade, potentially an additional 25-feet. Therefore, the borings are proposed to be set approximately 65-feet inboard of the bulkhead face to be in historic fill and natural formation along the creek shoreline. The proposed placement of the borings 65-feet inboard of the bulkhead is considered as close to the shoreline as practical to obtain relevant subsurface data. Existing utilities and operational features will also affect the final location of these and other bulkhead-dock structure borings.

The monitoring wells installed just inboard of the bulkhead-dock structure are to identify flow patterns relative to the former Newtown Creek, and English Kills to the south, the wells in central and western portions of the site are to further define hydraulic gradients, establish model boundary conditions, and assess potential off-site influences. Actual locations may be modified based on interim findings as the field effort and document review progresses. One water table monitoring well is planned at each location, and intermediate zone monitoring wells will be installed at approximately half of the locations, to define conditions related to potential confining layers. Supplemental monitoring wells will be installed to investigate areas of concern based on initial findings.

Shallow monitoring wells will be screened as water table wells above the meadow mat (if present). Nominally, intermediate monitoring wells will be screened below the meadow mat or other potential confining lenses, to define vertical gradients and variation in flow direction with depth. Care will be taken to evaluate the site stratigraphy and prevent dense non-aqueous phase liquid (DNAPL) migration below apparent confining layers. Deeper monitoring wells will be placed in the same or apparent similar hydrostratigraphic zones as suggested by the presence and elevation of possible semi-confining layers. Monitoring wells will be developed in accordance with the FSP.

Soil samples will be collected and logged continuously from each boring location in accordance with the FSP. Deep drilling through impacted zones will use telescoped casing to ensure that there is no vertical migration of DNAPL caused by the drilling. Specifically, the upper potentially-impacted units would be cased and sealed into a lower, more confining unit. Drilling methods and procedures are described in the FSP.

The locations and elevations of the new monitoring wells and borings will be surveyed. Two rounds of groundwater elevation readings will be taken at all monitoring wells, each round at both high and low tide. A full tidal study will be performed, consisting of 24-hour water level monitoring at select wells and tidal elevations in Newtown Creek using dataloggers. Rising head slug tests will be performed at all monitoring wells adjacent to Newtown Creek and at select upland locations to assess the hydraulic conductivity at each monitoring well location. Further details of field procedures are presented in the attached FSP.

Drilling equipment (i.e., drilling rods, auger, casing, and/or macro-core sampler) will be decontaminated between each sample location. Soil cuttings and decontamination fluids will be collected in 55-gallon United States Department of Transportation (USDOT) drums, lined roll-off dumpster or fractionation tank and will be disposed of by National Grid following characterization.

2.2.1.1 Laboratory Chemical Testing

To support RI characterization efforts, soil and groundwater samples collected during the investigation will be tested for chemical contaminants potentially associated with the former MGP operations, other historical operations, and for treatment and waste characterization purposes. Samples will be analyzed by a New York State Environmental Laboratory Accreditation Program (ELAP)-certified laboratory.

Up to three soil or sediment samples per boring will be selected for chemical analysis as follows.

- The depth interval indicating the greatest apparent degree of contamination within 5 feet of ground surface, to characterize the utility depth interval.
- The depth interval indicating the greatest degree of impacts over the depth of the boring.
- For intermediate zone monitoring well locations, a sample will be collected at the depth of the center of the well screen.
- The boring termination depth.
- If no evidence of contamination is observed, then a sample will be collected from the depth of the observed groundwater table.

Soil or sediment samples will be collected over approximate 2-foot depth intervals. The greatest degree of contamination will be identified by photoionization detector (PID) screening and by visual and olfactory observations. Field screening procedures are described in the FSP.

Each soil or sediment sample will be analyzed for:

- Volatile organic compounds (VOCs) by the United States Environmental Protection Agency (EPA) SW-846 method 8260B
- Semivolatile organic compounds (SVOCs) by EPA method 8270C
- Target Analyte List (TAL) metals by EPA method 6000/ 7000 series;
- Polychlorinated biphenyls (PCBs) by EPA method 8082.
- Free cyanide extraction by EPA method 9013A and analysis by Microdiffusion, American Society for Testing and Materials (ASTM) method D4282-02.
- Hexavalent chromium by EPA method 3060A/7196
- Total organic carbon by EPA method 9060 (select samples)

