

Appendix D Groundwater Model Investigation Work Plan, NYSDEC Approval, and Groundwater Model Report

December 19, 2016

Mr. Henry Willems
New York State Department of Environmental Conservation
MGP Remedial Section, Division of Environmental Remediation
Bureau of Western Remedial Action, 11th Floor
625 Broadway
Albany, New York 12233-7017

Re: Additional Investigation Work Plan
Phase 2/3 Remedial Investigation
Greenpoint Energy Center Former Manufactured Gas Plant
287 Maspeth Avenue, Brooklyn, New York
Site No. 224052

Dear Mr. Willems:

The Greenpoint Energy Center Remedial Investigation is being implemented following the New York State Department of Environmental Conservation (NYSDEC)-approved Phase 2/3 Remedial Investigation Work Plan (RIWP) for the Greenpoint Energy Center Former Manufactured Gas Plant (MGP) site (Site), dated October 31, 2013. Phase 2 of the RI program has been completed. GEI Consultants, Inc., P.C. (GEI) is currently conducting Phase 3 of the investigation.

As part of National Grid's ongoing effort to increase our understanding of geologic and hydrogeologic conditions at, and in the immediate vicinity of the Site, additional investigation is proposed. The proposed additional investigation includes:

- The installation of 17 additional monitoring wells,
- Gauging of new and existing wells,
- Sampling of the newly installed wells on-Site,
- Slug testing at select monitoring wells.

The investigation locations are shown on **Figures 1 and 2**, for the on-Site and off-Site areas, respectively. The proposed monitoring well locations and construction details are provided in **Table 1**.

The on-Site wells will be installed using rotary sonic techniques and the soil will be logged during casing advancement. Several shallow monitoring wells (total of six) will be installed within the Maspeth Avenue Right-of-Way in an effort to determine the influence of the 60-inch sewer main on groundwater flow in the area. The wells within Maspeth Avenue will be installed using Geoprobe[®] direct-push methods. The soil will be logged at the two deeper boring locations (GPEC-SIS102I and GPEC-SIS104I).

The on-Site monitoring well installations, as well as the development and sampling of the wells will be done in accordance with the RIWP. Investigative-derived waste (IDW) management and the implementation of a community air monitoring program (CAMP) will also be conducted in accordance with the RIWP.

One-inch monitoring wells are planned for installation for the sewer infiltration study on Maspeth Avenue. The wells will be installed using direct-push technology and 3.25-inch casing. The shallow wells will be completed with a sand pack to approximately 1 foot above top-of-screen and the deeper wells will have the sand pack installed to 2 feet above the top of the screen followed by 2 feet of wetted bentonite pellets, and tremie-grout to the surface.

A monitoring well gauging event is planned at new and existing accessible wells on and near the Site. In addition to on-Site wells, the gauging event would ideally include wells at the Equity former MGP site and the BCF Oil site, if access can be obtained. Gauging will performed across the tidal cycle.

Slug testing will be performed utilizing similar methods to those utilized during the December 2015 slug testing event. The methods utilized and testing results were summarized in the Slug Test Summary Letter submitted to NYSDEC on April 12, 2016.

Schedule

The field program will be scheduled upon approval of the work plan and will be based on subcontractor availability. We will provide notification of the start of the field program a minimum of one week prior to mobilization.

If you have any questions or require additional information, please feel free to contact me at 516-545-2586 or by e-mail at william.ryan@nationalgrid.com.

Sincerely,



William J. Ryan
Project Manager

Enclosures

cc: D. Hetrick (NYSDOH)
G. Cross (NYSDEC)

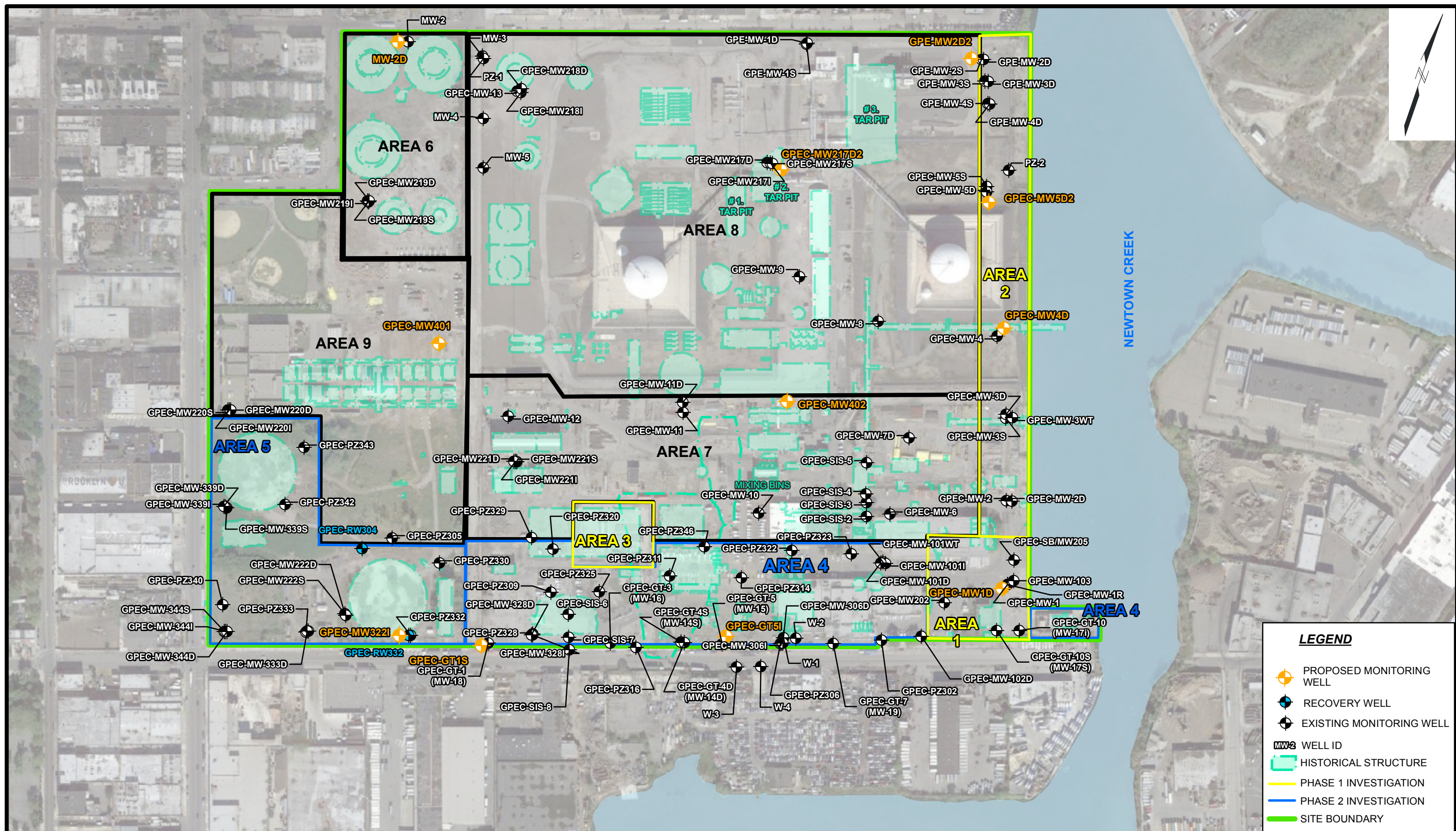
\\mcl1v-fs01\Data2\Tech\Projects\National Grid\Greenpoint\INVESTIGATIONS\Add'l Inv\Work plan\Greenpoint_Ph 2-3 Add'l Inv. Plan.docx

Table 1 - Proposed Monitoring Wells
Additional Investigation Work Plan
Phase 2/3 Remedial Investigation
Greenpoint Energy Center Remedial Investigation
Brooklyn, New York

WELL CATEGORY/ ID	LOCATION	ZONE (DEPTH, FT)*
On-Site		
GPEC-MW4D	AREA 2	DEEP (100)
GPEC-MW1D	AREA 1	DEEP (60-70)
GPEC-GT01S	AREA 4	SHALLOW (5-15)
GPEC-GT5I	AREA 4	INT (30-40)
GPEC-MW332I	AREA 5	INT (35-45)
GPEC-MW5D2	AREA 2	DEEP (200)
GPEC-MW217D2	AREA 8	DEEP (200)
GPEC-MW2D2	AREA 8	DEEP (200)
MW-2D	AREA 6	DEEP (200)
GPEC-MW401	AREA 9	DEEP (100)
GPEC-MW402	AREA 7	DEEP (100)
Off-Site		
GPEC-SIS101S	MASPETH AVENUE	SHALLOW (2-6)
GPEC-SIS102S	MASPETH AVENUE	SHALLOW (2-6)
GPEC-SIS102I	MASPETH AVENUE	SHALLOW (9-14)
GPEC-SIS103S	MASPETH AVENUE	SHALLOW (2-6)
GPEC-SIS104S	MASPETH AVENUE	SHALLOW (2-6)
GPEC-SIS104I	MASPETH AVENUE	SHALLOW (9-14)

Notes:

*: Deep wells assigned a 200-foot depth are intended to be installed at or near the bottom of the Upper Glacial Aquifer. Depth to bedrock may be as deep as 200 feet.



From: [Willems, Henry T \(DEC\)](#)
To: [Morris, Chris](#); [Ryan, William](#)
Subject: RE: Greenpoint Energy Center Site - Additional Investigation Work Plan
Date: Monday, January 09, 2017 1:49:21 PM
Attachments: [image001.png](#)

Gentlemen,

The work plan is acceptable. Please begin the field work as soon as practical.

Hank

From: Morris, Chris [mailto:CMorris@geiconsultants.com]
Sent: Tuesday, January 03, 2017 5:29 PM
To: Willems, Henry T (DEC) <henry.willems@dec.ny.gov>
Cc: Ryan, William <William.Ryan@nationalgrid.com>; Hettrick, Dawn E (HEALTH) <dawn.hettrick@health.ny.gov>
Subject: RE: Greenpoint Energy Center Site - Additional Investigation Work Plan

ATTENTION: This email came from an external source. Do not open attachments or click on links from unknown senders or unexpected emails.

Hank,

Please use this version for your review. One well was left out of the table in the version previously sent. Sorry for the confusion.

-Chris

From: Morris, Chris
Sent: Monday, December 19, 2016 3:48 PM
To: henry.willems@dec.ny.gov
Cc: 'Ryan, William' <William.Ryan@nationalgrid.com>; 'dawn.hettrick@health.ny.gov' <dawn.hettrick@health.ny.gov>
Subject: Greenpoint Energy Center Site - Additional Investigation Work Plan

Hank,

Attached for your review is a draft work plan for additional investigation at the Greenpoint Energy Center Site.

Please let me or Bill Ryan know if you have any questions or comments.

-Chris

Christopher Morris

Project Manager/Geologist



GEI Consultants, Inc., P.C.

110 Walt Whitman Road, Suite 204 | Huntington Station, NY 11746

T: 631.759.2967 | **M:** 631.484.9152

www.geiconsultants.com | [vCard](#) | [map](#) | [LinkedIn](#) | [Twitter](#) | [Facebook](#)



Geotechnical
Environmental
Water Resources
Ecological

**Remedial Investigation Report
Greenpoint Energy Center**

Appendix D – Groundwater Model

287 Maspeth Avenue
Brooklyn, New York
Site #224052

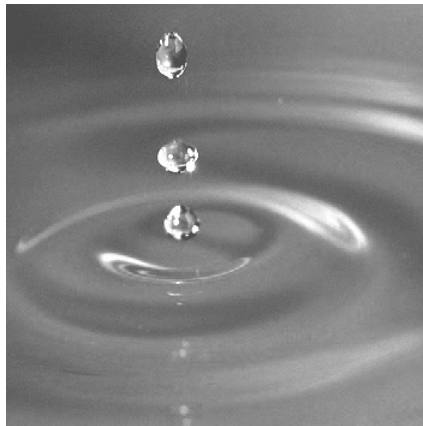


Table of Contents

1. Introduction	1
2. Conceptual Site Model	2
2.1 Upper Glacial Aquifer	2
2.2 Marsh Deposits	3
2.3 Moraine Ridge	3
2.4 Groundwater Extraction	4
2.5 Utility Infiltration	5
2.6 Shoreline Type	6
3. Computational Flow Model	7
3.1 Discretization	8
3.2 Stratigraphy	8
3.3 Constant Head Boundaries	9
3.4 No-Flow (Inactive) Boundaries	10
3.5 Drain Boundaries	10
3.6 Recharge	10
3.7 Bulkheads	11
3.8 Groundwater Extraction	12
3.9 Hydraulic Conductivity	13
4. Calibration	15
5. Results and Sensitivity Analysis	17
5.1 Hydraulic Conductivity Sensitivity	18
5.2 Recharge Sensitivity	18
5.3 Groundwater Withdrawal Sensitivity	18
References	20

Tables

- L1 Soil Boring Summary
- L2 Hydraulic Conductivity Measurements
- L3 Model Hydraulic Conductivity Zones
- L4 Calibration Data Set
- L5 Flow Model Mass Balance

Figures

- L1-1 Site Location
- L2-1 Site Reference Locations
- L2-2 Regional Groundwater Contours
- L2-3 North-South Conceptual Schematic of Hydrogeologic Units
- L2-4 USGS Calibration Wells
- L2-5 Historic Maps
- L2-6 Groundwater Extraction Locations
- L2-7 Maspeth Ave. Utilities
- L2-8 Shoreline Type
- L3-1 Model Grid
- L3-2 Model Grid Cross-Sections
- L3-3 Stratigraphic Input Soil Boring Locations
- L3-4 Shallow Head Boundaries
- L3-5 Upper Glacial Aquifer Constant Head Boundaries
- L3-6 Recharge Boundaries
- L3-7 Hydraulic Conductivity Measurements
- L3-8a Hydraulic Conductivity Layer 1
- L3-8b Hydraulic Conductivity Layer 2
- L3-8c Hydraulic Conductivity Layer 3
- L3-8d Hydraulic Conductivity Layer 4
- L3-8e Hydraulic Conductivity Layer 5
- L3-9 Shorefront Details
- L3-10 Hydraulic Conductivity Cross-Sections
- L4-1 Calibration Data Points
- L4-2 Calibration Residuals Plots
- L4-3 Qualitative Calibration – Water Table
- L4-4 Qualitative Calibration – Upper Glacial Aquifer
- L5-1 Computed Groundwater Flow – Water Table
- L5-2 Computed Groundwater Flow – Upper Glacial Aquifer
- L5-3 Sensitivity Analysis – Soil Type
- L5-4 Sensitivity Analysis – Recharge
- L5-5 Sensitivity Analysis – Supply Pumping
- L5-6 Sensitivity Analysis – Potential Pumping/Dewatering Locations

Attachments

Attachment A – Groundwater Contours

AnchorQEA, Figure F3-11, Arithmetic Average Groundwater Elevation Contours in Upper
Glacial Aquifer

GEI Consultants, Inc.

2015 Groundwater Contours

2017 Groundwater Contours

H:\WPROC\Project\NationalGrid\ Model Rept 122211.docx

1. Introduction

As part of the remedial investigation for the Greenpoint Energy Center (GPEC) former Manufactured Gas Plant (MGP) site, GEI Consultants, Inc. (GEI) performed a groundwater modeling analysis. The groundwater model analysis included development of a three-dimensional groundwater flow model for the site and vicinity (Figure L1-1), and calculation of flow gradients and flux rates. The model provided a quantitative understanding of groundwater flow conditions, and provides additional confidence in the conceptual understanding of the complex groundwater system at the site.

This report appendix is organized as follows. Section 2 provides a conceptual model describing regional groundwater flow, and local conditions and features influencing groundwater flow in the vicinity of GPEC. Section 3 describes the flow model and the input data set. Section 4 describes the flow model calibration sensitivity analysis. Section 5 presents the groundwater mass balance analysis and sensitivity analysis.

2. Conceptual Site Model

A conceptual site model (CSM) was developed to describe regional and local groundwater flow for the purpose of constructing the three-dimensional computer model and defining boundary conditions. The CSM was developed using information obtained during remedial investigation for activities for the GPEC site, the Newtown Creek Superfund site, other investigated upland sites along Newtown Creek for which data were available, and regional publications. A map showing remedial investigation sites for which data were available is included as Figure L L2-1.

The model area is shown in Figure L1-1, and generally comprises the southern end of Newtown Creek and portions of the surrounding basin. Aquifer components and anthropogenic factors influencing groundwater flow at GPEC are described below.

2.1 Upper Glacial Aquifer

Groundwater flow within the model area occurs in unconsolidated deposits of outwash sand and moraine with till lenses known as the Upper Glacial Aquifer (UGA). Newtown Creek is located at the western end of the UGA, where the UGA is the uppermost surficial aquifer across most of Long Island, including all of Brooklyn and Queens (Buxton and Smolensky, 1999). The UGA is underlain by clay known as the Gardiner's Clay and the clay member of the Raritan Formation, that overlies southeastward-dipping bedrock (Buxton and Shernoff, 1999). Groundwater elevation contours for the Upper Glacial Aquifer reported by AnchorQEA (AQ) and the U.S. Geological Survey (USGS) are shown in Figure L2-2. For purposes of regional characterization, discontinuous post-glacial marsh and lacustrine deposits and anthropogenic fill within the UGA have been considered to be part of the UGA (Misut and Monti, 1999). A conceptual profile of the aquifer components at GPEC and the surrounding area is shown in Figure L2-3.

Regional flow in the UGA in the area of GPEC originates as recharge from precipitation in upland areas, then converges toward Newtown Creek and its tributaries, as can be inferred from the regional groundwater contours shown in Figure L2-2. Groundwater discharges to Newtown Creek and its tributaries, and also exits the basin via localized influences including infiltration to utilities at shallow depths, groundwater extraction systems and pumping wells in the UGA, and pumping from subway tunnel dewatering systems in bedrock.

The UGA was widely used as a water supply source in the mid-1900s, causing a depression of water levels in the UGA [USGS, 1999]. Significant amounts of pumping ceased in the 1970s

after city water was supplied to the area via aqueducts. Historic measurements shown in Figure L2-4 indicate that water levels in the Upper Glacial Aquifer have recovered and remained stable over the past decade.

2.2 Marsh Deposits

Groundwater elevation measurements and soil boring observations show that the marsh deposits at and around GPEC serve as a semiconfining unit. The historic extent of marsh deposits as mapped in 1866 is shown on Figure L2-5. The entirety of the marsh area outside the present creek shoreline was subsequently filled in. The water table at GPEC appears to be mounded (perched) in fill above the marsh deposits, while the potentiometric surface below the marsh deposits is similar to that of the surrounding regional aquifer. The water table above the marsh deposits has been measured to be approximately 6 to 10 feet higher than the potentiometric surface below the marsh deposits.

