Appendix I

Geophysical Survey

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICAL SURVEY
FULTON MUNICIPAL WORKS FORMER MGP SITE
GOWANUS CANAL
BROOKLYN, NEW YORK

Prepared for:

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Prepared by:

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File 12AM10
October, 2012

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October 4, 2012
File 12AM10

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RE: Utility Location Services
Fulton Municipal Works Former MGP Site
Gowanus Canal
Brooklyn, New York

Dear Ms. Royko:

In this report, we summarize the results of a geophysical survey conducted in June and August, 2012 by Hager-Richter Geoscience, Inc. (H-R) at the Fulton Municipal Works Former MGP Site for GEI Consultants, Inc. (GEI). The scope of the project and areas of interest were specified by GEI. The geophysical survey is part of an environmental investigation by GEI.

INTRODUCTION

The Fulton Municipal Works Former MGP Site is part of a former manufactured gas plant located near the Gowanus Canal in Brooklyn, New York. Figure 1 shows the general location of the site. The site is bounded by Butler Street to the north, Nevins Street to the east, Union Street to the south and Bond Street to the west. GEI was interested in determining whether subsurface utilities were present in several areas of interest (AOIs) which encompassed approximately thirty (30) proposed borings. Hand drawn sketches of the results within a 20-ft by 20-ft area centered on each proposed boring location were delivered to GEI on site on the day each was surveyed. This report addresses the general areas of interest that were surveyed, but does not discuss the individual boring locations specifically.

The AOIs included streets, sidewalks and private lots. The streets and sidewalks included in the survey were portions of Douglass Street, Degraw Street and Sackett Street between Bond Street and the Gowanus Canal, and portions of Degraw Street and Sackett Street between the canal and Nevins Street.

Portions of private lots at Block 411-Lot 24 (Parcel VII), Block 418-Lot 1 (Parcel VI), Block 425-Lot 1 (Parcel I), Block 432-Lot 15, Block 431-Lot 17 and Block 424-Lots 1 and 20.

Block 417-Lots 14 and 21 (Parcel VIII) were also originally specified by GEI to be surveyed. Parked vehicles, staged equipment and debris prevented complete access for the geophysical survey, and the geophysical survey was not conducted at these locations due to access. Figure 2 is a site plan showing the locations of the AOIs for the geophysical survey.

OBJECTIVES

The objectives of the geophysical survey were to detect, and if detected, to locate possible utilities in 1) the accessible portions of 20-ft by 20-ft areas of interest centered on the proposed locations of approximately thirty borings, and 2) in the accessible portions of several streets and private parcels, that were specified by GEI, along the east and west side of the Gowanus Canal.

THE SURVEY

Alexis Martinez, Mikko Aarnio, Jose Carlos Cambero Calzada and Amanda Fabian of Hager-Richter conducted the field operations on June 5-8, 11-13 and August 6, 7, 13-14, 2012. The project was coordinated with Ms. Alexandra M. L. Royko of GEI, who was present on the site and specified the areas of interest for the geophysical survey.

The geophysical survey was conducted using three complementary geophysical methods: time domain electromagnetic induction (EM61), ground penetrating radar (GPR), and precision utility location (PUL). The EM61 method was only used on areas considered sufficiently large and unobstructed by vehicles, metal debris etc. The GPR and PUL methods were employed site-wide.

The EM61 data were acquired at approximately 8-inch intervals along lines spaced 5 feet apart in the accessible portions of the AOIs. The EM survey detects and outlines areas containing buried metal. However, the EM method cannot provide information on the type of objects causing EM anomalies. In order to aid in the identification of the objects, GPR data were acquired in two mutually perpendicular directions and spaced no more than 5 feet apart across the accessible portions of the AOI. The GPR method is useful for detecting both metallic and non-metallic subsurface objects. The GPR system was used with a 250 MHz antenna and a 60 ns[1] time window. A PUL system was used for tracking utilities in the AOIs.