Monitoring wells will be sampled for site contaminants of concern. Monitoring wells will be purged and sampled in accordance with the FSP. All monitoring wells will be sampled, with the exception of closely-spaced wells installed for monitoring groundwater fluctuations around utilities and for pumping testing (described further below in subsections 2.2.2.3 and 2.2.2.4). For closely-spaced well clusters, one shallow and one deep well within each cluster will be selected for sampling. Each groundwater sample will be analyzed for:

- VOCs by EPA method 8260B
- SVOCs by EPA method 8270C
- TAL metals by EPA method 6000/7000 series
- PCBs by EPA method 8082
- Total cyanide by EPA Method 9012B
- Free cyanide extraction by EPA method 9013B and analysis by Microdiffusion, ASTM method D4282-02
- Hexavalent chromium by EPA method 7196

If DNAPL accumulation is present in any well, no groundwater sample will be collected for laboratory analysis.

QA/QC procedures are detailed within the QAPP (Appendix D). QA/QC samples will include blind duplicate soil or sediment samples, Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, and equipment rinsate blank samples. The quality control samples will be completed on a frequency of 1/20 per matrix. An approved ELAP laboratory will perform the analyses. One trip blank will be included per shipment of samples to the laboratory.

2.2.1.2 NAPL Assessment

A NAPL [either DNAPL tar, or light non-aqueous phase liquid (LNAPL) hydrocarbons] assessment will be performed to evaluate the distribution, potential recoverability, physical and chemical characteristics of the material. All wells potentially containing NAPL based on boring observations will be gauged using an oil/water interface probe. If measurable NAPL is observed, then the NAPL will be bailed or pumped from the well and the volume of bailed material will be recorded. All NAPL removed from a well will be containerized for disposal. The recovery rate of the NAPL will be assessed through periodic measurements with an oil/water interface probe. Recovered NAPL will be examined and described by the field representative. If present, up to three samples of DNAPL tar will be collected and analyzed for waste characterization purposes, and to determine the density and viscosity of the DNAPL.

2.2.1.3 Stormwater Evaluation

A stormwater evaluation is proposed to:

- Assess the affect of potential preferential groundwater flow pathways along major utility corridors.
- Assess the affect of buried structures and impervious areas on groundwater flow sitewide.

Groundwater flow may be influenced locally by buried conduits, concrete foundations, and ponding at topographic low points. In addition, former stream channels and backfill around storm sewers may serve as preferential groundwater flow pathways. A study is proposed to investigate potential preferential flow pathways along Maspeth Avenue and along the central utility corridor for the former MGP process area (along the Stores Building and Service Building, Figure 2). The Maspeth Avenue corridor was chosen because it contains a 48-inch-diameter drain, which is the largest known drain at the site and, therefore, has the greater potential to result in measureable effects. The central utility corridor for the former plant (along the Stores Building and Service Building) contains two 36-inch drains and a variety of other utilities, which collectively have a higher potential to measurably affect groundwater flow.

A series of monitoring wells will be installed adjacent to and at specified distances from the utility corridors. Piezometers are proposed within or adjacent to the utility corridors, and at 50 and 125 feet from (perpendicular to) the utility corridor to assess drawdown or mounding approaching the corridors (Figure 2). Actual piezometer distances may vary depending on accessibility and soil type. Control locations will be selected further from the potential influences. Water level elevations will be logged electronically up to a 60 day period to capture storm events, tidal and barometric pressure affects, and associated fluctuations caused by potential leakage into or out of the drains.

Sitewide, if at any point in the pre-design investigation the potential for significant localized influences on the water table is identified, such as mounding due to water retention in pervious areas or buried structures, further infiltration studies may be performed.

Soil and groundwater samples may be collected from the infiltration study borings and monitoring wells at National Grid's discretion.

2.2.1.4 Aquifer Testing

Aquifer testing will be performed to evaluate groundwater response to pumping stress. Available information suggests that the flow boundaries along the former shoreline, anisotropy within the former stream channel, and connectivity between shallow and intermediate groundwater zones may significantly affect flow.

Following installation of the proposed monitoring wells (described earlier in this work plan), assessment of the groundwater contour patterns, and evaluation of potential variability in hydrostratigraphic units across the site, GEI will develop an aquifer pumping test work plan detailing the design of the pumping test, wells to be monitored, and the management, treatment, and disposal methods of extracted groundwater. The pumping test work plan will be submitted to NYSDEC for review and approval prior to start of the pumping test.