Conceptually, recharge from precipitation enters surficial fill material in unpaved areas. Drainage through the fill is impeded laterally due to relatively low hydraulic conductivity of the fill, and vertically by the underlying marsh deposits (see Section 3.9 for a discussion of hydraulic conductivity). As a result, groundwater from local recharge is retained in a perched condition relative to the underlying and surrounding UGA. A series of groundwater contour maps representing aquifer depths above and below the marsh deposits as measured at GPEC, is included in Attachment A. The mounding condition is predominant in southern areas of GPEC, and is also apparent off-site in portions of the BCF Oil, Ditmas, and Equity Former MGP sites (Fig. L2-1) [MPI 2010, CEUS 2012, AECOM 2016]. Dense fill material may also contribute to the higher groundwater elevations between Maspeth Ave. and English Kills, where pavement rubble was reportedly imported during the 1970s to expand the usable area of the site (MPI, 2010).

2.3 Moraine Ridge

The Harbor Hill Moraine is a predominant geologic feature extending southwest to northeast across Long Island, located outside the model area about 1-2 miles south of GPEC (Figure L2-5). The UGA within the modeled area is considered by USGS to be ground moraine, whereas the aquifer south of the Harbor Hill moraine is considered outwash (Buxton and Shernoff, 1999). A ridge north of GPEC (Figure L2-5) coincides with a zone of relatively low permeability deposits within the UGA, of which evidence is apparent in various studies described further below. The water table in several areas along the ridge line shown in Figure L2-5, ranges up to several feet higher than water levels measured in the surrounding UGA. Regionally, anomalously high water levels in eastern Long Island have been attributed to zones of low conductivity in moraine deposits (Buxton and Shernoff, 1999). In general, localized high water levels can result from buildup of natural recharge in dense or fine-grained native

material that is relatively slow to drain. A groundwater contour map prepared for the Draft Newtown Creek RI report, Figure F3-11 shows steep contours primarily north/northwest of Greenpoint. A copy of the contour map is included in Attachment A.

Soil observations support the high water level conditions. Till and silt/clay interbeds were reported in the ExxonMobil offsite plume area (Figure L2-1; URS, 2009). In some instances, logs for wells having high water table elevations show little to no fines. It is assumed in these cases that the water level is controlled by low-permeability material near the well location, or that the sand is densely packed till with natural low permeability. Evidence of dense moraine (relatively high water table and/or fine-grained material) are also apparent at:

- The northeast corner of GPEC (GPE-series borings, GEI, 2011) where relatively high soil variability was observed, in contrast with sand and gravel with few clay interbeds observed within the majority of GPEC.
- A relatively large area of fine-grained material was identified beneath Newtown Creek, adjacent to the northeast corner of GPEC (AQ 2016, Fig. F5-5)
- Fine-grained native material beneath marsh deposits were identified at Phelps-Dodge Refining Company (PDRC), coinciding with relatively high groundwater elevations at the upland boundary of PDRC (CRA, 2012) approaching the hill at Calvary Cemetery.

North of the moraine ridge, the water table is drawn down as far as 4 feet below sea level from the remedial groundwater extraction system for the ExxonMobil off-site plume. The moraine ridge appears to be isolating or impeding groundwater flow at GPEC from pumping influences. Groundwater contours in AQ's Figure F3-11 (Attachment A) show a steep drop-off in groundwater elevations north/northwest of GPEC, suggesting a relatively sharp transition from dense moraine material to more permeable sand and gravel that would support high remedial extraction rates. The extraction system is described in the next section.

2.4 Groundwater Extraction

Groundwater extraction in the model area is performed for site remediation and supply purposes. Groundwater extraction locations within the GPEC model area are shown on Figure L2-6.

North of GPEC, groundwater extraction for recovery of separate-phase petroleum and impacted groundwater has been ongoing since 1978 (Delta, 2006). A groundwater recovery system now handles groundwater pumped from the ExxonMobil off-site plume, Former Paragon Terminal, and BP areas (Fig. L2-1). A combined extraction rate of 530 gpm for the three facilities was reported by AQ, representing averaged rates spanning from 2012 to 2014 (AQ, 2016). The groundwater is then treated onsite and discharged under permit to Newtown

Creek. Additional extraction systems are located further north (AQ, 2016) but are outside the GPEC model area.

Northeast of GPEC, a groundwater collection system with cutoff wall has been installed along the shoreline at the PDRC site. The extraction system consists of a series of collector wells, and is reported to be extracting about 40 gpm (CRA, 2012). According to a Record of Decision, the purpose of the extraction system is to intercept contaminated groundwater prior to reaching the creek, and the purpose of the barrier wall is to prevent excessive amounts of water from the creek from entering the extraction system (DEC, 2008).

Southeast of GPEC, a pumping well is used at the Brooklyn Truck Wash for washing operations (AECOM, 2016). No details are available for the pumping well, including depth and pumping rate. AECOM (2016) reports that at the Equity site, piezometric heads observed in two wells screened at mid-depth in the UGA are lower than those at other wells in the vicinity, by a few tenths of a foot. The subject monitoring wells are screened in sand between two clay lenses. AECOM attributed the lower water levels to the effects of pumping at the truck wash, which is likely drawing water from a similar depth interval. Although details of the pumping well are not available, a sensitivity analysis (Section 5) shows that assumptions made in the subject flow model regarding the well have no significant effect on the model.

Two features near the southern model boundary, for which no information is available, are assumed to have no significant effect on the model. South of English Kills, a nonpotable supply well permit is reported to be on file for the Cornell Beverages, Inc. (AQ, 2016). No additional information is available for this well. A Metropolitan Transit Authority (MTA) subway tunnel is located south of English Kills, where shown on Figure L2-6. No information is available as to whether leakage or interception of groundwater is occurring due to the subway tunnel within the model area. A sensitivity analysis (Section 5) showed that drawdown effects of these two features, if any, would not affect groundwater flow at GPEC.

2.5 Utility Infiltration

Infiltration of groundwater into buried utility lines, or associated bedding material, can occur in low-lying developed areas where utilities intersect the water table. Along Maspeth Ave., shallow groundwater flow appears to be influenced by a storm drain and/or sanitary sewer line. Water table elevations measured in wells along Maspeth Ave. are a few feet lower than those measured on abutting properties including GPEC to the north, and BCF Oil, Ditmas, and Equity Former MGP. The high surrounding water table is attributed to water retention above marsh deposits and dense fill material as described in Section 2.1.2. The Maspeth Ave. utilities are shown on Figure L2-7.

Within Maspeth Ave., wells were installed at locations near the curb and in the travel lane north of the street centerline (SIS-100 and 200-series wells), in which measurements showed horizontal gradients toward the centerline (GEI, 2017). The sewer runs approximately along the centerline, and the drain is south of the centerline. The drain is relatively shallow and appears to straddle the water table. The sewer is several feet below the water table. Based on observed elevations of marsh deposits in surrounding areas, it is likely that marsh deposits were removed to install the sewer where shown on Figure L2-7. The water table depression along Maspeth Ave. most likely results from a combination of infiltration to the drain or bedding, and equilibration of water levels with the underlying UGA in areas where the marsh deposits are absent either naturally or by removal. It is less likely that the sewer itself has an effect, because the sewer is pressurized. The drain discharges to Newtown Creek and English Kills at outfall locations shown on Figure L2-7, allowing a potential flow path along bedding to equilibrate with surface water.

Other than along Maspeth Ave., water table elevations measured within and around GPEC show no other evidence of utility infiltration having an effect on groundwater flow patterns.

2.6 Shoreline Type

Groundwater seepage from GPEC into Newtown Creek and English Kills is assumed to be unimpeded by shoreline structures. The creek-side loading platform is a pile-supported structure, extending approximately 40 feet inland from its water-facing edge and has a large rip rap wedge surrounding its terminal landside edge (GEI, 2016). The English Kills shoreline in the area of GPEC is comprised of mainly of riprap, with shorter segments of concrete and wooden bulkheads. An approximately 100-foot length of steel sheetpile is located along the shoreline at the Ditmas property. Shoreline types within the model area as reported by AQ (2016) are shown on Figure L2-8.

Remedial barrier walls are located along the Newtown Creek shoreline at the ExxonMobil, Pratt Terminal, and Phelps-Dodge sites where shown in Figure L2-8. Sheetpile walls for structural purposes along Newtown Creek and English Kills are expected to affect groundwater discharge in the fill only, assuming the sheeting does not penetrate to depths that would alter flow in the underlying UGA. Sheetpile walls for remedial purposes penetrate partially into the UGA, at depths that are assumed to have local effects on groundwater flow and discharge to the creek.

3. Computational Flow Model

The three-dimensional groundwater model was constructed using Visual MODFLOW version 2010.0 from Schlumberger Water Services (SWS). MODFLOW is an industry standard program used for numerical groundwater modeling, developed by the United States Geological Survey (USGS) [McDonald and Harbaugh, 1988]. MODFLOW is a modular finite-difference flow model, which is a computer code that solves the general groundwater flow partial differential equation. The groundwater flow equation is a mathematical relationship which is used to describe the flow of groundwater through an aquifer. Visual MODFLOW is a graphical user interface which facilitates model input and output. The model domain is discretized into a number of three-dimensional blocks (rectangular cells) and boundary conditions are applied. For each cell, MODFLOW computes the hydraulic head using a number of hydrogeologic input parameters such as hydraulic conductivity. The site MODFLOW model was run in steady-state mode. In steady-state mode, model inflows, outflows, and heads do not vary over time. Steady-state results consist of a single flow field representing a stable condition over time. Three-dimensional particle tracking was used in the model to depict the predicted flow paths and velocities within the steady-state flow field. Elevations in the model are relative to the North American Vertical Datum of 1988 (NAVD).

General assumptions inherent to MODFLOW are:

- Groundwater flow occurs within a three-dimensional heterogeneous, anisotropic, saturated porous medium.
- Groundwater flow is laminar.
- Groundwater is incompressible.

Assumptions used in the development of the groundwater model that are specific to the Site are:

- Groundwater flow conditions are at steady-state for calibration purposes.
- The calibration data set and interpreted groundwater flow directions and gradients represent conditions typical of long-term present-day conditions, and are adequate for evaluation and comparison of potential future remedial alternatives.
- The calibration data set is assumed to represent mid-tide conditions. The groundwater elevation data set represents a multitude of investigations and gauging events, at varying or unreported times within the tide cycle. Tidal fluctuations adjacent to the canal were assumed to not affect net long-term flow directions or discharge rates to the canal.

- To model the net long-term effect of the canal surface elevation on groundwater, the head boundary within Newtown Creek and its tributaries was assumed to be Mean Sea Level.
- Each stratigraphic layer can be modeled as a homogeneous and horizontally isotropic unit, with the following localized variations in hydraulic conductivity
 - Fill material consists of sand containing silt, debris, gravel, and buried structures. It is assumed that the net effect of this condition can be represented as zones with varying hydraulic conductivity.
 - A series of clay lenses in the UGA approximately 40 feet below ground was apparent in several borings and are discretized in Layer 4 of the model. The hydraulic effects of other inter-bedding of fines or coarser material within the UGA within each layer can be approximated in the model by assigning a vertical anisotropy to hydraulic conductivity values.
- It is assumed that the Gardiners and Raritan clay units are impermeable and contributes no significant groundwater flow or pressure head to the overburden aquifer modeled.

3.1 Discretization

The model is comprised of a grid 10,000 by 10,000 feet in area with depths ranging from 100 to 330 feet deep in the southeast model corner where bedrock is deepest and ground elevation is highest. (Figures L3-1 and L3-2). Horizontal grid spacing ranges from 8 feet along Maspeth Ave., to 15 feet within and surrounding GPEC, and transitioning to 124 feet at the model corners.

The model grid is defined in North American Datum (NAD) 1983 New York State Plane East. The model axis is rotated 18.9 degrees west of north. The model axis was rotated for alignment with the GPEC property boundaries and with assumed principle flow directions of groundwater off-property towards Newtown Creek and English Kills.

3.2 Stratigraphy

Model layer elevations were defined by mapping the observed top and bottom elevations of each stratigraphic unit. For discontinuous units, dummy layer elevation points were assigned for numerical layer continuity where the geological unit is absent. The point elevations were imported to MODFLOW to define the numeric layers by interpolation.

The active model consists of five numerical layers representing seven geologic units (fill, marsh deposits, sediments, the UGA, and moraine). The model base is the Gardiners/Raritan clay, assumed to be impervious relative to the overlying UGA:

- Model Layer 1: Primary purpose is fill in and around GPEC. Also contains creek surface water boundary cells, and moraine and native UGA materials outside the filled areas.
- Model Layer 2: Primary purpose is marsh deposits and creek sediments. Also contains and moraine and native UGA materials beyond the creek and marsh deposits.
- Model Layer 3: Primary purpose is UGA. Includes moraine where inferred, and fine-grained native materials beneath sediments as mapped by AQ (2016).
- Model Layer 5: Primary purpose is UGA. Includes moraine where inferred.
- Model Layer 6: Gardiners Clay/Raritan Clay (inactive layer).

Lithology and hydrogeologic data used in defining layer elevation boundaries were obtained from boring logs as listed in Table L1. The locations of soil borings used for strata discretization are shown on Figure L3-3. Artificial elevation points were added to the data set for areas not covered by borings, mainly near the model corners to avoid excessive extrapolation during the import process. Within and along Newtown Creek and its tributaries, detailed bathymetry and sediment thickness contours reported by AQ (2016) were digitized at a spacing denser than the sediment core spacing, to produce consistent resolution and shoreline definition along the creek.

3.3 Constant Head Boundaries

Constant head boundaries (CHBs) were assigned along the model limits to represent the interface with the surrounding regional aquifer system. CHBs consist of potentiometric head elevations assigned to specific cells in the model. Groundwater can flow into and out of CHB cells, depending upon whether the neighboring groundwater is under a higher or lower potentiometric head, respectively. CHBs are commonly needed to represent conditions at the model limits where models do not extend to basin or groundwater divides.

Constant head cells were assigned in Layer 1 with head values at elev. 0.0 NAVD (Mean Sea Level) within the Newtown Creek and its tributaries (Fig. L3-4). CHB cells allow groundwater to enter the creek vertically from cells representing sediments and the underlying aquifer, and horizontally from fill through the banks or bulkheads.

A CHB was assigned along the southeastern model boundary in Layer 5 to represent a westerly component of UGA flow toward the creek consistent with regional contours. A head boundary of Elevation 14 NAVD was assigned where shown in Figure L3-5.

A CHB was assigned to the southwestern model boundary extents, where a trough in regional contours (Fig. L2-2) indicate a transition of UGA flow to a westerly direction toward the East

River. A head boundary of Elevation 2.5 NAVD was assigned to Layer 4 where shown in Figure L3-5.

A CHB was assigned along the northern model boundary where it intersects Newtown Creek. Groundwater extraction is occurring in that area outside the model limit, having an effect on UGA groundwater elevations within the model. A head boundary of Elevation 3 NAVD was assigned to model layer 5 where shown on Figure L3-5.

3.4 No-Flow (Inactive) Boundaries

No-Flow (Inactive) boundaries are located at the model limits where no head boundaries are present, and at the base of the model. At the model limits and the base of the model, where head boundaries are not present, no groundwater flow occurs in or out of the model. Flow occurs parallel to or radially outward from the inactive boundaries. At the model limits where no CHBs are shown on Figure L3-4 or L3-5, the model calibrated within tolerances without the need for CHBs. Groundwater flow patterns originating at the no-flow boundaries are governed in the model by recharge.

3.5 Drain Boundaries

Infiltration to the Maspeth Ave. drain was assumed in the model as described in Section 2.5 and where shown in Figure L2-7. Infiltration is modeled as “drain” cells with assigned head elevations, where surrounding groundwater computed to have higher head elevations can enter the drain cells, causing a flow gradient toward the drain cells. Model cells were assigned elevation values ranging from 1 to 7 feet NAVD where shown in Figure L2-7.

The drain elevations used in the model were determined by trial-and-error, where drain elevations were varied until well in the vicinity were within calibration tolerances. Where the storm drain is above the water table approaching Newtown Creek, the invert elevation was assigned, to the drain cells. Drain cells above the computed water table have no effect in the model. No drain cell elevations are below the drain invert.

3.6 Recharge

Five aquifer recharge zones were established for the model, to represent variations in ground cover (Figure L3-6). Aquifer recharge was set at:

- | | |
|---------------------------------|----------------|
| ▪ Generic Commercial/Industrial | 5 inches/year |
| ▪ Unpaved/gravel | 9 inches/year |
| ▪ Urban Undeveloped/Vegetated | 16 inches/year |
| ▪ Urban Residential | 8 inches/year |

- Impervious/Buildings 0.5 inches/year

The modeled recharge rates are consistent with estimated recharge rates for urban areas in the northeastern United States. Recharge in undeveloped areas of Long Island was estimated to equal about 50 percent of mean annual precipitation, but recharge from precipitation in the highly urbanized and industrialized areas of Kings and Queens Counties is reported to be far less because the large amounts of impervious surfaces impede infiltration (Cartwright, 2002). Buxton and Shernoff (1995) reported an annual recharge for Kings County of 15 percent of precipitation. Average annual precipitation for the New York City area for the years 1961 through 1991 was reported to be 40 to 50 inches per year [USGS, 2005]. Fifteen percent of annual precipitation would yield 6 to 7.5 inches/year of recharge to the aquifer system. AQ (2016) reported an average recharge over the potential groundwater recharge area for Newtown Creek of 8-9% of annual precipitation, using both regional recharge values scaled for land cover types within the Newtown Creek area, and separately using a more comprehensive method based on land cover. Eight to nine percent of annual precipitation would yield 3.2 to 4.5 inches/year of recharge to the aquifer system. Recharge rates in the model vary relative to the reported county-wide values to reflect local changes in infiltration rates based on ground cover. The above-average value of 20 inches/year applied in the model to some pervious areas represents a relatively small coverage of the model. The model-wide average recharge is about 6.3 inches/year. Other values reported from studies of urban areas in the region are similar, where recharge in urbanized areas near Pennsauken, New Jersey, and Allentown, Pennsylvania, were reported to range from 0 to 9 inches per year, and 0.11 to 11 inches per year, respectively [New Jersey Department of Environmental Protection (NJDEP), 2000; USGS, 2008].