[1] ns, abbreviation for nanosecond, 1/1,000,000,000 second. Light and the GPR signal require about 1 ns to travel 1 ft in air. The GPR signal requires about 3.5 ns to travel 1 ft in unsaturated sandy soil.

EQUIPMENT

EM61. For the EM61 survey, we used a Geonics EM61-MK2 time domain electromagnetic induction metal detector. The EM61 is a time-domain electromagnetic induction type instrument designed specifically for detecting buried metal objects. An air-cored 1-meter by ½-meter transmitter coil generates a pulsed primary magnetic field in the earth, thereby inducing eddy currents in nearby metal objects. The decay of the eddy current produces a secondary magnetic field that is sensed by two receiver coils, one coincident with the transmitter and one positioned 40 cm above the main coil. By measuring the secondary magnetic field after the current in the ground has dissipated but before the current in metal objects has dissipated, the instrument responds only to the secondary magnetic field produced by metal objects. Four channels of secondary response are measured in mV and are recorded on a digital data logger. The system is generally operated by pushing the coils as a wagon with an odometer mounted on the axle to trigger the data logger automatically at approximately 8-inch intervals.

GPR. The GPR survey was conducted using a Sensors & Software Smart Cart Noggin Plus digital subsurface interface radar system. The GPR unit includes a survey wheel, which provides data at a uniform horizontal scale, increasing the precision of locating subsurface objects over that of units without the survey wheel. The system was used with a 250 MHz antenna and a 60 ns[1] time window.

GPR uses a high-frequency electromagnetic pulse (referred to herein as “radar signal”) transmitted from a radar antenna to probe the subsurface. The transmitted radar signals are reflected from subsurface interfaces of materials with contrasting electrical properties. The travel times of the radar signal can be converted to *approximate* depth below the surface by correlation with targets of known depths, including stratigraphic horizons, pipes, cables, and other utilities, or by using handbook values of velocities for the materials in the subsurface. The acquisition of GPR data was monitored in the field on a graphic recorder and the real time images were immediately available for field use. The GPR data were also recorded digitally for subsequent processing. Interpretation of the records is based on the nature and intensity of the reflected signals and on the resulting patterns.

PUL. The PUL survey was conducted using a precision electromagnetic pipe and cable locator, Radiodetection RD4000 series. The RD4000 series consists of separate transmitter and receiver. The system can be used in "passive" and "active" modes to locate buried pipes by detecting electromagnetic signals carried by the pipes. In the "passive" mode, only the receiver unit is used to detect signals carried by the pipe from nearby power lines, live signals transmitted along underground power cables, or very low frequency radio signals resulting from long wave radio transmissions that flow along buried conductors. In the "active" mode of operation, the transmitter is used to induce a signal on a target pipe, and the receiver is used to trace the signal along the length of the pipe. Our system uses a 10W transmitter.

LIMITATIONS OF THE METHODS

HAGER-RICHTER GEOSCIENCE, INC. MAKES NO GUARANTEE THAT ALL SUBSURFACE TARGETS OF INTEREST WERE DETECTED IN THIS SURVEY. HAGER-RICHTER GEOSCIENCE, INC. IS NOT RESPONSIBLE FOR DETECTING SUBSURFACE TARGETS THAT NORMALLY CANNOT BE DETECTED BY THE METHODS EMPLOYED OR THAT CANNOT BE DETECTED BECAUSE OF SITE CONDITIONS. GPR SIGNAL PENETRATION MAY NOT BE DEEP ENOUGH TO DETECT SOME TARGETS. HAGER-RICHTER GEOSCIENCE, INC. IS NOT RESPONSIBLE FOR MAINTAINING FIELD MARKOUTS AFTER LEAVING THE WORK AREA. GEI UNDERSTANDS THAT MARK-OUTS MADE DURING INCLEMENT WEATHER OR IN AREAS OF HIGH PEDESTRIAN OR VEHICULAR TRAFFIC MAY NOT LAST.