As an overview, the proposed pumping test location will be at the edge of the former mud flats adjacent to the former MGP process area, where effects of the mud flat shoreline and abandoned facilities may be observed. Aquifer testing will likely consist of two step-drawdown tests: one pumping from the shallow screened zone, and one from the intermediate zone. Pumping test duration is expected to be of 30-hour, or less, if steady-state drawdown is observed in shorter time. Two temporary pumping wells (shallow and intermediate) and a network of monitoring wells will be installed at the proposed test location (Figure 2). Based on expected soil permeabilities, we propose installing monitoring wells at 10, 20, 40, and 80 feet from the pumping well in two directions, and at shallow and intermediate depth zones. Specific monitoring well locations and screening depths will be specified in the pumping test work plan.

Aquifer testing may require permits related to groundwater withdrawal and recharge or discharge to sewer depending on anticipated volume of water pumped. If a relatively low volume is anticipated, off-site disposal may be adequate.

2.2.2 Task 3 - Geotechnical Investigation

The geotechnical investigation will initially consist of advancement of 22 soil borings to evaluate constructability and design of the cutoff wall. The geotechnical borings will be advanced along the conceptual cutoff wall alignment (Figure 2) using cone penetrometer tests (CPTs) or conventional (hollow-stem auger, rotary, sonic) drilling methods.

Supplemental borings may be advanced along a more specific wall alignment or at closer spacings to be defined based on the initial geotechnical and hydrogeological findings.

The borings will be advanced to a minimum of 50 ft bgs or at least 10-feet below the deepest MGP-related contaminant observed in the borehole, based on field screening described in the FSP, whichever is deeper. Upon completion, the soil borings will be tremie grouted to grade using a cement/bentonite slurry mixture or completed as monitoring wells.

Geotechnical testing will include Standard Penetration Tests (SPT) and split barrel sample collection. Sampling will be performed continuously through fill materials and at 5-foot intervals in native deposits. Soil samples will be logged in accordance with Unified Soil Classification System. If encountered, organic and fine-grained soil will be sampled using a thin-walled sampler. Index tests, consisting of grain-size analyses (including hydrometer analyses), organic content, Atterberg Limits and moisture content, will be performed on representative soil samples. Unconsolidated-undrained triaxial compression tests will be performed on cohesive soil samples.

If conditions permit, cone penetrometer tests (CPTs) maybe substituted for selected boreholes. CPTs can provide a rapid assessment of soil stratigraphy, relative density, strength, and equilibrium groundwater pressures within certain subsurface conditions.

Any deep borings that penetrate tar-impacted zones will be telescoped to prevent vertical communication of DNAPL caused by the drilling. Specifically, the upper potentially-impacted units would be cased and sealed into a lower, more confining unit, if encountered. Drilling methods and procedures will be consistent with the FSP.

Up to three soil samples per boring will be selected for chemical analysis (excluding CPT borings), at the depth intervals and parameters described for the hydrogeologic investigation (Section 2.2.1) except for borings within Newtown Creek. For borings within Newtown Creek, sediment samples may be collected to represent the benthic zone or impacted sediments, in place of the utility corridor depth interval.

Decontamination will be performed as described in the FSP.

Since a portion of the borings will be advanced within Newtown Creek, it is anticipated that a barge mounted drill rig will be necessary. Permits will include Coast Guard, Corps of Engineers, and local law enforcement approval as appropriate.

Test pits may be excavated along the existing bulkhead to confirm the geometry of the existing wall and identify other potentially significant features. The need for test pits will be determined after soil boring and utility data are collected and evaluated. Test pits, if

excavated, will be performed according the FSP. Soil may be sampled for chemical analysis at National Grid's discretion.

2.3 Hydrogeologic Modeling

A three-dimensional model will be developed and calibrated using Visual MODFLOW, a proprietary interface which runs the public-domain MODFLOW code developed by the U.S. Geological Survey. The model will be based on the collected hydraulic head data, site stratigraphy, regional hydrogeologic data, and aquifer test parameters based on the results of the pumping tests and in-situ hydraulic conductivity tests. The proposed wall will be modeled at various depths and locations, with wing walls as needed. Groundwater mounding, and flow around or beneath the wall will be evaluated. For proposed wall layouts that may cause unacceptable mounding or flow around the wall, configuration modification, groundwater control or extraction systems will be modeled.