Recharge values used in the model were determined by trial-and-error adjustment across a range supported by the above literature. The values used at GPEC and areas between GPEC and English Kills were discretized to capture localized influences. The Generic Commercial/Industrial value represents an average recharge for paved, unpaved, and built areas, where further discretization of recharge was not considered necessary for model calibration.

3.7 Bulkheads

Sheetpile bulkheads inhibit or potentially inhibit groundwater flow to and from the canal, where the sheeting are less permeable than the adjacent upland soil. Sheetpile bulkheads along the canal are modeled as Horizontal Flow Boundaries (“wall” boundaries). Wall boundaries were placed in the model between cells representing the creek (and sediments), and cells representing upland soil.

Hydraulic conductivity values were assigned based on literature. Field studies performed at the University of Waterloo, Ontario, resulted in reported sheetpile hydraulic conductivity estimates (Starr, 1992):

- Cold-rolled sheetpile 1×10^{-4} cm/s
- Hot-rolled sheetpile $1.5\text{--}5 \times 10^{-7}$ cm/s

No information regarding sheetpile type was available. It was assumed that cold-rolled sheetpiling was used for non-remedial bulkhead construction, and hot-rolled sheetpiling was used for remedial barrier walls. The above hydraulic conductivities were assigned in the model at the respective locations shown on Figure L2-8.

3.8 Groundwater Extraction

Groundwater extraction described in Section 2.4 was included in the model using the MODFLOW well package. Wells were assigned pumping rates shown on Figure L2-6.

Extraction rates at the ExxonMobil (including the BP and Paragon terminals) and Phelps-Dodge remedial systems appear to be consistent in the last several years such that steady-state pumping conditions can be assumed. Roux Associates (2011) provided a summary drawing with well locations and extraction rates for ExxonMobil (including the BP and Paragon terminals) totaling 707 gpm, used in the model, while rates reported by AnchorQEA (AQ, 2016, Figure F4-8) total at 580 gpm. Similar drawdowns, on the order of 3 to 4 feet below sea level, are reported for the area by both Roux Associates and AnchorQEA.

Extraction rates at the Phelps-Dodge site are consistent based on annual Operations, Monitoring & Maintenance (OM&M) reports by Conestoga-Rovers & Associates (CRA) representing years 2008-2009 and 2010-2011 (May to April cycles). A chart in the 2008-2009 OM&M report showed a breakdown in which the combined flow rate for the three southernmost extraction wells was about 20% that of the four northern wells. Flow was split evenly in each set of wells in the model, for a combined rate of 43 GPM, the approximate monthly value reported for 2010-2011 (CRA, 2012). A combined rate of 40 GPM for the site was reported by AnchorQEA.

The pumping well at Brooklyn Truck Wash described in Section was modeled as a 10 gpm well screened in the upper UGA. The rate used is assumed to support pressure washers used in the truck washing bay. It is likely that the facility recycles wash water, creating less of a demand for pumped groundwater. The truck wash pumping well in the model lowers the water table slightly in its vicinity, but does not draw in water from GPEC or significantly alter its flow path toward English Kills.

3.9 Hydraulic Conductivity

Hydraulic conductivity values used in the model were assigned based on the characteristics of the geologic units represented, using hydraulic conductivity measurement results and literature-based values as guidance.

- Table L2 lists hydraulic conductivity measurement results obtained from available sources.
- Table L3 lists hydraulic conductivity values used in the model, in comparison to the range of available measurement and literature-based values.
- Figure L3-7 shows hydraulic conductivity test locations, values, and elevation of the test zone for each respective result.
- Figures L3-8a through L3-8e show the hydraulic conductivity zones assigned to each model layer.
- Figure L3-9 shows model hydraulic conductivity zones in cross-section.
- Figure L3-10 provides cross-sectional detail at Newtown Creek.

Hydraulic conductivities were selected based on field measurements, published values for the regional formations, and published ranges for the observed soil types [Anderson, 1992; USGS, 1999], and calibration of the model to observed water level elevations. Field measurements represent hydraulic conductivity values. Vertical anisotropy was assigned during the calibration process, using literature ranges as guidance where available.

A relatively high degree of water table mounding and water level variability is apparent in areas of fill and dense moraine, as compared to a flatter water table within the bulk of the UGA. As described in the CSM, greater variability in water levels is attributed to relatively slow aquifer drainage through low hydraulic-conductivity material. Localized subunits of fill and dense moraine were assigned, in combination with adjusting recharge values, resulting in higher computed water table elevations.

No hydraulic conductivity measurements were available for the marsh deposit unit. Hydraulic conductivity of the marsh deposit aquitard was assigned using an iterative approach, where the aquitard must maintain heads in the overlying fill that are above those within the underlying UGA.

Creek sediments include soft recent organic deposits and, where present, underlying native silt and peat. In the model, the sediment column is represented as a single layer. Although discharge upwelling is likely not uniform, no trends were identified in sediment core descriptions that would justify a basis for delineation of preferential upwelling areas. It is assumed therefore that the spacing of preferential upwelling locations, if any, is uniform and proximate to the degree that upland groundwater flow is not significantly deflected. A uniform horizontal hydraulic conductivity of 3 feet/day was assigned to the sediments, which is

a typical value reported by Anchor (2016). A vertical anisotropy ratio of 10:1 showed the best calibration fit and was used in the model.

The UGA is modeled as a zone of uniform hydraulic conductivity, with the exception of moraine ridge and an intermediate clay layer. A value of 80 ft./d is used in the model, as arrived at in the calibration process (Section 4). The UGA in general is expected to have a relatively high hydraulic conductivity. Wells in the region have been reported to yield between 60 and 300 gallons per minute (NYSDEC, 1937, 1938, 1944, and 1947). AnchorQEA (2016) cited a range of hydraulic conductivities reported by others for UGA moraine deposits as being 20 to 140 ft./day. The horizontal hydraulic conductivity used in the model is in the range of published values for clean sand (Anderson & Woessner, 1992).

4. Calibration

The groundwater model provides a calculated steady-state groundwater flow field representing long-term average groundwater elevations. The objectives of model calibration consisted of matching model-calculated heads to observed heads at monitoring wells, and qualitatively matching model-calculated groundwater elevation contours to reported local and regional contours. All available groundwater elevations for GPEC were used in the calibration data set. Off-site, a high density of data points were available, in which case a subset of wells representing elevations typical for those reported in their respective vicinities were selected as calibration points. Calibration data point locations are shown on Figure L4-1.

The model was calibrated by adjustment of soil and sediment conductivities, head boundary values, and areal recharge. The calibration data points with observed and final (calibrated) water level elevations for each calibration point are shown in Table L4. Calibration residuals plots for the entire model and the UGA are shown in Figure L4-2. Computed potentiometric head contours representing the water table and UGA in Figures L4-3 and L4-4, respectively. The computed relative difference of potentiometric elevations above and below the marsh deposits are consistent with measured differences and with the conceptual flow model as described in Section 2.2.

For purposes of site characterization in the GPEC remedial investigation, the UGA was subdivided into shallow, intermediate, and deep zones. The shallow zone represents the aquifer above the marsh deposits. The intermediate and deep zones represent the UGA below the marsh deposits. Monitoring wells representing the intermediate zone are screened in the approximate range of 25 to 60 feet below ground surface. Monitoring wells representing the deep zone are screened below 60 feet below ground surface. There is no geologic strata break between the zones. As can be seen by comparison of the shallow/deep contours in Attachment A, groundwater elevations appear to be similar between the two zones. A vertical gradient analysis was done as part of the Interim RI, where measured differences between intermediate and deep piezometric heads in well clusters were on the order of 0.02 ft., with a maximum difference of 0.52 ft (GEI, 2016). Measured gradients were both downward and upward, suggesting minor transient or tidally-influenced trends. In the model, a slight computed downward gradient in upland areas occurs due to recharge influence. Computed gradients shift upward beneath Newtown Creek where discharge occurs.

The calibration data set includes measurements taken at remedial investigation sites between 2008 and 2017, and at regional USGS locations from the 1990s through about 2013. Discrete measurements were used for all locations except:

- Newtown Creek site, tidally-averaged values based on continuous logging reported by AnchorQEA (AQ 2016, Table F3-4).
- Regional USGS locations, long-term regional stabilized groundwater elevations (Figure L2-4).
- For wells installed along the Maspeth Ave. utility corridor (Section 2.5), approximate average values from a continuous logging event were used (National Grid, 2017a).

On the calibration plots it can be seen that high heads were computed by the model where high heads were observed (at shallow depths near Maspeth Ave; the dense moraine area, and USGS locations further from the creek) and low heads were computed where low heads were observed (along the creek and in the ExxonMobil groundwater extraction area). The primary statistical goal for model calibration was to obtain a normalized root mean square of the residuals of less than 10%. The normalized RMS for the model calibration is approximately 5.4%, for all calibration points, and 6.6 % for the UGA calibration points, which are well below this statistical objective, and thus shows that the model is well calibrated.

The dominant trends in the conceptual site model are considered to be qualitatively met: upward preferential discharge zones with relatively low heads in the Upper Glacial Aquifer are represented by the lower observed and calculated heads (Figure L4-4), where the potentiometric surface within the Upper Glacial Aquifer at GPEC is relatively flat, ranging primarily between elevations 1 and 2.5 NAVD. Similarly, calibration residuals for the shallow zone (Figure L4-2, Layer 1) indicates that higher groundwater elevations are being maintained in areas at and south of GPEC above the marsh deposit unit.

A water budget for the model is presented in section I of Table L5. As shown in Table L5, the percent difference between calculated flow rates entering and leaving the model are within a fraction of a percent, which is considered acceptable. The model was run with head change and residual criterion between numerical iterations set to 0.01 feet using the Newton-Raphson solver for MODFLOW 2005 (MODFLOW-NWT).

5. Results and Sensitivity Analysis

Model output was evaluated using computed potentiometric contours, particle tracking, and Zone Budget flow rate calculations. Particle tracks were used to evaluate flow paths toward potential receptor locations. Zone Budget is a post-processing feature used to compute volumetric flow rates across user-defined horizontal and/or vertical planes in the model, based on the computed flow field.

Figures L5-1 and L5-2 show the computed potentiometric contours and particle paths for Layers 1 and 4 which represent the water table and intermediate-zone UGA, respectively. On Figure L5-1, computed shallow groundwater elevations are highest in the northeast and southwest areas of GPEC. In the northeast, the high elevations are associated with water retention in dense moraine material. In the southwest, the marsh deposits impede drainage of recharge in the fill, resulting in water table mounding above the marsh deposits. Groundwater flow occurs laterally above the marsh deposits, until connecting hydraulically with the UGA where the marsh deposits are absent. Particle paths depict this pattern on Figure L5-1. The model shows that shallow groundwater flowing off-property flows northward to the ExxonMobil extraction system; easterly toward Newtown Creek (discharging through or beneath the pervious loading platform support), and southerly toward English Kills. Groundwater divides, where flow splits between the three principle offsite flow directions, can be inferred in central areas of GPEC from the particle paths. Some shallow groundwater is captured by the Maspeth Ave. utilities. Although some particle tracks terminate along Maspeth Ave., some shallow groundwater may bypass the utilities.

On Figure L5-2, the computed heads in the UGA within GPEC are in the 1.0 to 2.0 ft elevation range. Computed flow directions are similar to those described for the shallow zone (except for mounded water above marsh deposits), where on-property flow splits toward the northern, eastern, and southern property boundaries.

The results of the Zone Budget flow analysis are shown in Section II of Table L5. In general, recharge originating within GPEC constitutes most (73%) of the computed groundwater flow occurring within GPEC. A lesser amount (24%) enters GPEC as UGA flow from areas further upland to the north. A relatively small amount of flow (4%) enters GPEC as northeasterly flow from eastern areas of Maspeth Ave. Flow leaving the GPEC site occurs at relatively similar computed rates across the northern (34%), eastern (42%), and southern (24%) property boundaries.

An analysis was performed to evaluate the sensitivity of input parameters on model calibration. Hydraulic conductivity and recharge would have the greatest effect on modeled groundwater

flow at the Site. Additional sensitivity analyses were performed due to uncertainties in water withdrawals or potential water withdrawals, where model calibration was to be compared to varying water withdrawal effects. The analysis was performed by comparing the change in calibration residuals with changes in input parameters.

Calibration error, as measured by the normalized root mean square (NRMS) of the calibration residuals (calculated minus observed heads) for the sensitivity runs are shown in Figures L5-3 and L5-4. The NRMS is a measure of the correlation between observed and predicted heads. In general, the NRMS varies as the parameters change, and the lowest NRMS value corresponds to the most accurate parameter value for the model. Therefore, as the parameter is varied further from its most accurate value, the NRMS increases, and the plot of NRMS vs. parameter value would be a curve where the low point corresponds to the value most appropriate for use in the system modeled. However, if the calibrated model is not sensitive to a parameter, the NRMS may not change, and a sensitivity analysis for the subject parameter would be recommended for the predictive model.

5.1 Hydraulic Conductivity Sensitivity

Hydraulic conductivity for key strata in the model (fill, UGA, marsh deposits, sediments, native fine-grained material beneath sediments, and moraine subunits) were increased and decreased to values within ranges reasonable for the soil type. Sensitivity analysis for vertical hydraulic conductivity was run for strata in which vertical hydraulic conductivity governs flow more so than horizontal (marsh deposits, sediments, and fine-grained material beneath sediment). Calibration showed that the model was sensitive to variation of each parameter.

5.2 Recharge Sensitivity

The annual recharge rate for each recharge zone in the model was varied over a range of several inches. The model was roughly equally sensitive to changes in each recharge zone. Based on the quantitative sensitivity analysis results shown on Figures L5-3 and L5-4, and qualitative model calibration where no data points exist, it is expected that the model inputs are reasonably accurate.

5.3 Groundwater Withdrawal Sensitivity

In the Conceptual Site Model description (Section 3.8), potential groundwater withdrawal sources were described, for which no information is available to confirm or quantify the sources. The two sources include: a pumping well at Brooklyn Truck Wash, a permitted non-potable well at Cornell Beverages, and the MTA L-Train subway tunnel (Figure L2-6).

At the Brooklyn Truck Wash, a withdrawal of 5 gpm was assumed in the calibrated model. As the actual rate is unavailable, a capture zone analysis was performed to evaluate whether the well or its pumping rate could potentially affect groundwater flow at GPEC. The modeled value was based on a review of commercial pressure-washer capacities, where washer models appear to have a 3 to 5 gpm capacity. Assuming that the truck wash does not operate full time annually, and that two pressure washers are used, and filtration/recycling of wash water is employed, it is unlikely that the withdrawal exceeds 5 gpm. A capture zone analysis was performed assuming 10 and 50 gpm continuous withdrawal rates. On Figure L5-5, particle tracks show that at the modeled pumping rates, the well does not capture groundwater from GPEC even at 50 gpm. With a higher pumping rate, groundwater flowing off-property from GPEC may deflect slightly, but would still discharge to English Kills.

The potential effects of Cornell Beverages pumping and MTA dewatering were analyzed as a single source, as drawdown from both or either would have similar effects on groundwater flow approaching English Kills and GPEC. Water withdrawals at those distances (about 1 mile from GPEC) would need be substantial to affect flow at GPEC. Drawdown was modeled by adding a head boundary where shown on Figure L5-6, and adjusting the head value to simulate drawdown up to several feet below the static condition in the area. Drawdown was stepped up (i.e. the CHB elevation lowered) incrementally and the effect on model calibration was compared. The graph on Figure L5-6 shows that calibration error increases with increasing drawdown. The increase in calibration error indicates that water withdrawals in the area of Cornell Beverages or the MTA tunnel, if any, are below levels that affect groundwater flow at GPEC.

References

AECOM, 2016. Draft Remedial Investigation Report, Former Equity Works MGP Site, 222-254 Maspeth Ave., Brooklyn, Kings County, New York, AECOM, March 2016.

AnchorQEA, 2016. Draft Remedial Investigation Report, Remedial Investigation / Feasibility Study, Newtown Creek, AnchorQEA, LLC, November 2016.

Anderson & Woessner, 1992. Applied Groundwater Modeling: Simulation of Flow and Advective Transport. Anderson M.P. and Wossner, W.W., Academic Press, Inc., 1992.

Buxton and Shernoff, 1999. Ground-Water Resources of Kings and Queens Counties, Long Island, New York, by Herbert T. Buxton and Peter K. Shernoff, Water-Supply Paper 2498, U.S. Geological Survey, 1999.

Buxton and Smolensky, 1999. Simulation of the Effects of Development of the Ground-Water Flow System of Long Island, New York, Water-Resources Investigations Report 98-4069. Buxton, H.T. and Smolensky, D.A., U.S. Geological Survey, 1999.

Cartwright, R. A., 2002. History and Hydrologic Effects of Ground-Water Use in Kings, Queens, and Western Nassau Counties, Long Island, New York, 1800s through 1997. United States Geological Survey Water-Resources Investigations Report 01-4096.

CEUS, 2012. Second Quarter 2012 Status Report, Former Ditmas Oil Terminal, 364 Maspeth Avenue, Brooklyn, New York, Spill Number 90-06603, CEUS Engineering, P.C. & Advanced Site Restoration, LLC., July 20, 2012.

CRA, 2012. Operations, Maintenance, and Monitoring Report – May 1, 2010 to April 30, 2011, Barrier Wall and Groundwater Collection/Treatment System, Laurel Hill Site, Maspeth, New York. Conestoga-Rovers & Associates, January 2012.

Delta, 2006. Remediation System Installation Summary and Annual System Status Report, BP Bulk Petroleum Storage Terminal, 125 Apollo Street, Brooklyn, New York, NYSDEC MOSF #02-1200, Delta Environmental Consultants, March 29, 2006.

DEC, 2008. Record of Decision, Phelps Dodge (Laurel Hill) Site, Maspeth, Queens County, Site Number 2-41-002. New York State Department of Environmental Conservation, January 2003.

Fetter, 1994. Applied Hydrogeology, Third Edition. Fetter, C.W. Prentice-Hall, Inc., 1994.

GEI, 2011. Remedial Investigation Work Plan, Greenpoint Energy Center Former Manufactured Gas Plant Site, 287 Maspeth Avenue, Brooklyn, New York 11211, ACO Index No. A2-0552-0606, site #224052. GEI Consultants, Inc., November 28, 2011.

GEI, 2016. Interim Remedial Investigation Report, Phases 1 and 2, Greenpoint Energy Center, 287 Maspeth Avenue, Brooklyn, New York 11211, Site #224052, GEI Consultants, Inc., November 2016.

HYDROQUAL, 2000. Remedial Investigation Report, Operable Unit 1A, Laurel Site, Maspeth, New York, Hydroqual/EEA, November 2000.