Field mark-outs. Utilities detected by the geophysical methods at the time of the survey are marked in the field, and the operator makes every attempt, field conditions permitting, to detect and mark as many utilities as possible at the time of survey. Adverse weather and site conditions (rain, snow, snow and soil piles, uneven surfaces, high traffic, etc.) can hamper in-field interpretation. Utility mark-outs made on wet pavement, snow, snow piles, gravel surfaces, or in active construction zones may not last. H-R is not responsible for maintaining utility mark-outs after leaving the work area.

EM61. All electromagnetic geophysical methods, including the EM method used here, are affected by the presence of power lines and surface metal objects (steel sided buildings, dumpsters, vehicles, railroad tracks, reinforced concrete, etc.). Where such are present, the effects of materials in the subsurface may be masked, and firm conclusions about subsurface conditions cannot be made.

Detection and identification should be clearly differentiated. Detection is the recognition of the presence of a metal object, and the electromagnetic method is excellent for such purposes. Identification, on the other hand, is determination of the nature of the causative body (i.e., what is the body -- a cache of drums, UST, automobile, white goods, etc.?). Although the EM61 data cannot be used to *identify* buried metal objects, they provide excellent guides to the identification of some objects. For example, buried metal utilities produce anomalies with lengths many times their widths.

GPR. There are limitations of the GPR technique as used to detect and/or locate targets such as those of the objectives of this survey: (1) surface conditions, (2) electrical conductivity of the ground, (3) contrast of the electrical properties of the target and the surrounding soil, and (4) spacing of the traverses. Of these restrictions, only the last is controllable by us.

The condition of the ground surface can affect the quality of the GPR data and the depth of penetration of the GPR signal. Sites covered with snow piles, high grass, bushes, landscape structures, debris, obstacles, soil mounds, etc. limit the survey access and the coupling of the GPR antenna with the ground. In many cases, the GPR signal will not penetrate below concrete pavement, especially inside buildings, and a target may not be detectable. The GPR method also commonly does not provide useful data under canopies found at some facilities. GPR surveys inside buildings may be severely constrained by space limitations and interference from above-grade structures.

The electrical conductivity of the ground determines the attenuation of the GPR signals, and thereby limits the maximum depth of exploration. For example, the GPR signal does not penetrate clay-rich soils, and targets buried in clay might not be detected.

A definite contrast in the electrical conductivities of the surrounding ground and the target material is required to obtain a reflection of the GPR signal. If the contrast is too small, possibly due to construction details or deeply corroded metal in the target, then the reflection may be too weak to recognize and the target can be missed. In many cases, plastic, clay, asbestos concrete (transite), brick-lined, stone-lined, and other non-metallic utilities cannot be detected.

Spacing of the traverses is limited by access at many sites, but where flexibility of traverse spacing is possible, the spacing is adjusted to the size of the target. The GPR operator controls the spacing between lines, and the design of the survey is based on the dimensions of the smallest feature of interest. Targets with dimensions smaller than the spacing between GPR survey lines can be missed.

PUL. The PUL equipment cannot detect non-metallic utilities, such as pipes constructed of vitrified clay, transite, plastic, PVC, fiberglass, and unreinforced concrete, when used in passive mode alone. Such pipes can be detected if a wire tracer is installed with access to such tracer for transmission of a signal or where access (such as floor drains and clean-outs) permits insertion of a device on which a signal can be transmitted.

In some, but not all, cases, the subsurface utility designation equipment cannot detect metal utilities reliably under reinforced concrete because the signal couples onto the metal reinforcing in the concrete. Similarly, the method commonly cannot be used adjacent to grounded metal structures such as chain link fences and metal guardrails.

In congested areas, where several utilities are bundled or located within a short distance, the signal transmitted on one utility can couple onto adjacent utilities, and the accuracy of the location indicated by the instrument decreases.