The model will assess effects of precipitation recharge and conduits found to significantly influence groundwater flow. The proposed model will include saturated groundwater flow only. No transport of dissolved contaminants or NAPL will be simulated in the model.

2.4 Investigation Findings Report

Once the subsurface explorations are complete, an Investigation Findings Report will be prepared. The report will summarize the geotechnical and hydrogeologic data, the available information on existing utility locations, topographic and boundary survey, analytical soil, sediment, and groundwater data, and other data collected during the pre-design activities. The report will describe the subsurface explorations and soil sampling methods used, summarize the geotechnical laboratory testing data collected, summarize the NAPL location data collected, include an exploration location plan, and include interpreted subsurface profiles. The extent of NAPL intended to be addressed by the cutoff wall will be depicted in the report. In addition, the groundwater model baseline calibration and relevant iterations depicting the affects of cutoff wall configurations will be presented in support of the conceptual wall configuration selection.

The report will be used in support of the design effort and will be provided to contractors for preparation of bids and construction. The report will be submitted to the NYSDEC as an informational document. A meeting with the NYSDEC is proposed to present and discuss the findings prior to initiation of wall design activities. Information within the report in conjunction with additional site investigations will be submitted to the NYSDEC as a Remedial Investigation Report.

3. Cutoff Wall Design

This section presents the approach to the Remedial Action Work Plan for the cutoff wall IRM. The process is divided into two work plan deliverables in general accordance with NYSDEC *Technical Guidance for Site Investigation and Remediation DER-10*. Each work plan is detailed below. A sheet pile cutoff wall is anticipated. However, alternative methods may be required in select locations due to subsurface conditions, obstructions or utilities.

At this point, a field constructability analysis has not been considered. However, this step may be required based on the findings of the IWP.

3.1 Draft Remedial Action Work Plan

The initial design submittal to the NYSDEC will be the Draft RAWP detailing the IRM. This submittal will contain draft versions of the cutoff wall construction approach, wall location and configuration, engineering drawings, and technical specifications. The work plan will include the following components:

- Design criteria of the cutoff wall system
- Movement criteria and geotechnical monitoring requirements
- Groundwater control and treatment
- Noise and vibration criteria and monitoring requirements (as applicable)
- Community air monitoring requirements (as applicable)
- Preliminary Permits Evaluation
- Engineering Plans (preliminary design drawings)
- Technical specifications (preliminary)

Comments from the NYSDEC on the draft work plan will be addressed in the Final RAWP.

3.2 Final Remedial Action Work Plan

The Final RAWP will be prepared after receipt of the NYSDEC comments. After the NYSDEC comments are received, National Grid and GEI will meet with the NYSDEC to discuss our responses to their comments. Once all responses are accepted by the NYSDEC, the Final RAWP will be prepared and submitted to the NYSDEC.

The Final RAWP will include those items noted in the draft submittal as edited plus the additions/modifications that follow:

- Final Engineering Plans and Technical Specifications
- Draft Operation Monitoring Maintenance Plan (OM&M) Plan for ongoing activities to be performed after the completion of the IRM
- Opinion of Cost estimate for construction of the IRM. Since contractor's means and methods may vary from the Engineer's assumption, the cost estimate will vary from the remedial contractor's costs.
- Schedule for completion of the IRM

4. Schedule

A draft schedule detailing the development of the RAWP is presented in Appendix A. The schedule targets a start date for field investigation activities of February 2009.