McDonald and Harbaugh, 1988. A modular three-dimensional finite-difference ground-water flow model, Techniques of Water-Resources Investigations 06-A1, USGS.

Misut and Monti, 1999. Simulation of Ground-Water Flow and Pumpage in Kings and Queens Counties, Long Island, New York, by Paul E. Misut and Jack Monti, Jr., Water-Resources Investigations Report 98-4071, U.S. Geological Survey.

MPI, 2010. Remedial Investigation Report, BCF Oil Site, Brooklyn, New York, Site #2-24-024, Malcolm Pirnie, Inc., December 2010.

National Grid, 2017a. Additional Investigation Report, Phase 2/3 Remedial Investigation, Greenpoint Energy Center Former Manufactured Gas Plant, 287 Maspeth Avenue, Brooklyn, New York, Site No. 224052, 2017.

National Grid, 2017b. Loading Platform Area Investigation Report, Remedial Investigation Areas 1 and 2, Greenpoint Energy Center Former Manufactured Gas Plant, 287 Maspeth Avenue, Brooklyn, New York, Site No. 224052. National Grid, 2017.

NJDEP, 2000. Ground-Water-Recharge Rates and Selected Open Space in the Rancocas, Pennsauken and Cooper Watersheds, New Jersey, Open-File Map OFM-32, Mark A. French and Jeffrey L. Hoffman, New Jersey Department of Environmental Protection, 2000.

NYSDEC, 1937. Record of Wells in Kings County, N.Y., State of New York Department of Conservation, by the United States Geological Survey, Bulletin GW-3, 1937.

NYSDEC, 1938. Record of Wells in Queens County, N.Y., State of New York Department of Conservation, by the United States Geological Survey, Bulletin GW-6, 1938.

NYSDEC, 1944. Record of Wells in Kings County, N.Y., State of New York Department of Conservation, by R.M. Leggette and M.L. Brashears, Jr., Bulletin GW-8, 1944.

NYSDEC, 1947. Record of Wells in Queens County, N.Y., Supplement 1, State of New York Department of Conservation, by the United States Geological Survey, by C.M. Roberts and Marion C. Jaster, Bulletin GW-6, 1947.

Roux, 2011. Recovery Well RW-26 Aquifer Test Report, ExxonMobil Greenpoint, Petroleum Remediation Project, Greenpoint, Brooklyn, New York, Roux Associates, Inc., April 11, 2011.

URS, 2009. Site Characterization, Phase IV Data Summary Report, Prepared for New York State Department of Environmental Conservation, Work Assignment D004433-22, Site No. 2-24-121, URS Corporation, May 2009.

USGS, 2005. New York Average Annual Precipitation, 1961-1990, in National Atlas of the United States, <http://nationalatlas.gov>

USGS, 2008. Spatial Distribution of Ground-Water Recharge Estimated with a Water-Budget Method for the Jordan Creek Watershed, Lehigh County, Pennsylvania. Scientific Investigations Report 2008-5041, U.S. Geological Survey, 2008.

Tables

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
UPLAND BORINGS												
GPEC	GPEC-SB01B/MW-01/1D	651236.8	687779.0	8.2	99.0	-21.8		-25.8				
GPEC	GPEC-SB02/MW-02	651144.0	688035.5	7.5	100.0			-30.6			-90.6	
GPEC	GPEC-SB03/MW-03D	651051.4	688300.9	6.9	115.0	-22.3		-31.1			-99.1	
GPEC	GPEC-MW-04/4D	650941.5	688532.8	6.1	115.0	-28.9		-40.9	-29.3	-40.9		
GPEC	GPEC-MW5D/D2	650755.9	688966.9	6.8	190.0	-14.2		-27.2			-107.2	-180.2
GPEC	GPEC-SB06/MW-06	650799.7	687870.6	12.3	50.0			1.3				
GPEC	GPEC-SB07/MW-07	650777.9	688126.2	7.3	114.0	-6.1		-18.7			-88.7	
GPEC	GPEC-SB08/MW-08	650558.5	688452.1	5.7	80.0							
GPEC	GPEC-SB10/MW-10	650394.3	687734.6	13.5	70.0			4.5				
GPEC	GPEC-SB12/MW-12	649520.1	687767.4	16.6	64.0	-6.0		-10.4				
GPEC	GPEC-SB13/MW-13	649202.1	688779.6	51.1	70.0							
GPEC	GPEC-SB101A/MW-101D	650823.0	687711.1	12.6	120.0			-5.4				-102.4
GPEC	GPEC-SB102/MW-102D	651026.4	687528.0	11.8	112.0	-8.2		-14.5	-18.2		-95.2	
GPEC	GPEC-SB103	651253.5	687792.3	7.3	120.0							
GPEC	GPEC-SB104	651193.2	687953.4	8.0	107.0	-25.0		-27.0			-94.0	
GPEC	GPEC-SB105/MW-02D	651161.1	688040.6	7.2	105.0			-25.8			-94.8	
GPEC	GPEC-SB106/MW-03WT	651074.8	688297.3	6.3	107.0						-97.1	
GPEC	GPEC-SB107/MW-11D	650043.2	687995.2	13.5	100.0	2.4		-2.6			-72.4	
GPEC	GPEC-SB-201/MW-201	649960.4	687570.6	12.5	75.0	-7.5		-12.5	-27.5			
GPEC	GPEC-SB-202/MW-202	651060.8	687655.6	9.8	83.0	-7.9		-20.2			-71.0	
GPEC	GPEC-SB-203	651266.0	687689.8	8.4	87.0	-20.3		-24.3				
GPEC	GPEC-SB-204	651178.7	687740.1	8.8	87.0	-8.2		-15.3				
GPEC	GPEC-SB-205/MW-205	651230.3	687861.2	8.4	97.0	-24.4		-27.6			-87.6	
GPEC	GPEC-SB-206	651125.5	688139.4	6.8	87.0	-21.7		-27.7				
GPEC	GPEC-SB-207	651100.1	688206.1	6.6	87.0	-22.9		-30.4				
GPEC	GPEC-SB-208	651041.9	688352.3	4.9	87.0	-25.1		-29.7	-29.7			
GPEC	GPEC-SB-209	651016.8	688445.9	5.9	87.0	-21.2		-23.2	-23.2			
GPEC	GPEC-SB-210	650976.6	688621.9	6.7	87.0			-33.3				
GPEC	GPEC-SB-211	650931.7	688746.5	6.5	80.0	-28.5		-30.4				
GPEC	GPEC-SB-212	650891.7	688868.4	6.1	87.0	-21.9		-26.9	-26.9			
GPEC	GPEC-SB-213	650682.6	689037.0	5.0	87.0			-27.9				
GPEC	GPEC-SB-214	650746.0	689179.9	5.9	87.0				-40.5		-67.9	
GPEC	GPEC-SB-215	650688.7	689349.4	7.2	87.0			-27.8	-24.8		-69.8	
GPEC	GPEC-SB-216	650656.4	689443.5	6.7	87.0				-30.3		-66.8	
GPEC	GPEC-SB-217/MW-217S.I.D	650048.9	688824.3	21.8	87.0			6.8	9.8		-52.5	
GPEC	GPEC-SB-218/MW-218I.D	649213.6	688790.1	51.1	117.0						-53.4	
GPEC	GPEC-SB-219/MW-219S.I.D	648863.2	688284.2	39.5	133.0						-58.0	
GPEC	GPEC-SB-220/MW-220S.I.D	648658.7	687492.9	21.9	97.0	3.7		-1.5			-57.1	
GPEC	GPEC-SB-221/MW-221S.I.D	649585.3	687634.6	14.7	95.0	-2.3		-12.3	-18.0		-76.6	
GPEC	GPEC-SB-222/MW-222S.D	649226.3	686985.6	13.9	100.0	-4.7		-23.2	-23.2		-67.4	
GPEC	GPEC-SB302	650904.6	687469.7	11.8	75.0	-9.0		-13.2				
GPEC	GPEC-SB304B	649221.2	687199.9	14.4	30.0	-6.6		-9.6				
GPEC	GPEC-SB306	650607.2	687360.3	12.0	75.0			-1.0				
GPEC	GPEC-SB314	650409.9	687516.7	13.1	15.0	0.4		-2.6				
GPEC	GPEC-SB317	650410.9	687317.3	11.9	15.0	-1.4		-4.4				
GPEC	GPEC-SB319	649983.7	687177.1	12.3	80.0	-8.5		-27.7	-27.7	-61.7		
GPEC	GPEC-SB325	649987.1	687324.0	12.2	30.0	-14.8		-17.8				
GPEC	GPEC-SB326	649371.5	686975.0	13.0	30.0	-13.7		-16.7				
GPEC	GPEC-SB328	649824.7	687119.1	11.7	75.0	-5.9		-28.3	-28.3	-48.3		

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
GPEC	GPEC-SB330	649463.5	687242.3	14.4	30.0	-8.1		-11.1				
GPEC	GPEC-SB331	649292.8	686925.4	13.9	75.0	-11.1		-24.1	-24.1			
GPEC	GPEC-SB332	649448.9	686982.6	13.5	90.0	-9.7		-28.2	-28.2	-56.5	-72.9	
GPEC	GPEC-SB333	649128.7	686891.9	14.2	80.0	-7.1		-26.0	-25.8	-47.1		
GPEC	GPEC-SB334	649017.0	686850.3	14.8	75.0	-10.8		-19.2	-19.4	-37.7		
GPEC	GPEC-SB339	648739.3	687188.5	15.1	85.0			-6.2			-49.9	
GPEC	GPEC-SB341	648833.6	687138.4	20.8	30.0	-5.2		-8.2				
GPEC	GPEC-SB344	648882.4	686805.2	15.2	85.0	-11.6		-18.8	-12.6	-18.8	-64.8	
GPEC	GPEC-SB346	650262.4	687573.7	12.6	20.0	-2.2		-5.2				
GPEC	GPEC-SB349	648788.5	687278.9	14.2	30.0	-2.6		-5.6				
GPEC	GPEC-MW401	649002	688086	30.0	100.0						-56.0	
GPEC	GPEC-MW402	650301	688085	13.5	100.0							
GPEC	GPEC-MW403	651255	687736	7.9	50.0	-18.1						
GPEC	GPEC-MW404	651232	687857	8.5	55.0							
GPEC	GPEC-MW405	651191	687955	8.6	70.0	-22.4						
GPEC	GPEC-MW406	651161	688048	7.4	80.0							
GPEC	GPEC-MW407	651129	688153	7.3	50.0							
GPEC	GPEC-MW408	651101	688218	6.9	50.0							
GPEC	GPEC-MW409	651085	688274	6.9	80.0							
GPEC	GPEC-MW410	651068	688321	6.5	55.0							
GPEC	GPEC-SB701	649846.2	688858.4	25.4	102.0	24.4		-5.0			-48.1	
GPEC	GPEC-SB708	649439.2	688706.5	49.3	30.0	49.3						
GPEC	GPEC-SB709	649292.8	688768.6	50.2	30.0	26.2		-5.0				
GPEC	GPE-MW-1S/1D	650044.9	689233.8	11.0	50.0	-7.0		-15.0				
GPEC	GPE-MW-2S/2D/D2	650606.2	689370.9	11.3	52.0	-24.7		-26.7			-76.2	
GPEC	GPE-MW-3S/3D	650643.6	689307.4	10.8	50.0	-7.7		-28.7				
GPEC	GPE-MW-4S/4D	650671.9	689241.0	11.1	52.0	-18.9		-22.9				
GPEC	GPEC-07	650483.9	689332.2	5.9	50.0	-7.1		-12.1				
GPEC	GPE-08	650543.9	689356.2	7.3	50.0	-12.8		-22.8				
GPEC	GPESB-18	650608.6	689240.9	5.7	50.0	-12.3		-28.3	-21.6	-30.3		
GPEC	GPESB-22	650618.2	689175.5	5.7	50.0	-10.8		-12.8	-20.3	-30.3		
GPEC	GPESB-25	649824.3	689180.5	28.7	48.0	5.7		-1.3				
GPEC	GPESB-27	650172.4	689252.2	22.1	30.0			-2.9				
GPEC	GPESB-28	650122.0	689183.5	22.7	30.0			-3.6				
GPEC	GPEC-GT01(MW)	649699.0	687047.4	10.7	62.0	-9.3		-17.3	-28.8			
GPEC	GPEC-GT03(MW)	650075.7	687177.6	12.7	52.0	-7.3		-25.8	-25.8			
GPEC	GPEC-GT04D(MW)	650302.1	687257.6	12.1	72.0	-9.9		-20.4				
GPEC	GPEC-GT05/5D	650420.6	687292.8	12.0	177.0	3.0		0.0			-117.5	
GPEC	GPEC-GT07D(MW)	650762.8	687412.0	12.4	52.0							
GPEC	GPEC-GT08	650951.2	687503.2	10.3	57.0	-1.7		-15.6	-17.7	-33.2		
GPEC	GPEC-GT10D(MW)	651321.9	687649.4	8.1	121.9			-28.5				
GPEC	GPEC-GT12	651325.2	687782.5	-14.9	66.0		-14.9	-38.4				
GPEC	GPEC-GT14	651237.3	688036.1	-16.1	52.0		-16.1	-39.6				
GPEC	GPEC-GT16	651138.3	688324.0	-16.0	102.0		-16.0	-39.5	-39.5	-49.5	-109.5	
GPEC	GPEC-GT18	651010.6	688694.4	-15.1	57.0		-15.1	-34.6	-34.6	-53.6		
GPEC	GPEC-GT20	650882.8	689065.1	-19.4	66.8		-19.4	-35.4	-35.4	-67.9		
GPEC	GPEC-GT22	650748.6	689448.9	-16.5	52.0		-16.5	-29.5	-29.5	-52.5		
GPEC	GPEC-SIS101S	649869.7	687064.9	11.5								
GPEC	GPEC-SIS102S	649876.5	687054.8	12.0								
GPEC	GPEC-SIS102I	649881.6	687056.3	12.0								

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
GPEC	GPEC-SIS103S	650430.7	687257.8	11.6								
GPEC	GPEC-SIS104S	650430.4	687247.9	11.9								
GPEC	GPEC-SIS104I	650436.3	687249.8	11.9								
BCF / Ditmas	BCF-SB-E13	650160.0	686979.5	11.0	30.0	-17.0			-17.0			
BCF / Ditmas	BCF-SB-G9	650173.0	687058.5	13.0	20.0	-6.0						
BCF / Ditmas	BCF-SB-I9	650202.1	687068.5	11.8	30.0	-6.7		-9.7				
BCF / Ditmas	BCF-SB-I9A	650199.1	687071.7	13.0	35.0	-18.0			-18.0	-21.0		
BCF / Ditmas	BCF-SB-I19A	650279.7	686881.3	10.9	20.0	-5.1		-9.1				
BCF / Ditmas	BCF-SB-K19	650319.4	686906.9	17.0	30.0	0.5						
BCF / Ditmas	BCF-SB-M7	650254.2	687137.8	12.0	15.0	1.0		-2.0				
BCF / Ditmas	BCF-SB-N21A	650371.5	686888.6	16.0	25.0	-6.0		-9.0				
BCF / Ditmas	BCF-SB-O8	650305.4	687127.7	12.0	20.0	-7.0		-10.0				
BCF / Ditmas	BCF-SB-Q17	650390.9	686967.0	15.9	20.0	-1.1		-4.1				
Equity MGP	SB-3B/MW-3B(Eq)	649224.2	686735.7	12.1	48.0	-1.9		-11.9	-25.9			
Equity MGP	SB-4C/MW-4C(Eq)	649387.3	686648.6	12.9	87.0	-9.1		-14.1	-31.1	-74.1		
Equity MGP	SB-6B/MW-6B(Eq)	648871.9	686625.0	13.2	55.0	-4.8		-18.8	-22.8	-26.8		
Equity MGP	SB-7B(Eq)	649404.9	686600.2	12.5	46.0	-2.5		-12.8				
Equity MGP	SB-11(Eq)	649222.8	686609.4	13.6	64.0	-4.4		-12.4	-30.6			
Equity MGP	SB-12B(Eq)	649313.7	686661.3	12.3	54.0	-5.7		-13.7				
Equity MGP	SB-14B(Eq)	649081.9	686605.7	12.9	56.0	-6.1		-11.6	-31.1			
Equity MGP	SB-15(Eq)	649175.8	686693.1	11.9	54.0	-4.6		-11.8	-30.1			
Equity MGP	SB-17(Eq)	649316.5	686604.6	12.8	50.0	-5.2		-11.7	-33.2			
Equity MGP	SB-18(Eq)	649370.5	686598.4	12.5	52.0	-3.1		-12.8	-27.6			
Equity MGP	SB-1C/MW-1C(Eq)	648934.5	686446.7	12.9	100.0	-7.1		-11.1			-84.0	
Equity MGP	SB-25	649555.8	686593.1	11.1	110.0	-8.9		-18.9	-26.9	-78.9	-93.4	
Equity MGP	SB-27	648987.0	686797.5	14.0	100.0	-10.5		-13.3	-22.0	-59.0	-82.0	
Equity MGP	SB-28	649137.1	686851.3	13.4	100.0	-9.6		-15.6	-23.6	-51.6	-84.6	
Equity MGP	SB-33	648966.5	686867.9	15.3	100.0	-2.7		-20.7	-20.7	-31.7	-67.7	
Equity MGP	SB-34	648894.4	686792.4	15.1	100.0	-7.9		-13.9			-63.4	
Equity MGP	SB-35	648944.6	686944.9	16.2	50.0	-9.8		-28.8	-28.8	-32.8		
Equity MGP	T1-SB1	649528.8	686647.2	11.0	0.0	-9.0		-14.0				
Equity MGP	T1-SB5	649558.0	686562.2	10.8	0.0	-6.2		-13.0				
Equity MGP	T1-SB10	649585.8	686481.7	10.7	0.0	-10.3		-12.3				
Equity MGP	T2-SB1	649590.6	686467.7	11.0	0.0	-9.0		-13.0				
Equity MGP	T3-SB1	649442.0	686285.3	10.0	0.0	-4.5		-13.5				
Equity MGP	T3-SB5	649583.9	686334.1	10.4	0.0	-6.6		-14.1				
Equity MGP	T4-SB6	649807.4	686403.8	11.0	8.0							
Equity MGP	T5-SB1	649868.1	686599.1	11.4	30.0	-2.6		-8.6				
Equity MGP	T5-SB5	649848.6	686655.8	11.8	30.0	-0.7		-8.2	-8.2	-14.2		
Equity MGP	T5-SB8	649833.9	686698.3	11.6	30.0	-9.4		-15.4				
Equity MGP	T6-SB1	649890.3	686534.6	11.3	30.0	-14.7		-15.7				
Meeker Ave.	DEC-005	648098.8	688776.8	42.2	48.0			-5.0				
Meeker Ave.	DEC-006	648555.4	688631.9	48.9	56.0	20.9		-5.0				
Meeker Ave.	DEC-014	648374.6	687992.9	36.2	40.0	17.2		-5.0				
Meeker Ave.	DEC-018	649032.3	689018.2	53.2	92.0	24.2		-5.0				
Meeker Ave.	DEC-021	649527.0	689743.4	27.9	37.0			-5.0				
Meeker Ave.	DEC-024	646819.6	690261.3	20.2	55.0	19.2		-5.0	-39.8			
Meeker Ave.	DEC-029	648484.5	688206.8	38.9	51.0	24.9		-5.0				
Meeker Ave.	DEC-030	648258.5	688123.6	37.4	45.0	13.4		-5.0				
Meeker Ave.	DEC-031	648326.2	687876.8	34.7	45.0			-5.0				