RESULTS

The geophysical survey was conducted using EM61, GPR and PUL methods. The presence of reinforced concrete pavement and surface metal objects such as vehicles and metal debris severely limited access, The EM61 survey was limited to Parcel VI, Sackett Street on both sides of the canal, and the private properties on Sackett Street west of the canal (Block 424-Lots 1 and 20). The GPR and PUL methods were used across the accessible portions of all specified AOIs. Plate 1 is a color contour plot of the results of the EM61 survey, and Plate 2 shows the integrated interpretation of the geophysical data.

EM61. Interpretation of EM data is based on the relative response of the instrument in millivolts to local c onditions. The instrument is not calibrated to provide an absolute measure of a particular property, such as the conductivity of the soil or the strength of the earth's magnetic field. Subsurface metal objects produce sharply defined positive anomalies when the EM61 is positioned directly over them. Acquiring data at short intervals along closely spaced lines, as was done at the subject site, provides high spatial resolution of the location and footprint of the targets. Thus, buried metal is recognized in contour plots of EM data by positive anomalies roughly corresponding to the dimensions of the buried metal.

Several small areas of moderate to high-amplitude EM61 response are located throughout the AOIs. The GPR records for the locations of EM anomalies were carefully examined to determine the cause of the anomalies. Where the GPR records show no clear indication for the origin of the EM anomalies, such anomalies are simply called buried metal, and their locations are shown on Plate 2 as red hatched areas. Linear EM61 anomalies with various amplitudes are also prominent and extensive in Plate 1. Such EM anomalies are interpreted as possible metallic utilities, and their locations are shown in Plate 2.

Surface metal objects also produce positive EM anomalies. Anomalies related to surface metal, such as parked vehicles, manholes, building walls and fences are indicated as such in Plate 2. We note that the presence or absence of subsurface metal in such areas cannot be determined on the basis of the EM data alone due to the anomaly caused by the surface metal object.

GPR. The locations of the GPR traverses are shown in Plate 2 with the integrated interpretation of the geophysical data. Apparent GPR signal penetration for the areas of interest varied to from limited to fair, with reflections received for about 15-25 nsec. Based on handbook time-to-depth conversions for the GPR signal in average soils, the GPR signal penetration is estimated to have been approximately 2 - 4 feet.

GPR reflections typical of an underground storage tank (UST) were detected in two locations on the southern sidewalk of Degraw Street on the west side of the canal. However, no EM data is available at these locations. Reflections typical of USTs are not present in the GPR records for the rest of the areas.

The GPR records also exhibit GPR reflections typical of extensive subsurface utilities, and segments of utilities, some of which were also detected by the EM method. On Sackett Street, west of the canal, the GPR data indicate a presence of a possible buried structure at two locations. Reflections from scattered small unidentified buried objects were also detected.

Whether subsurface utilities or USTs occur at a depth greater than the effective depth of penetration of the GPR signal (approximately 2-4 feet) or in areas inaccessible to the geophysical survey cannot be determined from the geophysical data.

PUL. The PUL transmitter was attached to fire hydrants, water valves, light poles and gas meters located throughout the AOIs. We also conducted a PUL survey in "passive" mode to detect signals carried by utilities from nearby power lines. The locations of detected utilities are shown in Plate 2.

CONCLUSIONS

Based on the geophysical survey performed by Hager-Richter Geoscience at the Fulton Municipal Works Former MGP Site located in Brooklyn, New York, we conclude that:

- Two possible USTs were detected on the southern sidewalk of Degraw Street, west of the canal.
- Several utilities were detected throughout the areas of interest.
- Structural elements were detected next to the canal on Parcel VII.
- A buried structure was detected on Sackett Street west of the canal, and on the property

north of Sackett Street, also on the west side of the canal.

- Segments of possible utilities and small unidentified buried objects were detected throughout the areas of interest.