Table

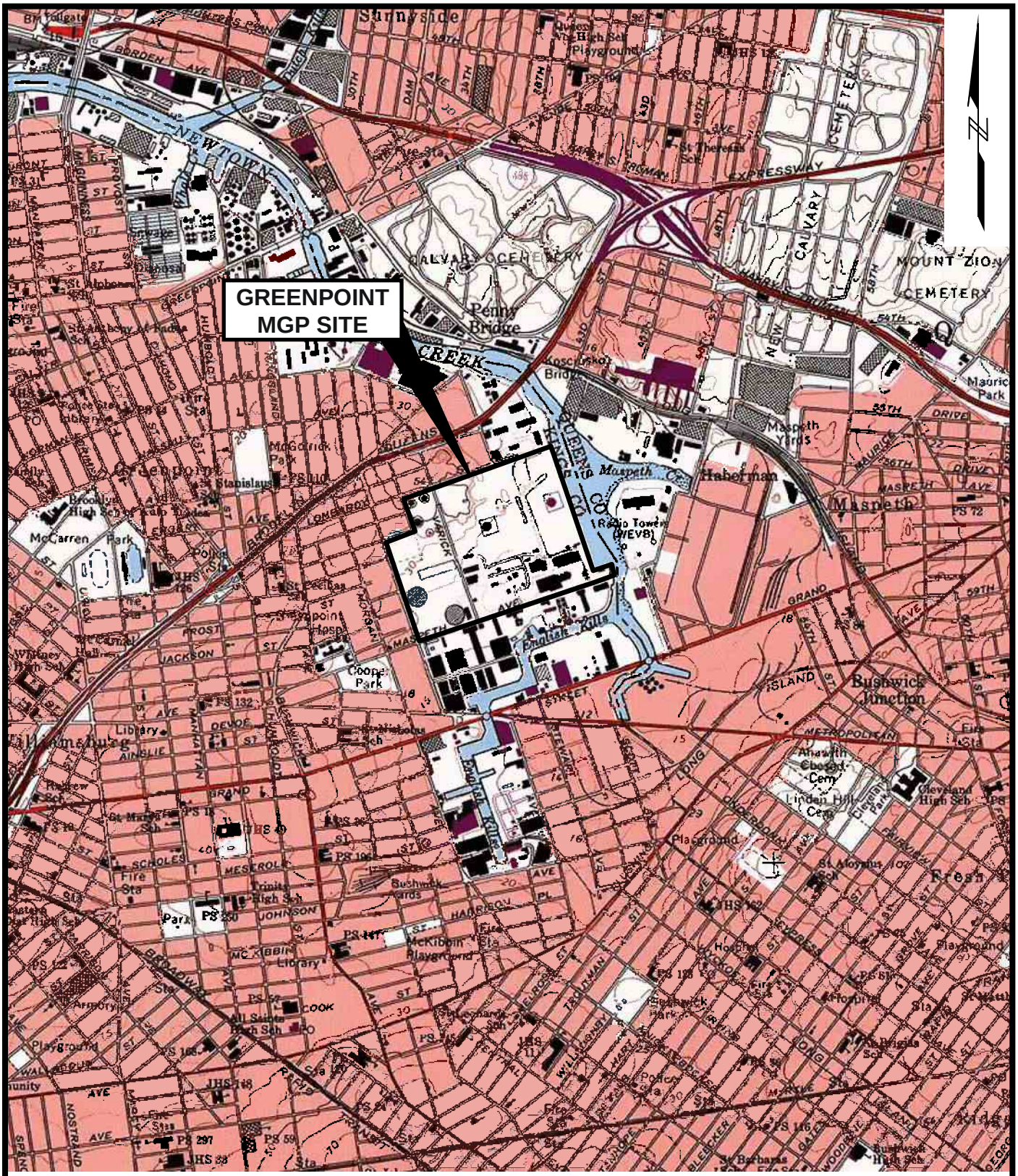
Table 1
Existing Monitoring Well Summary
Greenpoint Energy Center
Brooklyn, New York

Monitoring Well Name	Well Depth, ft bgs	Screen Length, ft	Associated Boring	Existence Verified[1]
Northeast Corner IRM Well Grouping				
GPE-MW-1S	26	10	GPE-MW-1S/1D	Yes
GPE-MW-1D	55.5	10	GPE-MW-1S/1D	Yes
GPE-MW-2S	12	10	GPE-MW-2S/2D	Yes
GPE-MW-2D	40.5	10	GPE-MW-2S/2D	Yes
GPE-MW-3S	12	10	GPE-MW-3S/3D	Yes
GPE-MW-3D	40	10	GPE-MW-3S/3D	Yes
GPE-MW-4S	12	10	GPE-MW-4S/4D	Yes
GPE-MW-4D	40	10	GPE-MW-4S/4D	Yes
GPE-MW-5S	26	10	GPE-MW-5S/5D	No
GPE-MW-5D	55	10	GPE-MW-5S/5D	No
North Varick Street Well Grouping				
MW-1	Unknown	Unknown	Unknown	No
MW-2	53	Unknown	Unknown	Yes
MW-3	49	Unknown	Unknown	Yes
MW-4	45	Unknown	Unknown	Yes
MW-5	10	Unknown	Unknown	Yes
Well	49	Unknown	Unknown	Yes
Central Maspeth Avenue Well Grouping				
W-1	20	Unknown	Unknown	Yes
W-2	20	Unknown	Unknown	Yes
W-3	18	Unknown	Unknown	Yes
W-4	Unknown	Unknown	Unknown	No
Maspeth/South Varick Well Grouping				
GPW-7	Unknown	Unknown	Unknown	No