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
Meeker Ave.	DEC-032	648452.0	687639.7	28.3	45.0			-5.0				
Meeker Ave.	DEC-041	648859.5	688940.3	54.5	63.0	19.5		-5.0				
Meeker Ave.	DEC-043	648704.1	688291.8	37.7	50.0			-5.0				
Meeker Ave.	DEC-048	648258.5	687281.6	28.7	45.0	19.7		-5.0				
Meeker Ave.	DEC-050	649245.8	689560.4	33.3	76.0			-5.0				
Meeker Ave.	DEC-051	649367.8	689340.1	39.3	81.0	22.3		-5.0				
Meeker Ave.	DEC-052	649489.8	689136.8	35.4	45.0	-5.6		-5.0				
Meeker Ave.	MW-19	647781.9	688771.6	37.8	35.0							
Meeker Ave.	MW-20	647424.8	689398.8	30.4	36.0							
PDRC	OW12-99	651406.033	691182.4	38.0	40.0							
PDRC	PD-17	650958.244	690032.3	9.0	71.0							
PDRC	PDW-13	651253.793	690308.5	11.0	70.0							
PDRC	PDW-36	651642.173	689412.1	10.0	72.0							
PDRC	B-5	651602.792	689643.9	8.0	101.0							
PDRC	PDI-31	651829.554	689887.2	13.0	72.0							
USGS	K37.1	647561.9	683272.3	25.0	130				-38.0	-76.0	-101.0	
USGS	K675.1	650462.6	687237.6	13.0	222.2						-87.0	-190.0
USGS	K677.1	648311.2	686515.3	19.0	215.2				-31.0	-75.0	-107.0	-176.5
USGS	K678.1	646621.8	685796.2	39.0	221.2				-46.0	-81.0	-81.0	-161.0
USGS	K679.1	647142.7	688633.0	35.0	218				-47.0	-85.0	-85.0	-163.0
USGS	K689.1	648674.7	689857.1	31.0	160				-44.0	-64.0	-89.0	-111.0
USGS	K889.1	648557.2	684189.4	15.0	74							
USGS	K893.1	648796.0	682976.6	20.0	118						-61.0	
USGS	K894.1	649726.7	681970.6	30.0	282				-57.0	-82.0	-82.0	
USGS	K1346.1	651486.7	683702.4	15.0	168						-147.0	
USGS	K3111.1	649333.8	683182.5	17.3	89							
USGS	Q390.1	648894.0	691680.1	23.0	211				-56.0	-76.0	-85.0	-171.0
USGS	Q431.1	653654.8	693532.8	104.0	242.7						-113.0	-118.7
USGS	Q432.1	653216.9	692156.8	115.0	301.8							-166.8
USGS	Q434.1	653280.6	691911.1	89.0	262.8				-30.0	-42.0	-53.0	-147.3
USGS	Q435.1	653054.4	691201.3	63.0	259.3							-176.3
USGS	Q436.1	651921.5	687854.3	8.0	217.2				-57.0	-112.0	-112.0	-189.2
USGS	Q437.1	653841.7	688575.4	5.0	260						-81.0	-206.5
USGS	Q438.1	652837.4	689074.7	4.0	207.6						-83.4	-183.5
USGS	Q603.1	649432.9	691683.6	69.0	202.2							-111.2
USGS	Q1068.1	654912.8	689594.5	20.0	42			0.0	-22.0			
USGS	Q1085.1	651513.4	691393.5	55.0	170			-5.0			-29.0	-114.0
USGS	Q1274.1	654761.5	689188.7	15.0	80			0.0	-40.0			
USGS	Q1412.1	656473.7	686467.9	42.0	140			-5.0			-95.0	
USGS	Q1947.1	652480.5	684822.1	14.2	83			-5.0				
SEDIMENT CORES												
GPEC	GPEC-SED01	651535.8	687819.1	-14.4	20.0		-14.4	-30.4				
GPEC	GPEC-SED02	651441.1	687786.8	-13.8	20.0		-13.8	-28.9				
GPEC	GPEC-SED03	651346.4	687754.6	-11.7	20.0		-11.7	-31.7				
GPEC	GPEC-SED04	651497.0	687937.8	-17.8	20.0		-17.8	-30.9				
GPEC	GPEC-SED05	651400.6	687905.6	-15.9	20.0		-15.9	-30.5				
GPEC	GPEC-SED06	651306.0	687873.3	-18.3	20.0		-18.3	-35.4				
GPEC	GPEC-SED07	651454.8	688056.6	-18.5	20.0		-18.5	-33.6				
GPEC	GPEC-SED08	651360.2	688024.3	-18.3	20.0		-18.3	-34.7				
GPEC	GPEC-SED09	651265.5	687991.0	-18.2	20.0		-18.2	-35.4				

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
GPEC	GPEC-SED10	651445.1	688180.2	-22.4	20.0		-22.4	-40.2				
GPEC	GPEC-SED11	651329.6	688129.7	-17.8	20.0		-17.8	-35.8				
GPEC	GPEC-SED12	651225.0	688110.8	-16.9	20.0		-16.9	-33.8				
GPEC	GPEC-SED13	651373.9	688294.1	-22.0	20.0		-22.0	-36.1				
GPEC	GPEC-SED14	651279.2	688261.8	-19.8	20.0		-19.8	-35.4				
GPEC	GPEC-SED15	651184.6	688229.5	-18.4	20.0		-18.4	-33.4				
GPEC	GPEC-SED16	651333.4	688412.8	-22.0	20.0		-22.0	-35.7				
GPEC	GPEC-SED17	651239.0	688348.9	-22.1	20.0		-22.1	-39.0	-39.0	-42.1		
GPEC	GPEC-SED18	651144.1	688348.3	-16.8	20.0		-16.8	-32.1	-32.1	-36.8		
GPEC	GPEC-SED19	651105.5	688918.2	-23.0	20.0	-37.4	-23.0	-37.4	-39.6	-43.0		
GPEC	GPEC-SED20	650948.2	688859.3	-19.7	20.0		-19.7	-36.0				
GPEC	GPEC-SED21	651027.4	689603.8	-18.6	20.0		-18.6	-33.5	-33.5			
GPEC	GPEC-SED22	650735.8	689504.2	-13.8	20.0		-13.8	-27.9				
GPEC	GPEC-SED23	651128.1	689361.9	-25.8	20.0		-25.8	-37.0	-37.0			
GPEC	GPEC-SED24	651313.7	688744.6	-17.0	20.0		-17.0	-33.5				
GPEC	GPEC-SED25	651397.1	688335.2	-19.9	20.0		-19.9	-34.2				
GPEC	GPEC-SED26	651580.9	688083.4	-15.3	20.0		-15.3	-33.0				
GPEC	GPEC-SED27	651424.8	688346.0	-18.1	20.0		-18.1	-32.8				
GPEC	GPEC-SED28	651423.5	689098.0	-11.7	20.0		-11.7	-31.7				
GPEC	GPEC-SED29	651209.0	688539.5	-19.9	20.0	-32.4	-19.9	-32.4				
GPEC	GPEC-SED30	651210.0	688703.1	-21.5	20.0		-21.5	-36.2				
GPEC	GPEC-SED31	650976.0	689268.0	-26.9	20.0		-26.9	-34.1	-34.1			
Newtown Creek (NCG)	SD113	651002.1	689144.0	-25.0	11.9		-25.0	-33.4	-33.4			
Newtown Creek (NCG)	SD115	651512.5	689175.2	-10.7	16.3		-10.7	-27.0				
Newtown Creek (NCG)	SD128	651262.5	688501.0	-20.3	16.5		-20.3	-34.6	-34.6			
Newtown Creek (NCG)	SD129	651542.8	688016.8	-21.3	16.2		-21.3	-34.8	-34.8			
Newtown Creek (NCG)	SD141A&BCore	650780.9	689466.4	-20.6	6.9		-20.6	-27.5				
Newtown Creek (NCG)	SD146	651010.6	688916.9	-22.1	16.8	-35.1	-22.1	-35.1	-36.5			
Newtown Creek (NCG)	SD158A&BCore	650881.0	689143.5	-23.1	7.5		-23.1	-30.5				
Newtown Creek (NCG)	SD205	651100.0	688680.1	-17.7	16.6		-17.7	-30.5	-30.5			
Newtown Creek (NCG)	SD206	651176.1	688459.3	-18.3	15.7		-18.3	-30.5	-30.5			
Newtown Creek (NCG)	SD207	651273.6	688133.5	-17.0	16.0		-17.0	-30.9				
Newtown Creek (NCG)	SD211	651425.5	688259.8	-20.3	16.8	-29.8	-20.3	-29.8	-31.7			
Newtown Creek (NCG)	SD212	651581.7	688351.9	-2.8	15.9	-9.7	-2.8	-9.7	-10.1			
Newtown Creek (NCG)	NC066ASC	650754.4	689578.0	-13.0	19.0		-13.0	-13.0				
Newtown Creek (NCG)	NC069SC-A	650922.5	688980.3	-17.8	30.0		-17.8	-32.8				
Newtown Creek (NCG)	NC070ASC	651097.6	689044.9	-23.2	14.0		-23.2	-23.2				
Newtown Creek (NCG)	NC071ASC	651297.8	689068.2	-15.4	19.0		-15.4	-15.4				
Newtown Creek (NCG)	NC072SC-A	651162.0	688303.5	-18.1	19.0		-18.1	-27.8				
Newtown Creek (NCG)	NC075SC-A	651269.9	688060.8	-18.0	23.0		-18.0	-31.0				
Newtown Creek (NCG)	NC296SC-A	651058.8	688629.2	-20.0	22.0		-20.0	-34.0				
Newtown Creek (NCG)	NC298SC-A	651358.0	687849.4	-16.8	27.0		-16.8	-16.8				

General Notes:

1. Horizontal Coordinates in feet State Plane New York East, North American Datum 1983.
2. Elevations relative to North American Vertical Datum of 1988.
3. Blank or no data indicates strata not encountered, or boring terminated above respective stratum.

Table L2
Hydraulic Conductivity Measurements
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Well ID	Site	Screen Depth (ft. bgs)	Screen Top Elev. (ft. NAVD)	Screen Bot Elev. (ft. NAVD)	Avg Scrn elev.	K RH1	K RH2	K RH3	K FH1	K FH2	K Average	Reference
Fill												
GPEC-GT-3	GPEC	2 - 17	10.7	-4.3	3	0.024	NT	--	--	--	0.024	GEI (2016)
GPEC-GT-4S	GPEC	3 - 18	9.16	-5.84	2	5.1	6.9	--	--	--	6.0	GEI (2016)
GPEC-MW-221S	GPEC	8 - 18	6.79	-3.21	2	59.2	82.73	--	--	--	71.0	GEI (2017a)
GPEC-MW-222S	GPEC	2 - 12	11.89	1.89	7	7.8	7.7	--	--	--	7.8	GEI (2016)
GPEC-MW-339S	GPEC	3 - 13	11.8	1.8	7	1.33	0.3263	--	--	--	0.8	GEI (2017a)
GPE-MW-2S	GPEC	2 - 12	5.74	-4.26	1	19	27	--	--	--	23	GEI (2016)
OW3-90	PDRC	3 - 13	5	-5	0	>28.4	--	--	--	--	>28.4	CRA (1992)
OW7-90	PDRC	3 - 13	6	-4	1	0.21	--	--	0.24	--	0.2	CRA (1992)
W-8R	PDRC	3 - 13	5	-5	0	1.16	--	--	0.62	--	0.9	CRA (1992)
OW4-90	PDRC	(a)	(a)	(a)	NA	>28.4	--	--	--	--	>28.4	CRA (1992)
OW5-90	PDRC	(a)	(a)	(a)	NA	>28.4	--	--	--	--	>28.4	CRA (1992)
Upper Glacial Aquifer												
GPEC-MW-3S	GPEC	25 - 40	-18.09	-33.09	-26	3.2	2.8	--	5.2	5.6	4.2	GEI (2016)
GPEC-MW-5S	GPEC	28 - 38	-21.53	-31.53	-27	15	18	--	19	15	16.8	GEI (2016)
GPEC-MW-9	GPEC	10 - 25	6.42	-8.58	-1	230	120	--	NA	NA	175	GEI (2016)
GPEC-MW-103	GPEC	50 - 60	-42.67	-52.67	-48	25	24	--	25	33	26.8	GEI (2016)
GPEC-MW-218D	GPEC	95 - 105	-43.92	-53.92	-49	15.1	15.9	--	NT	NT	15.5	GEI (2017a)
GPEC-MW-218I	GPEC	75 - 85	-24.1	-34.1	-29	102	NT	--	52.31	NT	77.1	GEI (2017a)
GPEC-MW-333I	GPEC	30 - 40	-15.66	-25.66	-21	2.2	4.6	--	7.5	6	5.1	GEI (2016)
GPEC-MW-339I	GPEC	30 - 40	-15.08	-25.08	-20	88.7	74.8	--	NT	NT	81.8	GEI (2017a)
GPEC-MW-339D	GPEC	56 - 66	-40.78	-50.78	-46	12.2	20.6	--	NT	NT	16.4	GEI (2017a)
GPEC-GT-1S	GPEC	30 - 40	-18.9	-28.9	-24	0.12	3.25	--	NA	NA	1.69	GEI (2017a)
GPEC-GT-4D	GPEC	54 - 69	-41.88	-56.88	-49	53	50	--	54	NT	52.3	GEI (2016)
GPEC-GT-10D	GPEC	43 - 58	-34.95	-49.95	-42	9	13	--	6.7	7.2	9.0	GEI (2016)
MW003SC	NC	25 - 29.8	-14.1	-18.9	-17	0.82	1.02	--	1.25	1.53	1.16	AQ (2016)
MW004SC	NC	28.2 - 33	-15.5	-20.3	-18	5.39	6.52	--	4.82	5.95	5.67	AQ (2016)
MW005SC	NC	29.8 - 34.6	-15	-19.8	-17	10.8	14.7	--	8.50	10.8	11.2	AQ (2016)
MW006SC	NC	28.5 - 33.3	-11.3	-16.1	-14	1.19	1.45	--	1.98	2.44	1.76	AQ (2016)
MW-5	NC (Frito Lay)	7 - 17	6.8	-3.2	2	14.7	36.8	--	22.1	51.0	31.18	AQ (2016)
MW-6	NC (Frito Lay)	7.7 - 17.7	8	-2	3	25.8	56.7	--	NT	NT	41.24	AQ (2016)
NC056GWA	NC	10.9 - 15.9	-25.6	-30.6	-28	85	116	--	53.9	73.7	82.2	AQ (2016)
NC069GWA	NC	18.3 - 23.3	-36.1	-41.1	-39	36.8	51.02	--	48.2	65.2	50.31	AQ (2016)
OW1-90	PDRC	5 - 15	13	3	8	>28.4	--	--	--	--	>28.4	CRA (1992)
OW8-99	PDRC	17 - 27	13	3	8	145	--	--	--	--	145	CRA (2000)
OW10-99	PDRC	7.2 - 17.2	5.8	-4.2	1	94.8	65.4	--	--	--	80.1	CRA (2000)
OW11-99	PDRC	10.2 - 20.2	10.66	0.66	6	48.1	48.1	--	--	--	48.1	CRA (2000)
MW-9	ExxonMobil	18.1 - 33.5	7.51	-7.89	0	17.1	18.6	--	--	--	17.9	Roux (1991)
MW-14	ExxonMobil	18.3 - 33.7	11.2	-4.15	4	4.2	4.35	--	--	--	4.22	Roux (1991)
RW-A	ExxonMobil	NR	NR	NR	-16(b)	NA - Constant Rate Pump Test			--	--	188	Roux (2003)
RW-C	ExxonMobil	NR	NR	NR	-4(b)	NA - Constant Rate Pump Test			--	--	218	Roux (2003)
RW-26	ExxonMobil	43 - 73	-23.16	-53.16	-38	NA - Constant Rate Pump Test			--	--	96.0	Roux (2011)
Fine-Grained Native Material												
MW-1	ExxonMobil	8.2 - 23.6	4.46	-10.94	-3	--	--	--	--	--	9.88	
MW-2	ExxonMobil	2.74 - 22.94	4.78	-15.42	-5	--	--	--	--	--	2.33	
EB025GWA	NC	18.8 - 23.8	-24.6	-29.6	-27	0.31	0.43	--	0.48	0.68	0.47	AQ (2016)
EK098GWA	NC	15.5 - 20.5	-24.8	-29.8	-27	11.9	15.02	--	12.19	15.31	13.61	AQ (2016)
MC031GWA	NC	25.6 - 30.6	-28.4	-33.4	-31	0.79	1.13	--	0.85	1.22	1.00	AQ (2016)
OW2-99	PDRC	8 - 18	12	2	7	0.31	--	--	0.24	--	0.3	CRA (1992)
OW6-90	PDRC	25 - 30	-19.5	-24.5	-22	>28.4	--	--	--	--	>28.4	CRA (1992)
Dense Moraine												
GPE-MW-2D	GPEC	30.5 - 40.5	-22.87	-32.87	-28	12.5	10.13	--	NT	NT	11.3	GEI (2017)
GPE-MW-4D	GPEC	30 - 40	-22.59	-32.59	-28	0.11	NT	--	0.17	0.17	0.15	GEI (2016)
GPEC-MW-2	GPEC	20 - 35	-12.97	-27.97	-20	0.65	0.67	--	1.1	1	0.86	GEI (2016)
MW-4	ExxonMobil	14.5 - 29.6	9.29	-5.76	2	27.2	19.20	23.80	--	--	23.4	Roux (1991)
MW-18	ExxonMobil	29.2 - 44.1	13.5	-1.45	6	1.29	1.42	--	--	--	1.36	Roux (1991)

September 2019

C:\Users\laadinolfi\Desktop\temp local\GPEC\
Table L2 3D K measurements
Table 2

Table L2
Hydraulic Conductivity Measurements
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Well ID	Site	Screen Depth (ft. bgs)	Screen Top Elev. (ft. NAVD)	Screen Bot Elev. (ft. NAVD)	Avg Scrn elev.	K RH1	K RH2	K RH3	K FH1	K FH2	K Average	Reference
MW-19	ExxonMobil	20.5 - 35.3	17.57	2.77	10	0.08		--	--	--	0.077	Roux (1991)
MW-20	ExxonMobil	20.5 - 35.8	10.58	-4.72	3	2.06	2.26	--	--	--	2.16	Roux (1991)
MW-18	PDRC	17 - 37.1	6.6	-13.5	-3	6.80	10.49	--	7.94	11.62	9.21	
Clay Interbedding												
GPEC-MW-328I	GPEC	30 - 40	-18.14	-28.14	-23	7.50E-03	NT	--	6.90E-03	NT	7.20E-03	GEI (2016)
Gardiner's/Raritan Clay												
GPEC-GT-5D	GPEC	157 - 177	-144.78	-164.78	-155	4.71E-03		--	NT	NT	4.71E-03	GEI (2017)
MW-2D	GPEC	130 - 150	-72.98	-92.98	-83	1.01	1.006	--	NT	NT	1.01	GEI (2017)
Sediments												
DK052GWB	NC	2.4 - 7.4	-13.2	-18.2	-16	2.10	2.69	--	NT	NT	2.40	AQ (2016)
EB025GWB	NC	4.7 - 9.7	-10.5	-15.5	-13	3.40	4.54	--	3.12	4.25	3.83	AQ (2016)
EK098GWB	NC	4.7 - 6.7	-14	-16	-15	22.4	27.78	--	17.01	20.98	22.0	AQ (2016)
MC031GWB	NC	8.2 - 13.2	-11	-16	-14	0.09	0.12	--	0.12	0.15	0.12	AQ (2016)
NC056GWB	NC	3.4 - 8.4	-18.1	-23.1	-21	3.68	4.54	--	2.15	2.66	3.26	AQ (2016)
NC069GWB	NC	4.6 - 9.6	-22.5	-27.5	-25	1.28	1.67	--	0.96	1.28	1.30	AQ (2016)
NC320GWB	NC	8.1 - 13.1	-18.4	-23.4	-21	0.51	0.65	--	0.26	0.34	0.44	AQ (2016)

General Notes:

K = Hydraulic conductivity (horizontal) in units of feet per day.