LIMITATIONS ON USE OF REPORT

This letter report was prepared for the exclusive use of GEI Consultants, Inc. (Client). No other party shall be entitled to rely on this Report or any information, documents, records, data, interpretations, advice or opinions given to the Client by Hager-Richter Geoscience, Inc. (H-R) in the performance of its work. The Report relates solely to the specific project for which H-R has been retained and shall not be used or relied upon by the Client or any third party for any variation or extension of this project, any other project or any other purpose without the express written permission of H-R. Any unpermitted use by the Client or any third party shall be at the Client's or such third party's own risk and without any liability to H-R.

H-R has used reasonable care, skill, competence and judgment in the performance of its services for this project consistent with professional standards for those providing similar services at the same time, in the same locale, and under like circumstances. Unless otherwise stated, the work performed by H-R should be understood to be exploratory and interpretational in character and any results, findings or recommendations contained in this Report or resulting from the work proposed may include decisions which are judgmental in nature and not necessarily based solely on pure science or engineering. It should be noted that our conclusions might be modified if subsurface conditions were better delineated with additional subsurface exploration including, but not limited to, test pits, soil borings with collection of soil and water samples, and laboratory testing.

Except as expressly provided in this limitations section, H-R makes no other representation or warranty of any kind whatsoever, oral or written, expressed or implied; and all implied warranties of merchantability and fitness for a particular purpose, are hereby disclaimed.

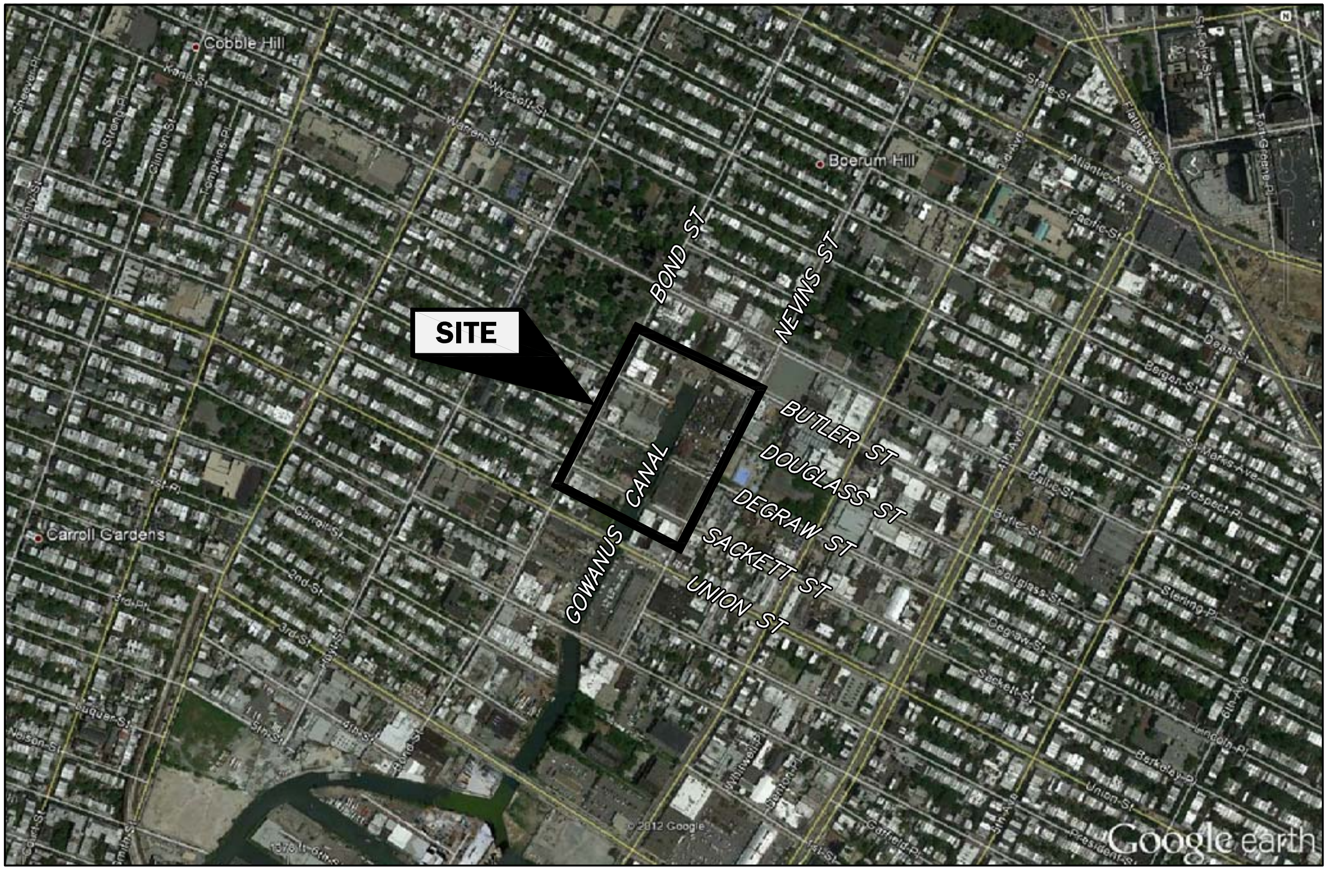
If you have any questions or comments on this letter report, please contact us at your convenience. It has been a pleasure to work with GEI on this project. We look forward to working with you again in the future.