Note:
ft bgs - feet below ground surface

[1] Monitoring wells identified during site reconnaissance on June 16th, 2008

Figures



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

0 2000 4000

SCALE, FEET

PRE-DESIGN INVESTIGATION WORK PLAN
GREENPOINT ENERGY CENTER
BROOKLYN, NEW YORK

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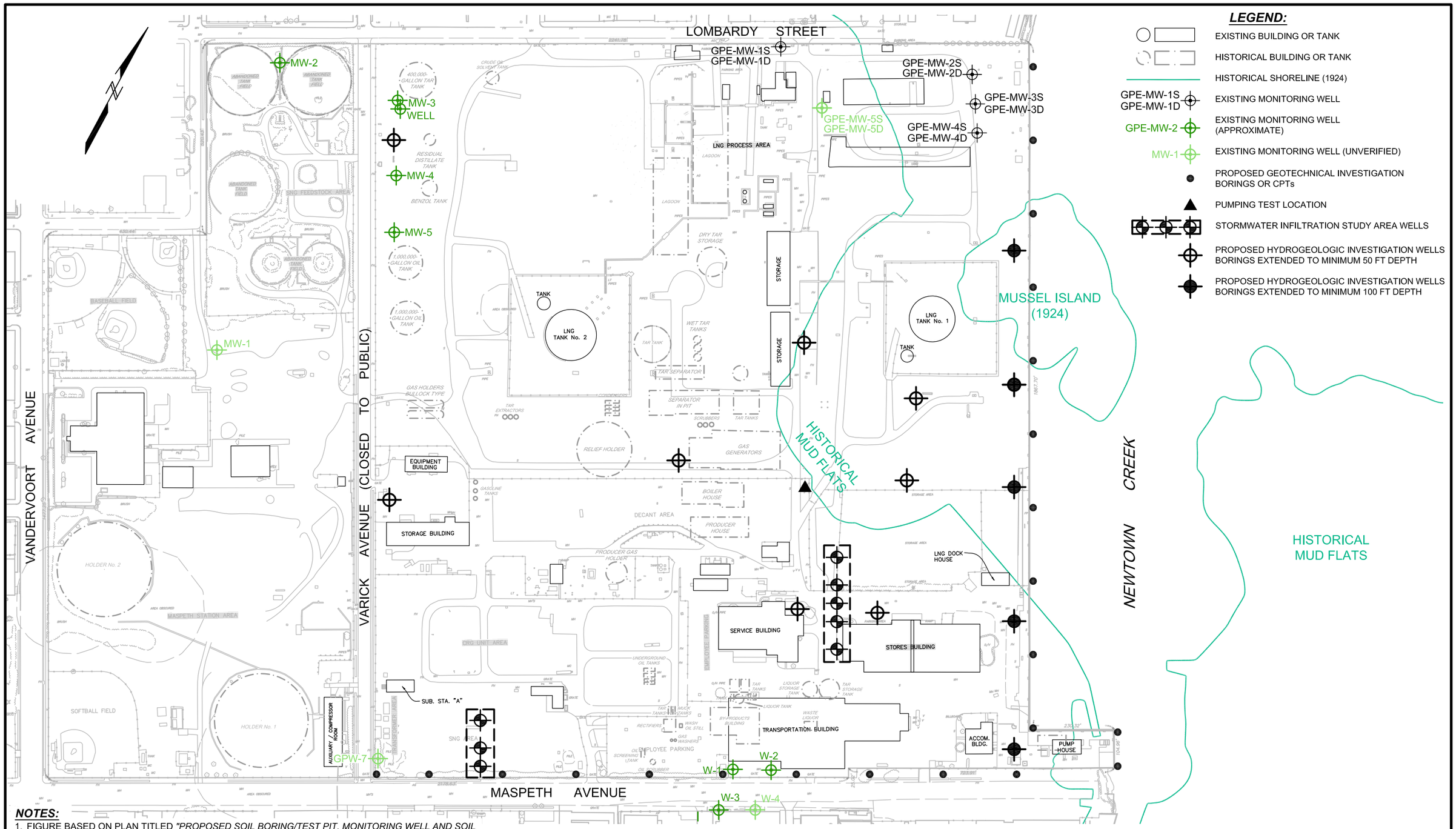
PROJECT 081200