FH, RH = Falling or Rising Head test used to measure hydraulic conductivity.

Footnotes:

- Well screen information not reported or available. Assumed fill because other OW-series wells screened across water table; and underlying material is fined-grained within general depth range of investigations.
- Well screen information not reported or available. Average screen elevation shown as being ~3 ft. below top of measured free product elevation 11/18/08.

References:

AQ (2016)	Interim Data Report,
CRA (1992)	Supplemental Remedial Program Final Report, Laurel Hill Site, Maspeth, New York, Conestoga-Rovers & Associates, March 1992.
CRA (2000)	Preliminary Site Assessment Report, Operable Units Nos. 2, 3, 4, and 5, Laurel Hill Site, Maspeth, New York, Conestoga-Rovers & Associates, March 1992.
GEI (2017a)	Data Report
GEI (2016)	Interim Data Report, Phases 1&2, Greenpoint Energy Center, 287 Maspeth Avenue, Brooklyn, New York 11211, Site #224052, GEI Consultants, Inc., November 2016.
Roux (2003)	Supplemental Investigation of the Off-Site Free Product Plume, Off-Site Free Product Recovery System, ExxonMobil Refining & Supply Company, Greenpoint, Roux Associates, Inc., January 24, 2003.
Roux (2011)	Recovery Well RW-26 Aquifer Test Report, ExxonMobil Greenpoint, Petroleum Remediation Project, Greenpoint, Brooklyn, New York, Roux Associates, Inc., April 19, 2011.

Table L3
Model Hydraulic Conductivity Zones
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Stratigraphic Unit	Hydraulic Conductivity (ft./day)				Anisotropy Ratio Used in Model	Literature Value for Soil Type
	Horizontal Used in Model	Vertical Used in Model	Slug Test Results (See Table 2)	Published USGS Regional (b)		
Fill	See Below	See Below	0.024 - 71		--	0.5 - 50
Fill 1 / Basin	2	0.2			10:1	
Subunit 1	0.1	0.05			10:1	
Subunit 2	0.5	0.1			10:1	
Marsh Deposits	0.1	0.001			10:1	10 ⁻⁶ - 1.0 (e)
Creek sediment	3	0.3	0.12 - 22		10:1	
Upper Glacial Aquifer	80	30	0.5 - 218	20-270 (a,b)	5:1	3 - 300 (d)
Fine-Grained Material near Cree	20	2				
Basin at ExxonMobil	250	25				
Clay beds	0.05	0.05	0.0069			
Gardiner's/Raritan Clay	Inactive	Inactive	4.7E-3 - 1.01(c)	0.001-0.0029 (b)	1:1	10 ⁻⁶ - 0.005 (f)
Sand Fringe					10:1	0.1 - 20
Dense Moraine	10	5	0.077 - 23.4			
Subunit 1	0.012	0.012				
Subunit 2	0.4	0.08				

- a. Misut and Monti (1999) reports 28-80 ft./d (moraine) and 200-300 ft./d (outwash). Buxton and Smolensky (1998) reports 200 - 270 ft./d for outwash south of moraines, and less than 135 ft./d for moraine deposits.
- b. Misut and Monti, 1999.
- c. Higher result of 1.01 ft./d attributed to sand lens in clay/silt unit.
- d. Reported by Fetter (1994) for glacial outwash.
- e. Published range for silt and clay (Anderson, 1992).
- f. Published range for clay (Anderson, 1992).

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements																
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17	
Calibration Wells																										
GPEC	GPEC-MW-1R	7.63	-46.99	651250	687751	GEI (2016)			1.14	0.30	1.55	-	-	-	-	-	-	1.55	-	1.40	0.30	--	--	1.31		
GPEC	GPEC-MW-1D	7.16	-57.62	651250	687751	GEI (2016)			1.29	1.29	1.29	-	-	NM	NM	NM	NM	NM	NM	--	--	--	--	1.29	1.29	
GPEC	GPEC-MW-2	7.45	-22.97	651144	688036	GEI (2016)			1.76	1.14	2.42	-	-	2.03	1.69	1.55	1.93	1.14	2.37	2.42	1.38	--	--	1.31		
GPEC	GPEC-MW-2D	6.77	-77.79	651144	688036	GEI (2016)			1.33	0.88	1.77	-	-	-	-	-	-	0.88	1.77	--	--	--	--	NM		
GPEC	GPEC-MW-3WT	6.01	-1.74	651075	688297	See note b			1.28	-0.44	3.00	1.28	-	-	-	-	-	-	--	--	NM	NM	NM			
GPEC	GPEC-MW-3S	6.35	-28.09	651075	688297	GEI (2016)			0.95	-1.83	2.46	-	-	2.30	2.22	2.18	-1.83	0.70	-1.32	2.46	0.53	--	--	1.29		
GPEC	GPEC-MW-3D	6.42	-93.13	651075	688297	GEI (2016)			1.53	-0.08	2.85	-	-	2.85	2.40	1.91	-0.05	1.21	-0.08	2.44	1.57	--	--	NM		
GPEC	GPEC-MW-4	8.72	-53.19	650941	688533	GEI (2016)			2.00	1.00	4.49	-	-	2.33	2.33	2.40	1.00	1.16	1.27	4.49	1.71	1.37	--	1.91		
GPEC	GPEC-MW-4D	9.24	-88.93	650941	688533	GEI (2016)			1.72	1.48	1.95	-	-	-	-	-	-	-	--	--	1.48	--	--	1.95		
GPEC	GPEC-MW-5S	9.02	-28.10	650750	688982	GEI (2016)			2.06	1.43	2.62	-	-	2.62	2.45	2.37	1.57	1.43	2.01	2.31	1.91	--	--	1.74	2.16	
GPEC	GPEC-MW-5D	9.61	-68.19	650750	688982	GEI (2016)			2.02	1.49	2.61	-	-	2.61	2.46	2.39	1.59	1.49	1.52	2.37	1.95	--	--	1.82		
GPEC	GPEC-MW-6	12.04	-5.68	650800	687871	GEI (2016)			1.76	1.28	2.13	-	-	2.01	2.03	1.72	1.43	1.43	1.28	2.13	2.01	--	--	NM		
GPEC	GPEC-MW-7D	6.9	-81.66	650778	688126	GEI (2016)			2.19	0.88	3.91	-	-	3.91	2.42	1.90	0.88	--	--	2.15	1.85	--	--	NM		
GPEC	GPEC-MW-8	8.09	-49.29	650559	688452	GEI (2016)			1.59	-0.92	2.46	-	-	2.46	2.41	2.14	1.40	1.67	1.24	2.28	-0.92	--	--	1.65		
GPEC	GPEC-MW-9	15.96	-1.08	650269	688506	GEI (2016)			2.08	1.57	2.63	-	-	2.54	2.63	2.20	2.14	1.60	1.60	2.21	2.19	--	--	1.57		
GPEC	GPEC-MW-10	13.16	-36.55	650394	687735	GEI (2016)			1.74	1.23	2.12	-	-	2.12	2.12	1.71	--	1.50	1.23	--	--	--	--	NM		
GPEC	GPEC-MW-11	13.14	-29.39	650054	687966	GEI (2016)			2.01	1.49	2.38	-	-	2.35	2.38	1.92	1.86	1.49	1.92	2.32	2.27	--	--	1.62		
GPEC	GPEC-MW-11D	13.08	-71.53	650054	687966	GEI (2016)			1.91	1.63	2.29	-	-	--	--	--	--	1.63	1.68	2.18	2.29	--	--	1.75		
GPEC	GPEC-MW-12	16.34	-1.37	649520	687767	GEI (2016)			6.00	5.28	6.97	-	-	6.38	6.23	5.45	6.13	5.28	5.31	6.14	6.15	--	--	6.97		
GPEC	GPEC-MW-101WT	12.18	-0.46	650829	687716	GEI (2016)			1.50	0.97	2.24	-	-	--	--	--	--	1.14	0.97	2.24	1.79	--	--	1.35		
GPEC	GPEC-MW-101I	12.02	-57.63	650829	687716	GEI (2016)			1.48	0.59	2.25	-	-	-	-	-	-	1.40	0.59	2.25	1.75	--	--	1.41		
GPEC	GPEC-MW-101D	12.14	-91.88	650829	687716	GEI (2016)			1.90	0.58	3.70	-	-	-	-	-	-	1.49	0.58	2.06	1.69	--	--	3.70		
GPEC	GPEC-MW-102D	9.15	-80.51	651026	687528	GEI (2016)			1.32	-0.06	2.32	-	-	-	-	-	-	1.65	-0.06	2.32	1.35	--	--	1.35		
GPEC	GPEC-MW-103	7.07	-47.67	651252	687797	GEI (2016)			1.39	0.12	2.40	-	-	-	-	-	-	0.12	1.77	2.40	1.21	--	--	1.43	-	
GPEC	GPEC-MW202	9.14	-4.72	651061	687656	GEI (2016)			1.82	1.43	2.18	-	-	-	-	-	-	1.43	1.49	2.18	2.15	--	--	1.87	-	
GPEC	GPEC-SB/MW205	7.86	-60.70	651230	687861	GEI (2016)			1.79	1.56	2.01	-	-	-	-	-	-	2.01	-	-	-	--	--	1.56	-	
GPEC	GPEC-MW217I	21.21	-13.30	650066	688826	GEI (2016)			1.75	1.48	2.15	-	-	-	-	-	-	1.49	1.48	2.14	2.15	--	--	1.51	-	
GPEC	GPEC-MW217D	21.33	-48.17	650066	688826	GEI (2016)			1.77	1.47	2.16	-	-	-	-	-	-	1.52	1.47	2.16	2.16	--	--	1.53	-	
GPEC	GPEC-MW218I	53.23	-29.10	649215	688778	GEI (2016)			1.69	1.46	2.04	-	-	-	-	-	-	1.47	1.46	2.01	2.04	--	--	1.47	-	
GPEC	GPEC-MW218D	53.58	-48.92	649215	688778	GEI (2016)			1.68	1.45	2.02	-	-	-	-	-	-	1.45	1.45	2.01	2.02	--	--	1.45	-	
GPEC	GPEC-MW219S	41.86	1.00	648863	688280	GEI (2016)			1.72	1.71	1.72	-	-	-	-	-	-	1.72	1.71	--	--	--	--	--	-	
GPEC	GPEC-MW219I	42.11	-25.54	648863	688280	GEI (2016)			1.71	1.70	1.71	-	-	-	-	-	-	1.71	1.70	--	--	--	--	--	-	
GPEC	GPEC-MW219D	42.18	-55.50	648863	688280	GEI (2016)			1.73	1.71	1.75	-	-	-	-	-	-	1.75	1.71	--	--	--	--	--	-	
GPEC	GPEC-MW220S	21.56	2.03	648650	687490	GEI (2016)			2.17	1.93	2.42	-	-	-	-	-	-	2.05	2.04	2.40	2.42	--	--	1.93	-	
GPEC	GPEC-MW220I	21.64	-23.02	648650	687490	GEI (2016)			2.16	1.94	2.42	-	-	-	-	-	-	2.02	2.02	2.40	2.42	--	--	1.94	-	
GPEC	GPEC-MW220D	21.58	-53.13	648650	687490	GEI (2016)			2.17	1.94	2.44	-	-	-	-	-	-	2.02	2.04	2.43	2.44	--	--	1.94	-	
GPEC	GPEC-MW221S	14.28	1.79	649594	687637	GEI (2016)			6.28	6.03	6.64	-	-	-	-	-	-	6.03	6.03	6.36	6.36	--	--	6.64	-	
GPEC	GPEC-MW221I	14.32	-35.28	649594	687637	GEI (2016)			1.89	1.53	2.28	-	-	-	-	-	-	1.74	1.53	2.28	2.22	--	--	1.70	-	
GPEC	GPEC-MW221D	14.06	-70.34	649594	687637	GEI (2016)			1.94	1.59	2.32	-	-	-	-	-	-	1.79	1.59	2.32	2.25	--	--	1.75	-	
GPEC	GPEC-MW222S	13.56	6.89	649231	686982	GEI (2016)			9.27	8.35	12.65	-	-	-	-	-	-	8.35	8.37	8.44	8.53	--	--	12.65	-	
GPEC	GPEC-MW222D	13.35	-61.15</																							