Sincerely yours,
HAGER-RICHTER GEOSCIENCE, INC.

Alexis Martinez
Senior Geophysicist

Dorothy Richter, P.G.
President

Attachments: Figures 1 and 2
Plates 1- 2



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H-R

APPROXIMATE SCALE (feet)

0 1000 2000

LOCATION

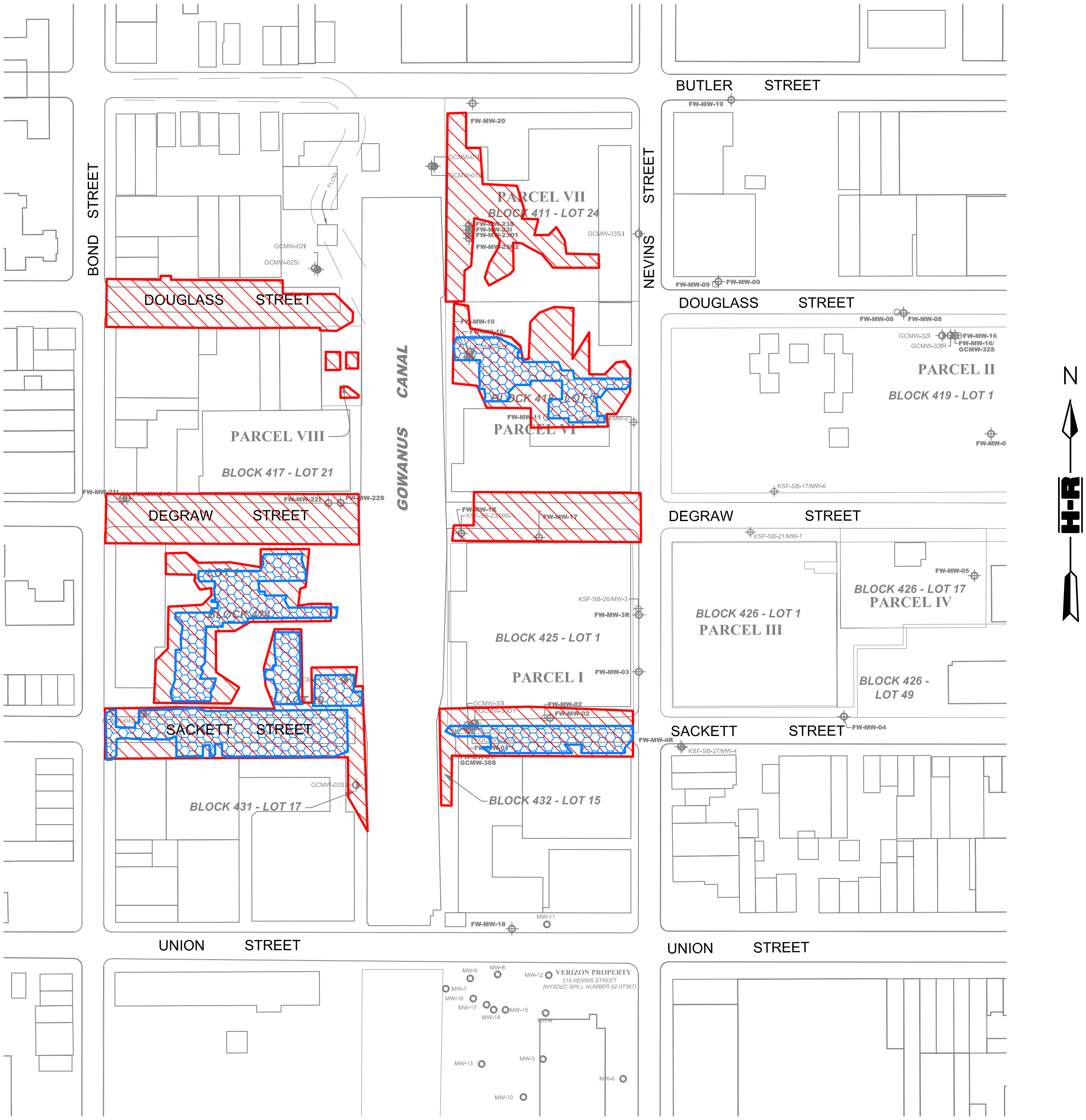
NOTE:

Modified from Google Earth aerial photograph.

Figure 1
General Site Location
Fulton Municipal Works
Former MGP Site
Gowanus Canal
Brooklyn, New York

File 12AM10	October, 2012

HAGER–RICHTER GEOSCIENCE, INC.
Fords, New Jersey



NOTE:

Modified from base plan provided bY GEI Consultants, Inc., identified as Fulton–Site.

LEGEND

APPROXIMATE LIMITS OF EM SURVEY AREA

APPROXIMATE LIMITS OF GPR & PUL SURVEY AREA

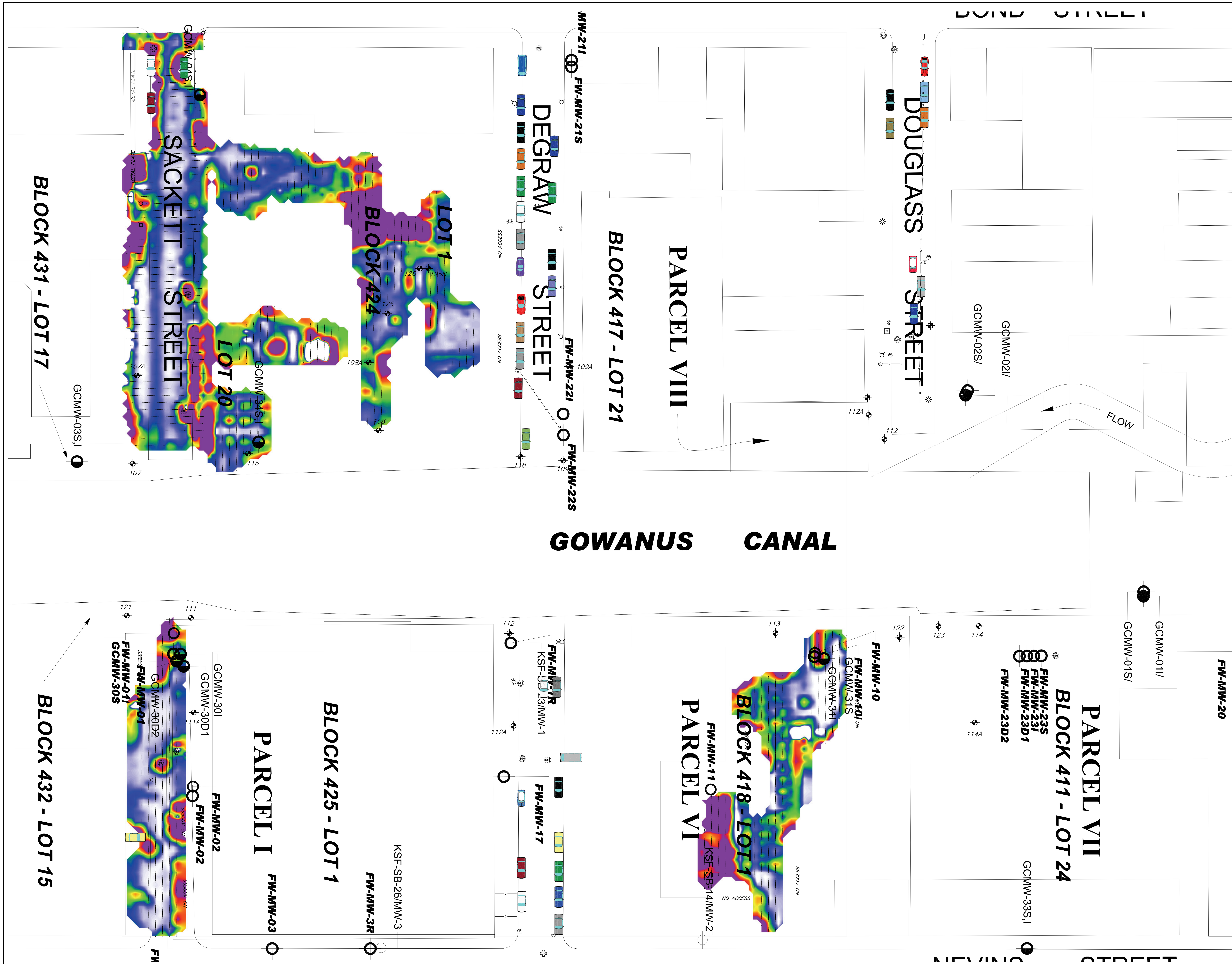
SCALE (feet)

0 200 400

Figure 2
Site Plan
Fulton Municipal Works
Former MGP Site
Gowanus Canal
Brooklyn, New York

File 12AM10	October, 2012

HAGER–RICHTER GEOSCIENCE, INC.
Fords, New Jersey



APPROX. N

Response (mV)
400
350
300
250
200
150
100
50
0

LEGEND

- DATA STATIONS
- PROPOSED BORING
- GAS VALVE
- ELECTRIC VAULT
- LIGHT POLE
- UTILITY POLE
- HYDRANT
- WATER VALVE
- MANHOLE
- CATCH BASIN