SITE LOCATION MAP

January 2009 Figure 1

NATIONAL GRID\GREENPOINT\PDI WORKPLAN\GREENPOINT-LOC.PPT



NOTES:

1. FIGURE BASED ON PLAN TITLED *"PROPOSED SOIL BORING/TEST PIT, MONITORING WELL AND SOIL GAS SAMPLE LOCATIONS SITE PLAN,"* BY PAULUS SOKOLOWSKI AND SARTOR ENGINEERING, PC DATED OCT. 2004.
2. HISTORIC SHORELINE FROM *PORT FACILITIES AT PORT OF NEW YORK, NEWTOWN CREEK,* PREPARED BY US ENGINEER OFFICE, FIRST DISTRICT, NEW YORK CITY, DATED JUNE 1924, SCALE: 1" = 100' FEET.
3. PROPOSED BORING/PIEZOMETER LOCATIONS SUBJECT TO CHANGE BASED ON FINDING OF INITIAL GROUNDWATER SURVEY FROM EXISTING WELL (PHASE 1 OF IRM INVESTIGATION).
4. UNVERIFIED WELLS WERE NOT LOCATED DURING GEI SITE RECONNAISSANCE VISIT ON JUNE 16, 2008.

0 250 500

SCALE, FEET

PRE-DESIGN INVESTIGATION WORK PLAN
GREENPOINT ENERGY CENTER
BROOKLYN, NEW YORK

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FIELD INVESTIGATION PLAN

Project 081200 | January 2009 | Figure 2

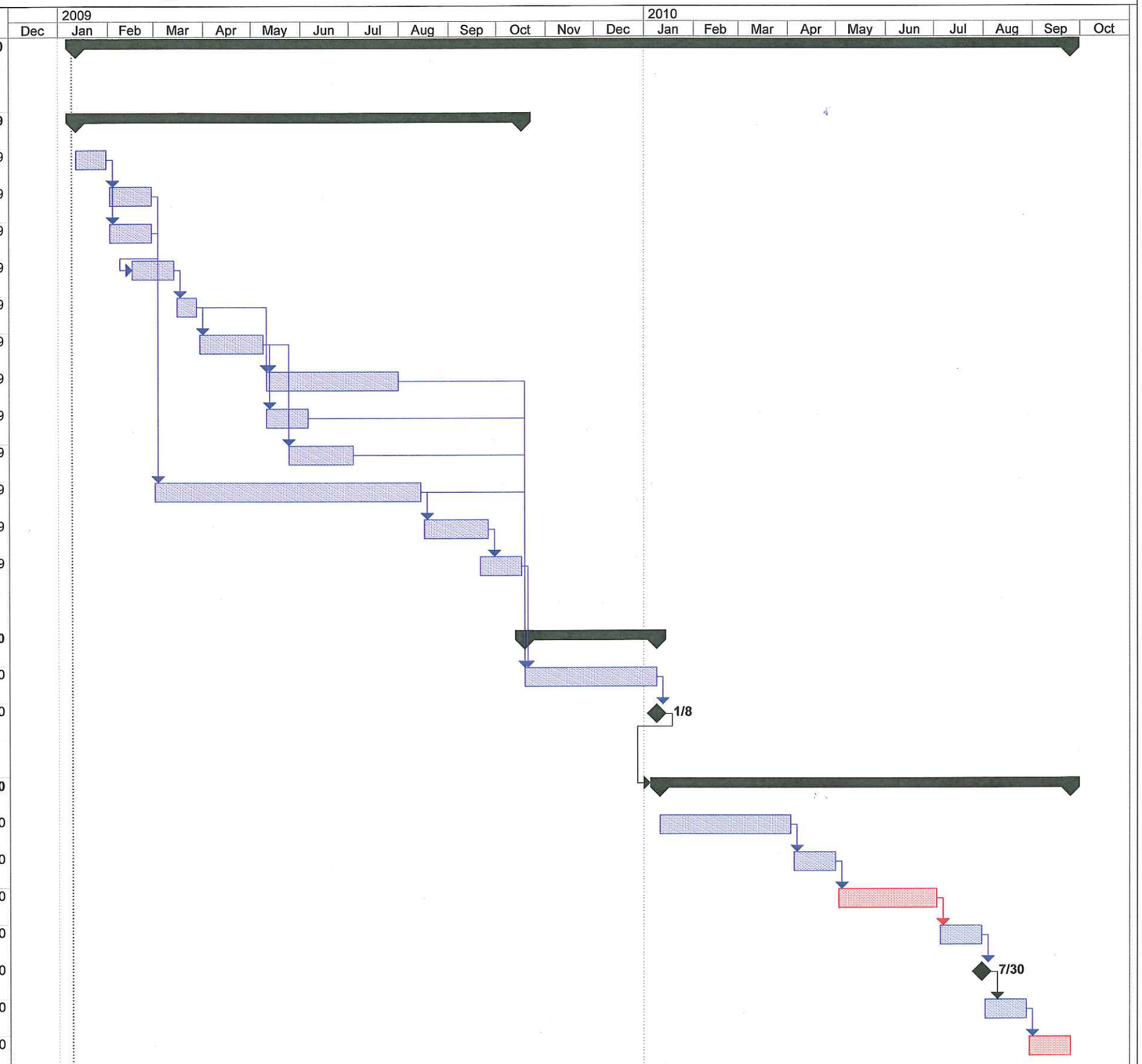
I:\GEI\National Grid\Greenpoint\PDI Work Plan\ Greenpoint-Proposed.dwg \Jan 09, 2009