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
GPEC	GPEC-GT-1	10.72	-23.90	649683	687043	GEI (2016)			1.44	0.71	3.45	-	-	-	-	3.45	0.75	0.77	0.71	1.68	1.77	--	--	0.97	-
GPEC	GPEC-GT01S	11.43	1.46	649683	687043	GEI (2016)			6.45	6.45	6.45	-	-	-	-	-	-	-	-	--	--	--	--	6.45	-
GPEC	GPEC-GT-3	14.35	0.70	650008	687153	GEI (2016)			8.37	7.47	9.64	-	-	-	-	7.47	9.09	7.53	-	8.2	8.26	--	--	9.64	-
GPEC	GPEC-GT-4S	11.75	-0.84	650302	687258	GEI (2016)			4.58	4.13	4.88	-	-	-	-	4.57	4.88	4.13	4.23	4.81	4.87	--	--	NM	-
GPEC	GPEC-GT-4D	11.79	-51.88	650302	687258	GEI (2016)			1.18	-0.07	2.03	-	-	-	-	1.57	-0.07	1.63	0.75	2.03	1.83	--	-	0.50	-
GPEC	GPEC-GT-5	11.75	-0.46	650386	687283	GEI (2016)			2.79	0.96	4.26	-	-	-	-	3.78	2.86	1.06	0.96	4.26	4.2	--	-	3.58	1.59
GPEC	GPEC-GT5I	11.94	-22.74	650386	687283	GEI (2016)			1.24	1.17	1.31	-	-	-	-	-	-	-	-	--	--	1.17	-	1.31	-
GPEC	GPEC-GT-7	12.08	-27.56	650765	687412	GEI (2016)			1.48	0.91	2.15	-	-	-	-	1.68	0.91	1.59	0.94	2.15	1.82	--	-	1.30	-
GPEC	GPEC-GT-10S	9.16	-5.42	651251	687626	GEI (2016)			1.46	1.21	1.73	-	-	-	-	1.45	1.73	1.21	-	--	--	--	-	-	-
GPEC	GPEC-GT-10	7.70	-44.95	651251	687626	GEI (2016)			-0.04	-2.62	1.42	-	-	-	-	1.42	-0.92	-0.50	-	-2.62	1.03	--	-	1.32	-
GPEC	GPEC-SIS-2	13.61	0.97	650729	687839	GEI (2016)			1.66	0.84	2.48	-	-	-	-	1.70	1.48	1.34	0.84	2.13	2.48	--	-	-	-
GPEC	GPEC-SIS-6	10.61	1.10	649915	687221	GEI (2016)			6.71	5.89	7.73	-	-	-	-	7.37	7.73	5.92	5.89	--	--	--	-	6.65	-
GPEC	GPEC-SIS-7	11.37	4.70	649940	687151	GEI (2016)			8.64	8.23	9.05	-	-	-	-	8.23	9.05	-	-	--	--	--	-	-	-
GPEC	GPEC-SIS-8	11.45	5.77	649956	687112	GEI (2016)			9.38	8.47	10.28	-	-	-	-	8.47	10.28	-	-	--	--	--	-	-	-
GPEC	GPEC-SIS101S	11.28	3.01	649869.7	687064.9	GEI (2016)			4.70	4.10	5.00	-	-	-	-	-	-	-	-	--	--	4.7	-	-	-
GPEC	GPEC-SIS102S	11.73	3.45	649876.5	687054.8	GEI (2016)			4.30	3.70	4.60	-	-	-	-	-	-	-	-	--	--	4.3	-	-	-
GPEC	GPEC-SIS102I	11.75	-4.51	649876.5	687054.8	GEI (2016)			4.16	3.60	4.50	-	-	-	-	-	-	-	-	--	--	4.16	-	-	-
GPEC	GPEC-SIS103S	11.34	0.14	650430.7	687257.8	GEI (2016)			2.70	1.70	3.00	-	-	-	-	-	-	-	-	--	--	2.7	-	-	-
GPEC	GPEC-SIS104S	11.58	0.36	650430.4	687247.9	GEI (2016)			1.51	0.00	1.70	-	-	-	-	-	-	-	-	--	--	1.51	-	-	-
GPEC	GPEC-SIS104I	11.56	-6.14	650430.4	687247.9	GEI (2016)			1.50	0.10	1.80	-	-	-	-	-	-	-	-	--	--	1.5	-	-	-
GPEC	GPE-MW-1S	24.27	3.58	650044	689231	GEI (2016)			1.86	1.36	2.58	-	1.82	NM	2.58	2.15	2.01	1.40	1.38	2.02	2.02	-	-	1.36	-
GPEC	GPE-MW-1D	24.33	-26.02	650044	689231	GEI (2016)			1.92	1.40	2.59	-	1.95	NM	2.59	2.13	1.76	1.40	1.88	2.03	2.03	-	-	1.47	-
GPEC	GPE-MW-2S	6.97	0.74	650599	689369	GEI (2016)			3.48	2.69	4.70	-	2.69	4.70	3.98	3.04	4.16	2.78	2.90	3.48	3.57	-	-	3.44	3.55
GPEC	GPE-MW-2D	7.01	-31.40	650599	689369	GEI (2016)			3.44	2.75	4.33	-	2.75	4.33	4.19	3.20	4.24	2.87	2.91	3.40	3.35	-	-	3.13	-
GPEC	GPE-MW-3S	6.67	0.34	650633	689305	GEI (2016)			3.22	2.49	4.39	-	2.49	4.39	3.57	2.86	4.04	2.69	2.65	3.13	3.13	-	-	-	-
GPEC	GPE-MW-3D	6.79	-29.70	650633	689305	GEI (2016)			2.22	1.86	2.69	-	1.86	2.69	2.52	2.53	1.92	1.95	2.10	2.37	2.02	-	-	-	-
GPEC	GPE-MW-4S	6.95	0.25	650666	689240	GEI (2016)			3.17	2.48	4.36	-	2.48	4.36	3.55	2.84	4.01	2.67	2.61	3.12	3.12	-	-	2.93	-
GPEC	GPE-MW-4D	7.01	-27.00	650666	689240	GEI (2016)			2.93	2.15	3.87	-	2.15	3.87	3.26	2.77	3.61	2.72	2.47	2.94	2.82	-	-	2.66	-
Varick Street	MW-2	59.28	5.78	648815	688815	GEI (2016)			1.95	1.37	2.73	-	2.08	2.43	2.73	2.25	1.94	1.39	1.39	1.92	2.02	-	-	1.37	1.94
Varick Street	PZ-1	55.08	2.58	649064	688844	GEI (2016)			1.92	1.43	2.77	-	2.09	NM	2.77	2.28	1.92	1.43	1.44	1.95	1.96	-	-	1.43	-
Varick Street	PZ-2	8.40	-10.14	650801	689057	GEI (2016)			0.86	0.53	1.19	-	-	-	-	-	-	0.53	1.19	--	--	-	-	-	-
Ditmas	W-1	11.51	-0.41	650603	687377	GEI (2016)			1.24	0.37	2.04	-	0.91	1.49	1.47	1.27	0.74	0.87	0.37	2.04	2.00	-	-	1.26	-
Ditmas	W-2	12.29	0.29	650641	687389	GEI (2016)			1.58	1.15	2.06	-	1.34	1.89	1.91	1.63	1.19	1.27	1.15	2.06	2.02	-	-	1.29	-
Ditmas	DMW-10/W-3	10.81	2.09	650490	687237	GEI (2016)			1.38	1.00	1.65	-	1.00	NM	1.65	1.40	-	1.39	1.44	--	--	-	-	-	-
Ditmas	DMW-8/W-4	11.27	1.55	650564	687264	GEI (2016)			2.30	1.94	2.54	-	1.94	2.45	2.54	2.25	-	-	-	--	--	-	-	-	-
Ditmas	DMW-2	11.71	-0.09	650764	687217	CEUS (2012)			4.11	2.77	4.94	4.11	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-5	7.70	1.88	651101	687027	CEUS (2012)			0.81	-0.06	3.54	0.81	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-6	11.48	5.18	650813	687063	CEUS (2012)			5.35	3.41	7.48	5.35	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-7A	11.34	8.50	650584	687112	CEUS (2012)			6.79	5.36	9.61	6.79	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-20	11.24	1.30	650543	687307	CEUS (2012)			1.79	0.91	5.00	1.79	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-21	11.02	1.34	650763	687383	CEUS (2012)			1.74	0.10	4.61</														

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
Equity	MW-4A	12.25	4.75	649389	686652	AECOM (2017)			5.40	5.40	5.58	5.40	-	-	-	-	5.40	-	-	-	-	-	-	-	-
Equity	MW-4B	12.47	-22.50	649389	686652	AECOM (2017)			0.02	-0.66	0.66	0.02	-	-	-	-	0.37	-0.31	0.00	-	-	-	-	-	-
Equity	MW-4C	12.03	-68.00	649389	686652	AECOM (2017)			0.85	-0.02	2.08	0.85	-	-	-	-	1.63	0.94	-0.02	-	-	-	-	-	-
Equity	MW-5A	14.14	4.14	649165	686581	AECOM (2017)			5.65	5.65	5.83	5.65	-	-	-	-	5.65	-	-	-	-	-	-	-	-
Equity	MW-5B	14.19	-16.30	649165	686581	AECOM (2017)			0.64	0.64	0.87	0.64	-	-	-	-	0.64	-	-	-	-	-	-	-	-
Equity	MW-6A	12.85	2.85	648864	686667	AECOM (2017)			5.56	5.02	6.06	5.56	-	-	-	-	5.65	5.37	5.43	-	-	-	-	5.79	-
Equity	MW-6B	12.50	-22.50	648864	686667	AECOM (2017)			1.07	0.65	1.39	1.07	-	-	-	-	0.65	1.32	1.06	-	-	-	-	1.24	-
Equity	MW-11B	10.66	-26.20	649556	686593	AECOM (2017)			0.17	-0.46	0.91	0.17	-	-	-	-	-	0.15	0.19	-	-	-	-	-	-
Equity	MW-11C	10.48	-84.52	649556	686593	AECOM (2017)			1.28	0.63	2.13	1.28	-	-	-	-	-	1.95	0.6	-	-	-	-	-	-
Equity	MW-16A	11.36	-1.14	649848	686638	AECOM (2017)			1.60	1.08	2.13	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-16B	11.09	-31.18	649848	686638	AECOM (2017)			0.71	0.07	1.05	0.71	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-16C	11.10	-91.18	649848	686638	AECOM (2017)			1.86	1.20	2.39	1.86	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-19A	9.65	-8.04	649502	686299	AECOM (2017)			4.91	4.75	5.07	4.91	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-19B	9.39	-23.10	649502	686299	AECOM (2017)			0.87	0.58	1.16	0.87	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-19C	9.43	-73.10	649502	686299	AECOM (2017)			1.97	1.67	2.26	1.97	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EB025GW	5.70	-27.10	651770	685623	AQ(2016) Table F3-4			2.40	0.97	3.50	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EB025GW	5.70	-11.00	651770	685623	AQ(2016) Table F3-4			0.51	-2.40	3.10	0.51	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EK098GWA	5.80	-27.30	649582	684650	AQ(2016) Table F3-4			-0.30	-3.80	3.10	-0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EK098GWB	5.50	-10.00	649582	684650	AQ(2016) Table F3-4			-0.20	-3.60	2.90	-0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MC031GWA	6.50	-27.20	652544	689039	AQ(2016) Table F3-4			0.15	-3.10	3.40	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MC031GWB	4.10	-5.00	652544	689039	AQ(2016) Table F3-4			0.02	-2.90	3.20	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC056GWA	5.30	-28.10	648916	690983	AQ(2016) Table F3-4			-0.69	-1.90	0.38	-0.69	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC056GWB	5.40	-21.10	648916	690983	AQ(2016) Table F3-4			-0.33	-2.90	3.40	-0.33	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC069GWA	6.40	-38.60	650915	688968	AQ(2016) Table F3-4			2.00	2.00	0.92	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC069GWB	6.60	-25.00	650915	688968	AQ(2016) Table F3-4			-0.16	0.92	2.80	-0.16	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW003SC	10.80	-16.50	651829	685358	AQ(2016) Table F3-4			1.70	0.71	2.60	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW004SC	12.40	-17.90	651831	685041	AQ(2016) Table F3-4			2.60	0.58	3.50	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW005SC	14.50	-17.40	652765	688840	AQ(2016) Table F3-4			4.40	4.00	4.80	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW006SC	16.90	-13.70	653176	688659	AQ(2016) Table F3-4			5.20	4.80	5.50	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Frito Lay)	MW-5	13.80	1.80	649526	684673	AQ(2016) Table F3-4			2.00	-0.09	3.70	2	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Frito Lay)	MW-6	15.70	3.00	649352	684606	AQ(2016) Table F3-4			4.90	3.80	5.70	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Waste Mgmt)	MW-18	23.60	-5.60	649009	691253	AQ(2016) Table F3-4			2.60	2.00	4.30	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Waste Mgmt)	MW-19	24.90	-1.90	649093	691426	AQ(2016) Table F3-4			3.10	2.90	3.30	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	K 889. 1	-	-53	648557	684189	NYSDEC (1937-1947)			3.40	2.2	5.0	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	Q 3809. 1	-	-4.5	652732	693324	NYSDEC (1937-1947)			10.80	8.5	13.0	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	K 3260.2	-	-11.3	646601	689034	NYSDEC (1937-1947)			9.40	8.2	12.6	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	Q 1391.1	-	-85	656010	686768	NYSDEC (1937-1947)			13.40	13.0	15.8	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon	CMW-29D	-	-50	648923	690466	AQ(2016) Table F-E-2			-2.10	-2.60	-1.20	-2.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon	CMW-34D	-	-50	648417	690716	AQ(2016) Table F-E-2			-2.90	-3.30	-2.00	-2.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon	CMW-41D	-	-50	648080	691030	AQ(2016) Table F-E-2			-0.90	-2.30	0.20	-0.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Meeker	DEC-006D	-	-50	648591	688629	AQ(2016) Table F-E-2			2.40	2.4	2.4	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Meeker	DEC-031	-	-10	648348	687862	AQ(2016) Table F-E-2			2.60	2.6	2.6	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Meeker	DEC-042	-	-10	648183	688606	AQ(2016) Table F-E-2			2.50	2.5	2.5	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	OW2R-07	-	-19.6	651883	690055	AQ(2016) Table F-E-2			7.40	6.3	7.7	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	OW11R-07	-	-10.7	650968	691234	AQ(2016) Table F-E-2			7.10	6.8	7.7	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	PDW-18	-	-10	651035	689898	AQ(2016) Table F-E-2			2.10	1.4	3.0	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	PMW-1A	-	-10	650648	690423	AQ(2016) Table F-E-2			0.																

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
EMGPRP	MW-124I	-	-10	647353	690701	Roux (2013-2016)			-3.60	-7.00	-2.60	-3.6	-	-	-	-	-	-	-	-	-	-	-	-	-
EMGPRP	MW-130	-	-10	646064	690391	Roux (2013-2016)			4.70	3.00	5.30	4.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Gardiner's/Raritan Clay																									
GPEC	GPEC-MW5D2	10.01	-153.19	650750	688982				-0.34			-	-	-	-	-	-	-	-	-	-	-	-	-0.37	-0.30
GPEC	GPEC-GT5D	11.81	-154.78	650386	687283				-1.70			-	-	-	-	-	-	-	-	-	-1.66	-	-1.92	-1.52	
GPEC(LNG)	GPE-MW2D2	6.97	-102.48	651144	688036				1.27			-	-	-	-	-	-	-	-	-	-	-	0.98	1.56	
Varick Street	MW-2D	59.6	-82.98	648815	688815				0.87			-	-	-	-	-	-	-	-	-	0.56	-	0.71	1.34	
Not Representative																									
GPEC	GPEC-MW217S	21.11	12.44	650066	688826				9.18			-	-	-	-	-	-	9.17	9.19	-	-	-	-	-	-

- Notes:**
1. Elevations are in feet relative to North American Vertical Datum of 1988.
2. Easting and northing coordinates in feet relative to North American Datum of 1983, New York State East.

- Footnotes:**
a. For model purposes, identical coordinates used for wells in same cluster.
b. Calibration values based on averaged values from tidal monitoring (Anchor 2016); long-term USGS reporting; and averaged quarterly readings 2013-2015 at ExxonMobil (Roux 2015, 2015, and 2016).
 Tidal monitoring (Anchor 2016)
 Long-term USGS reporting
 Quarterly gauging 2013-2015 (Roux 2014, 2015, 2016)
 Equity MGP (7/31/13 and 7/16/15 for MW-19 cluster and 7/31/13, 7/16/15, and 12/4/15 for MW-16 cluster)
 Ditmas (2005-2012 quarterly); BCF Oil (various events 2007-2009).
 GPEC (Well not gauged on synoptic dates; measurements during interim gauging and sampling used).
c. Italicized elevations shown for Equity site taken on same day as measurements at GPEC. Average for those wells used for calibration includes other dates not shown per note above.

Table L5 - Flow Model Mass Balance
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

		Water Balance			Pct. Of Subtotal
		MGD	GPM	FT ³ /D	
I. Full Model					
a. Sources					
Constant Head Cells Into Model	1.3	919.6	177,023	55.8%	
Recharge Into Model	1.05	727	140,025	44.2%	
Total Into Model	2.37	1647	317,048	100.0%	
b. Sinks					
Constant Head Cells Out of Model	1.31	908	174,838	55.1%	
Drains Out of Model	0.006	4.5	866	0.3%	
Wells Out of Model	1.06	734	141,345	44.6%	
Total Out of Model	2.37	1647	317,049	100.0%	
c. % Error (sources - sinks) (b)			-0.00032%		
d. Creek Budget					
Induced Infiltration from Creek (from pumping)	0.76	530	102,070	NA	
Net Discharge to Creek	1.27	885	170,390	NA	
II. Flow Specific to Greenpoint Energy Center (d)					
a. Entering GPEC					
Recharge	0.07	49.0	9,423	72.6%	
UGA flow entering site from west of GPEC	0.02	15.8	3,035	23.4%	
Flow entering or returning to GPEC from eastern end of Maspeth Ave.	0.004	2.7	521	4.0%	
Total Into GPEC	0.10	67.4	12,979	100.0%	
b. Leaving GPEC					
Southern - Offsite flow along Maspeth Ave.	0.023	15.9	3,068	23.7%	
Eastern - Offsite flow along Newtown Creek shoreline (Shallow)	0.010	6.7	1,290	10.0%	
Eastern - Offsite flow along Newtown Creek shoreline (Intermediate/Deep)	0.031	21.8	4,188	32.3%	
Northern - Offsite flow along northern property line	0.033	22.9	4,413	34.1%	
Total Out of GPEC	0.097	67	12,959	100.0%	
c. Maspeth Ave. utility infiltration	0.0065	4.50	866	NA	

Notes:

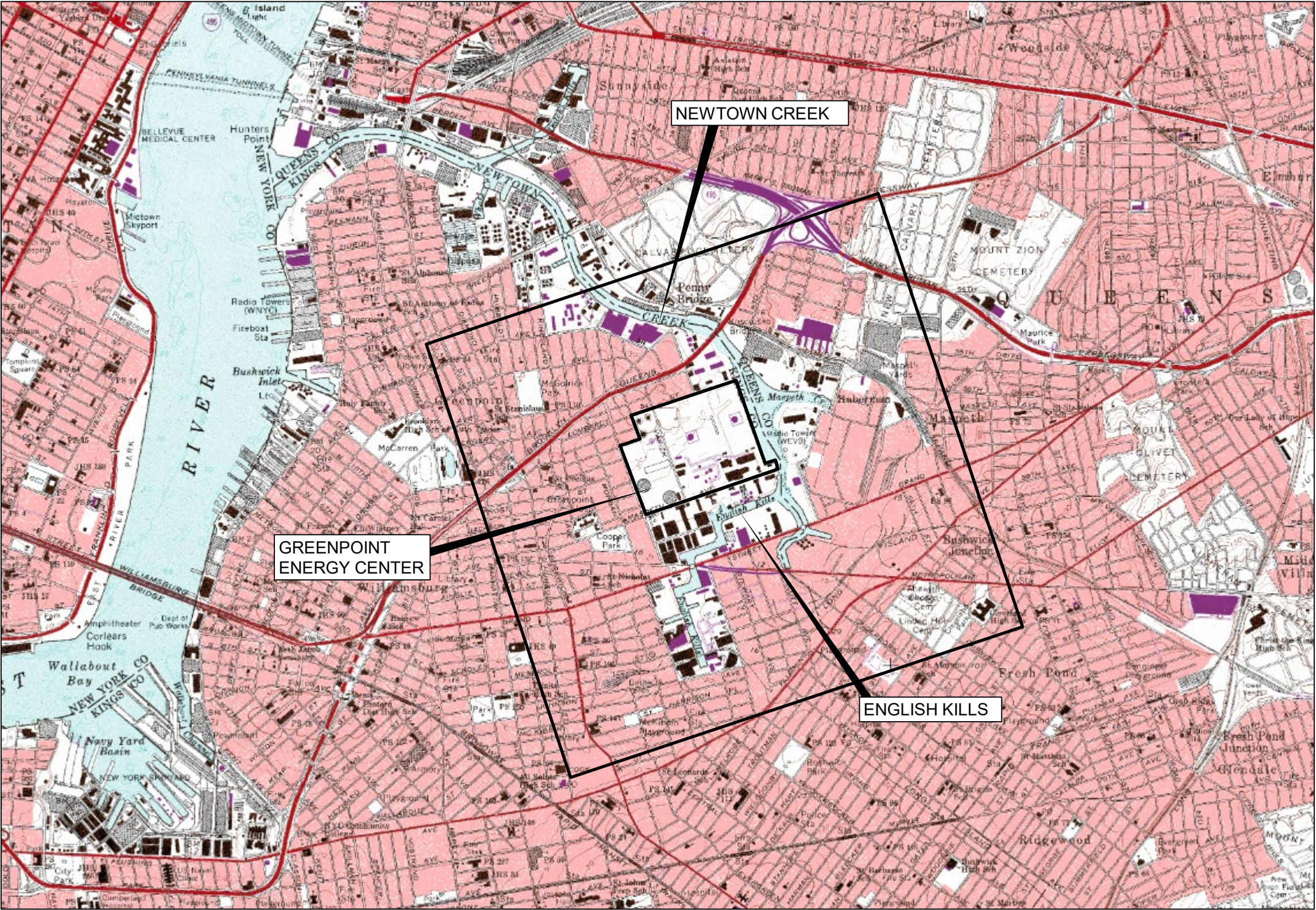
- a. Flow calculated by Modflow using Mass Balance and Zone Budget.
- b. Percent Error shown for difference between model-calculated total flow in and total flow out, for check of numeric mass balance calculation.
- c. Values shown for comparative purposes; they do not need to balance.
- d. Total flow on and off-site differ slightly due to computed occurrence of localized areas of parallel or reverse flow across zones, and does not indicate model error.