- UNKNOWN VALVE
- POSSIBLE FILL PORT
- MONITORING WELL
- GAS LINE – MARKED BY OTHERS
- ELECTRIC LINE – MARKED BY OTHERS
- VEHICLE

SCALE (feet)
0 30 60

NOTES:

1. Modified from base plan provided bY GEI Consultants, Inc., identified as Fulton–Site.
2. Data were acquired with Geonics EM61–MK2. Differential response shown.
3. Differential response equals top coil response – bottom coil response.

PLATE 1
EM SURVEY
FULTON MUNICIPAL WORKS
FORMER MGP SITE
GOWANUS CANAL
BROOKLYN, NEW YORK

FILE 12AM10	OCTOBER, 2012

HAGER–RICHTER GEOSCIENCE, INC.
SALEM, NEW HAMPSHIRE

NOTE:

Modified from base plan provided by GEI Consultants, Inc., identified as Fulton-Site.

PLATE 2
GPR SURVEY &
INTEGRATED INTERPRETATION
FULTON MUNICIPAL WORKS
FORMER MGP SITE
GOWANUS CANAL
BROOKLYN, NEW YORK

FILE 12AM10	OCTOBER, 2012

HAGER–RICHTER GEOSCIENCE, INC.
SALEM, NEW HAMPSHIRE