Appendix A

Schedule

Cutoff Wall Remedial Action Work Plan
Greenpoint Energy Center
Working Schedule

ID	Task Name	Duration	Start	Finish
1	**Program Duration**	**445 days**	**Mon 1/12/09**	**Fri 9/24/10**
2				
3	**Pre-Design Investigation**	**200 days**	**Mon 1/12/09**	**Fri 10/16/09**
4	Mobilization	3 wks	Mon 1/12/09	Fri 1/30/09
5	Existing Well Redevelopment, Survey and Monitoring	4 wks	Mon 2/2/09	Fri 2/27/09
6	Property/Topo Survey	4 wks	Mon 2/2/09	Fri 2/27/09
7	Subsurface Utility Location/Clearing	4 wks	Mon 2/16/09	Fri 3/13/09
8	Utility/Geophysical Survey	2 wks	Mon 3/16/09	Fri 3/27/09
9	Hydrogeologic and SW Evaluation Well Installation	6 wks	Mon 3/30/09	Fri 5/8/09
10	SW System Evaluation	12 wks	Mon 5/11/09	Fri 7/31/09
11	Chemical Lab Testing	4 wks	Mon 5/11/09	Fri 6/5/09
12	Groundwater Monitoring, Slug Tests, Pumping Test	6 wks	Mon 5/25/09	Fri 7/3/09
13	Groundwater Modeling	24 wks	Mon 3/2/09	Fri 8/14/09
14	Geotechnical Borings	6 wks	Mon 8/17/09	Fri 9/25/09
15	Geotechnical Lab Testing	4 wks	Mon 9/21/09	Fri 10/16/09
16				
17	**Reporting and Approach Development**	**60 days**	**Mon 10/19/09**	**Fri 1/8/10**
18	Investigation Findings Report	12 wks	Mon 10/19/09	Fri 1/8/10
19	Findings Meeting with NYSDEC	0 days	Fri 1/8/10	Fri 1/8/10
20				
21	**RAWP Development**	**185 days**	**Mon 1/11/10**	**Fri 9/24/10**
22	Cutoff Wall Design Development	12 wks	Mon 1/11/10	Fri 4/2/10
23	75% Design: National Grid Review, Edits, Submittal	4 wks	Mon 4/5/10	Fri 4/30/10
24	75% Design: NYSDEC Review and Comments	9 wks	Mon 5/3/10	Fri 7/2/10
25	95% Design: National Grid Review, Edits	4 wks	Mon 7/5/10	Fri 7/30/10
26	Final Comments Meeting with NYSDEC	0 days	Fri 7/30/10	Fri 7/30/10
27	RAWP Finalization	4 wks	Mon 8/2/10	Fri 8/27/10
28	Final RAWP: NYSDEC Review and Approval	4 wks	Mon 8/30/10	Fri 9/24/10



Appendix B

Health and Safety Plan (HASP) [electronic only]

Appendix C

Field Sampling Plan (FSP) [electronic only]

Appendix D

Quality Assurance Project Plan (QAPP) [electronic only]