MGD Million gallons per day

GPM Gallons per minute

FT³/D Cubic feet per day

Figures



DRAFT



LEGEND



GROUNDWATER
MODEL LIMIT



SCALE, MILES

SOURCE:

UNITED STATES GEOLOGICAL SURVEY, BROOKLYN, N.Y. QUADRANGLE,
1967, PHOTOREVISED 1979.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



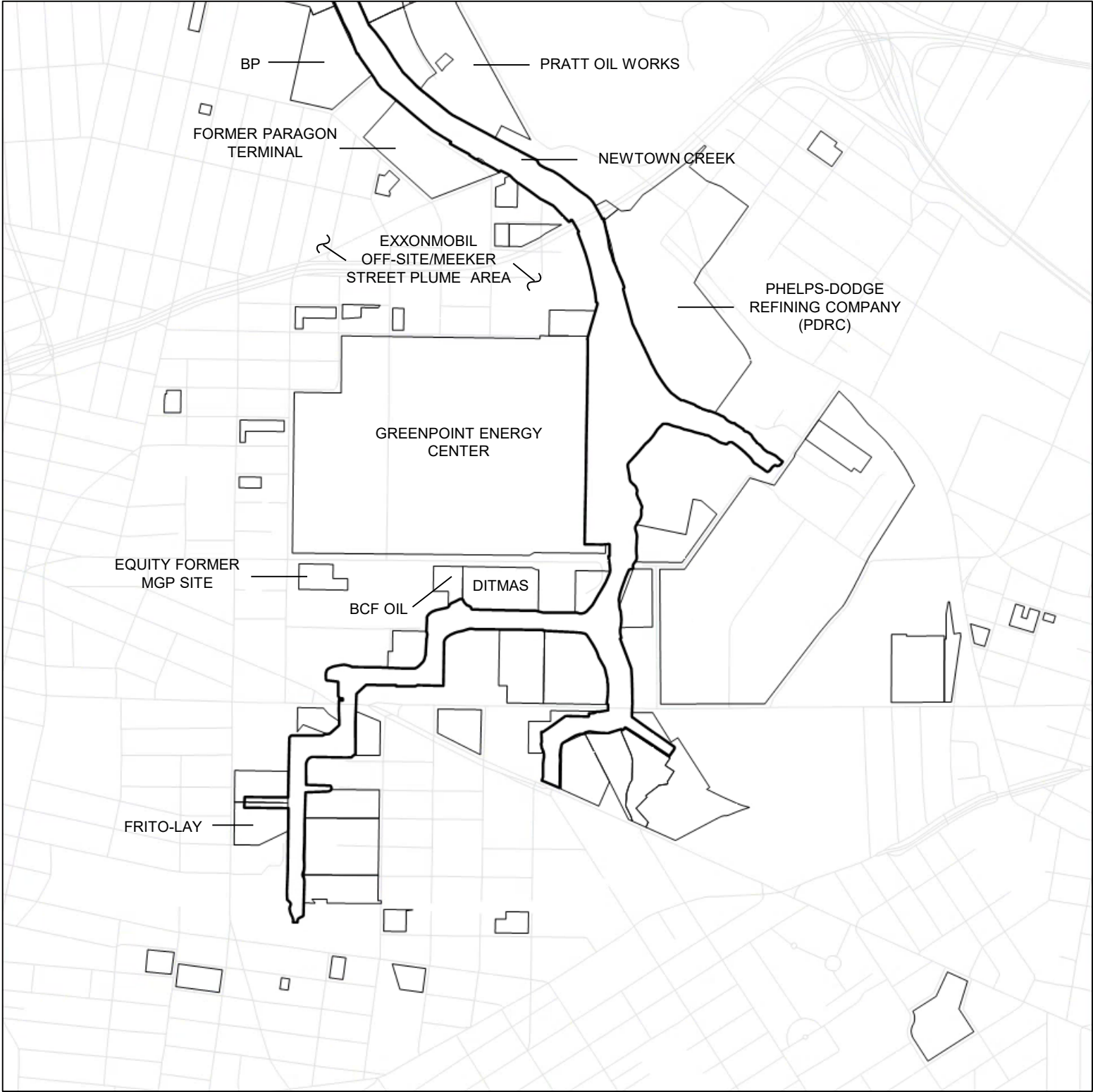
Project 125180

SITE LOCATION

September 2019

Figure L1-1

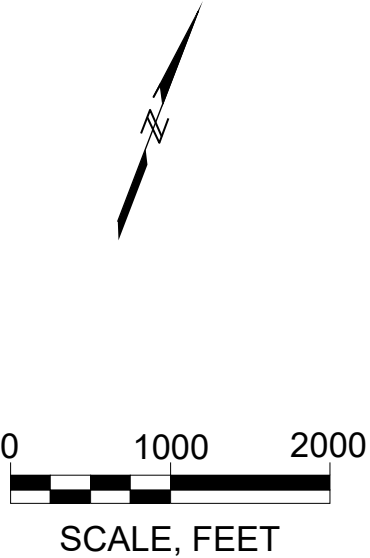
DRAFT



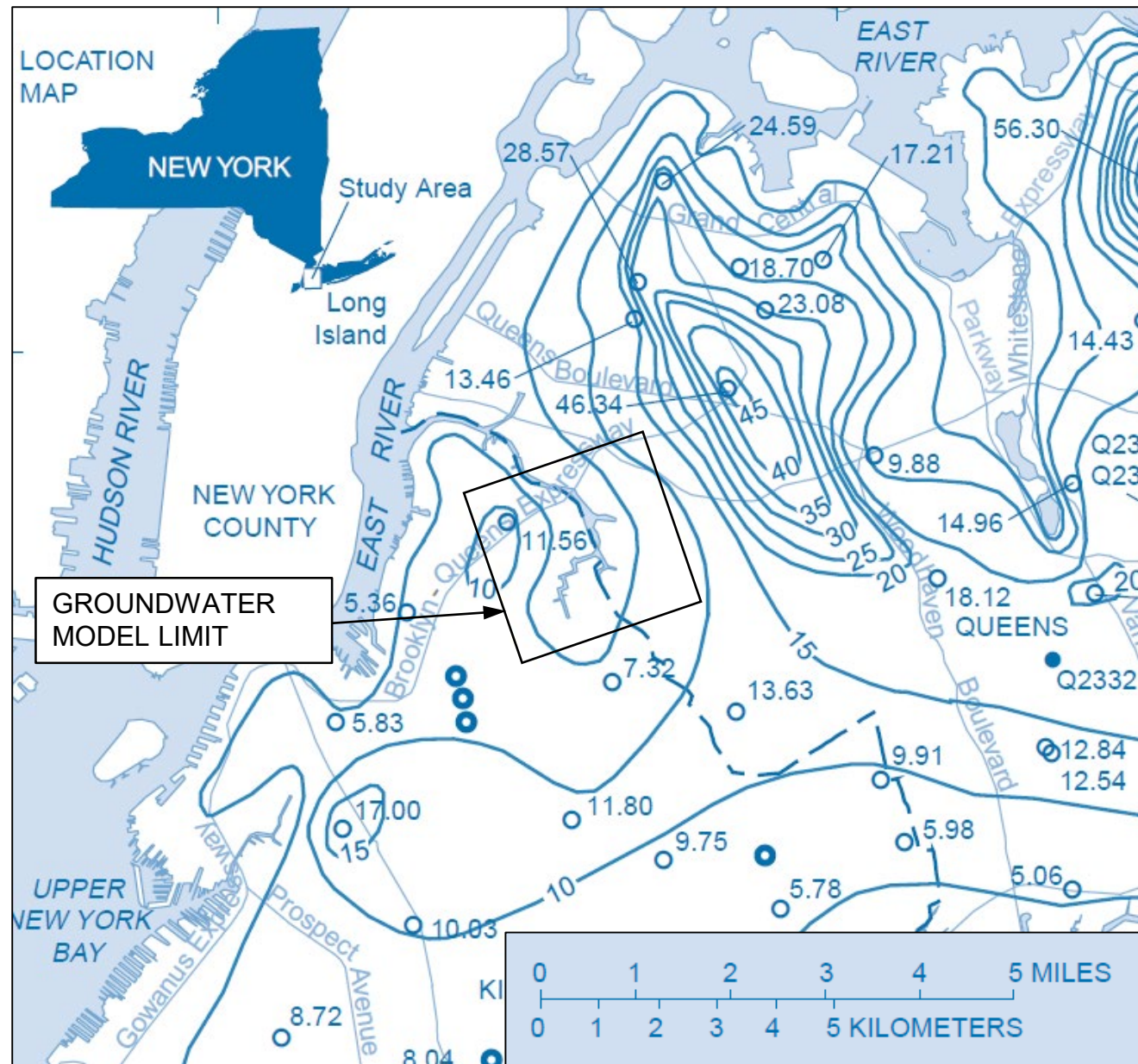
LEGEND



INVESTIGATED SITE (SITES WITH AVAILABLE SUBSURFACE DATA USED FOR MODEL ARE LABELED)



Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SITE REFERENCE LOCATIONS	
		Project 125180	September 2019 Figure L2-1



MEASURED 1997 WATER TABLE OF UPPER GLACIAL AQUIFER [USGS, 1997].

NOTE: CONTOURS SHOWN REPRESENT THE OUTWASH/MORaine PORTION OF THE UPPER GLACIAL AQUIFER. LOCALIZED WATER TABLE MOUNDING IN FILL ABOVE LOW-PERMEABILITY MARSH DEPOSITS ARE NOT REFLECTED IN THESE CONTOURS.

SOURCES:

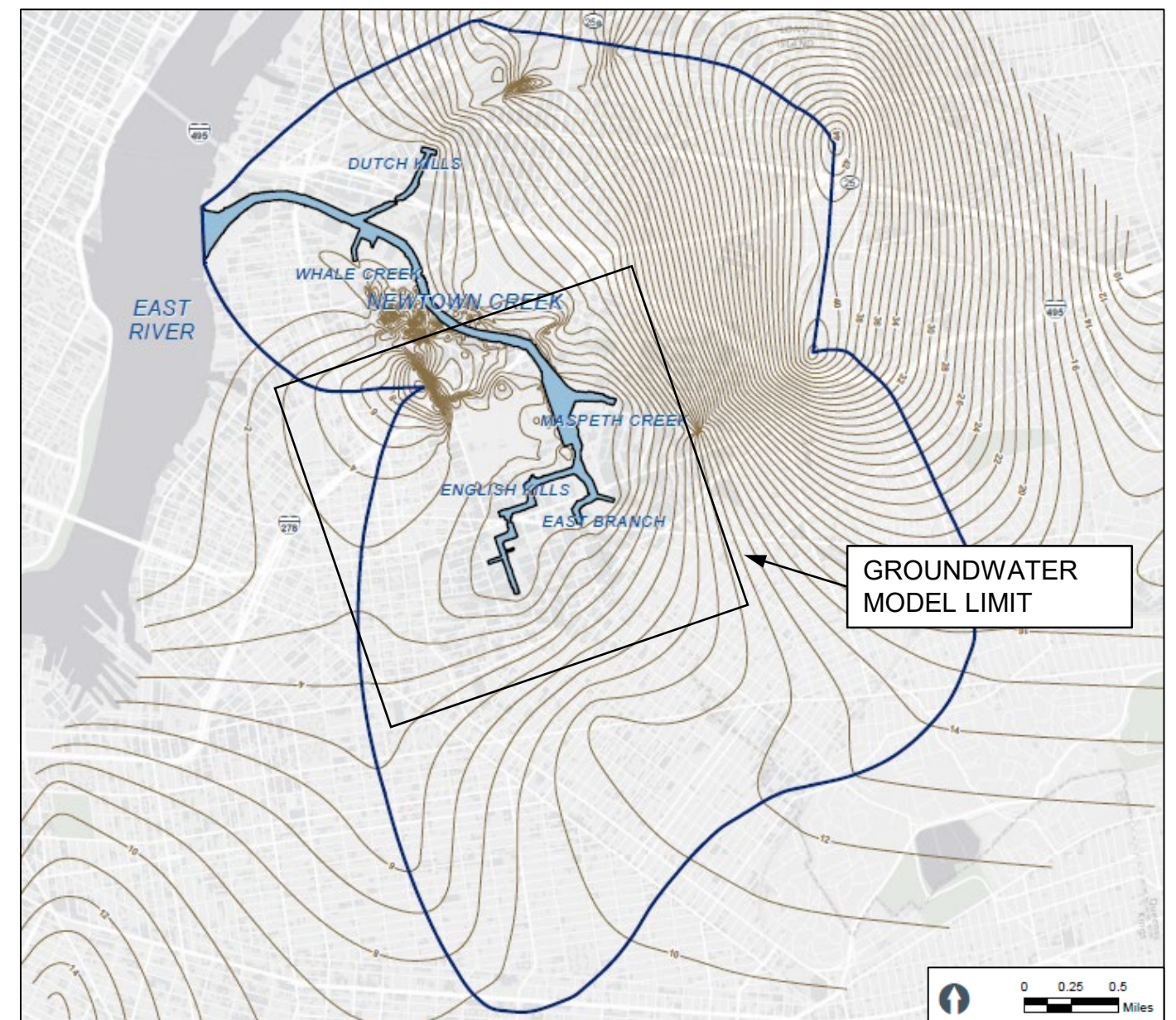
USGS, 1997. WATER-TABLE ALTITUDE IN KINGS AND QUEENS COUNTIES, NEW YORK, IN MARCH 1997, FACT SHEET FS 134-97, USGS, NOVEMBER 1997.

AQ, 2016. DRAFT REMEDIAL INVESTIGATION REPORT, REMEDIAL INVESTIGATION/FEASIBILITY STUDY, NEWTOWN CREEK. ANCHOR QEA LLC, NOVEMBER 2016.

LEGEND



GROUNDWATER MODEL LIMIT



1-FOOT ARITHMETIC AVERAGE GROUNDWATER ELEVATION CONTOURS IN UPPER GLACIAL AQUIFER (FT. NAVD 88) [AQ, 2016]

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

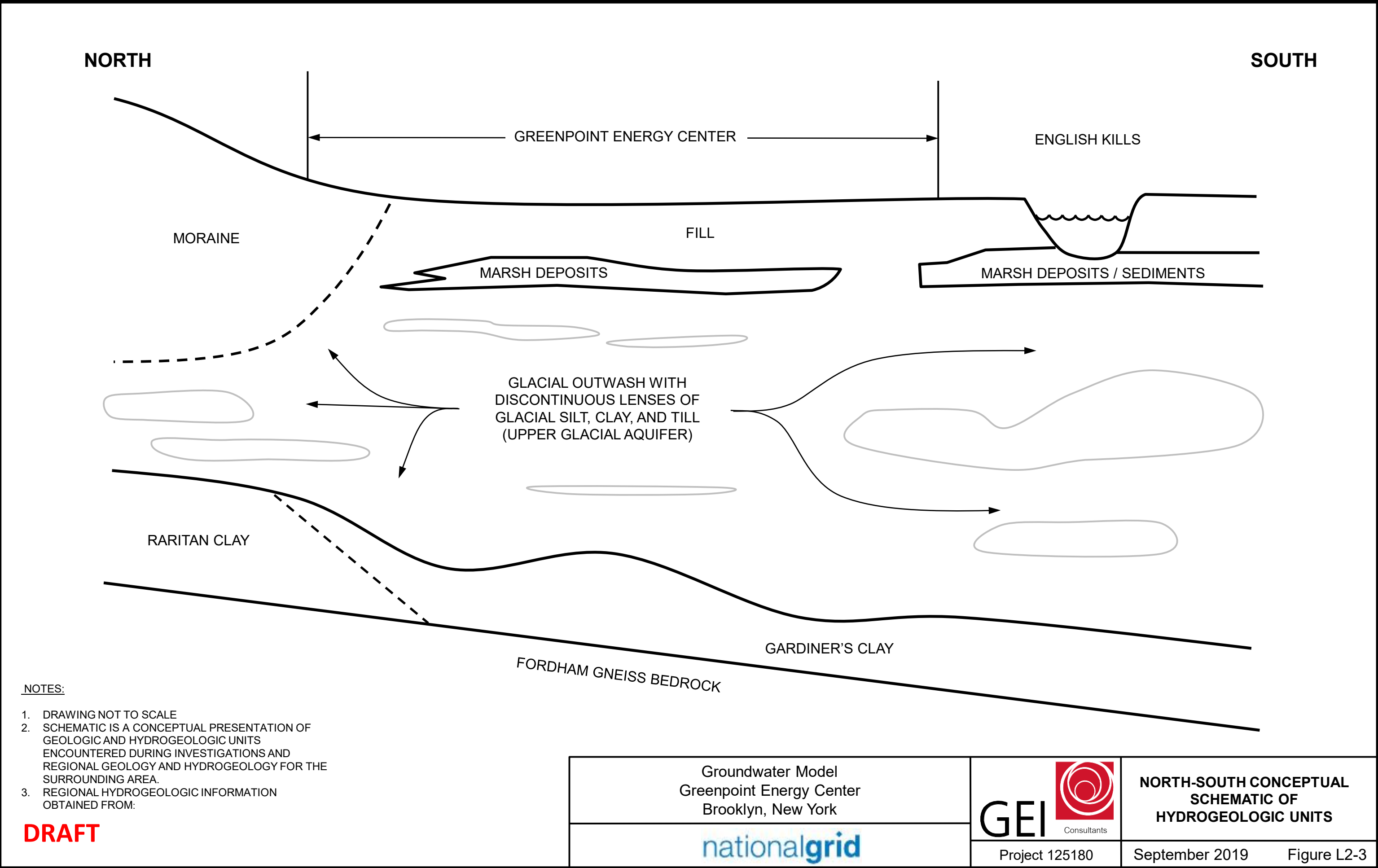


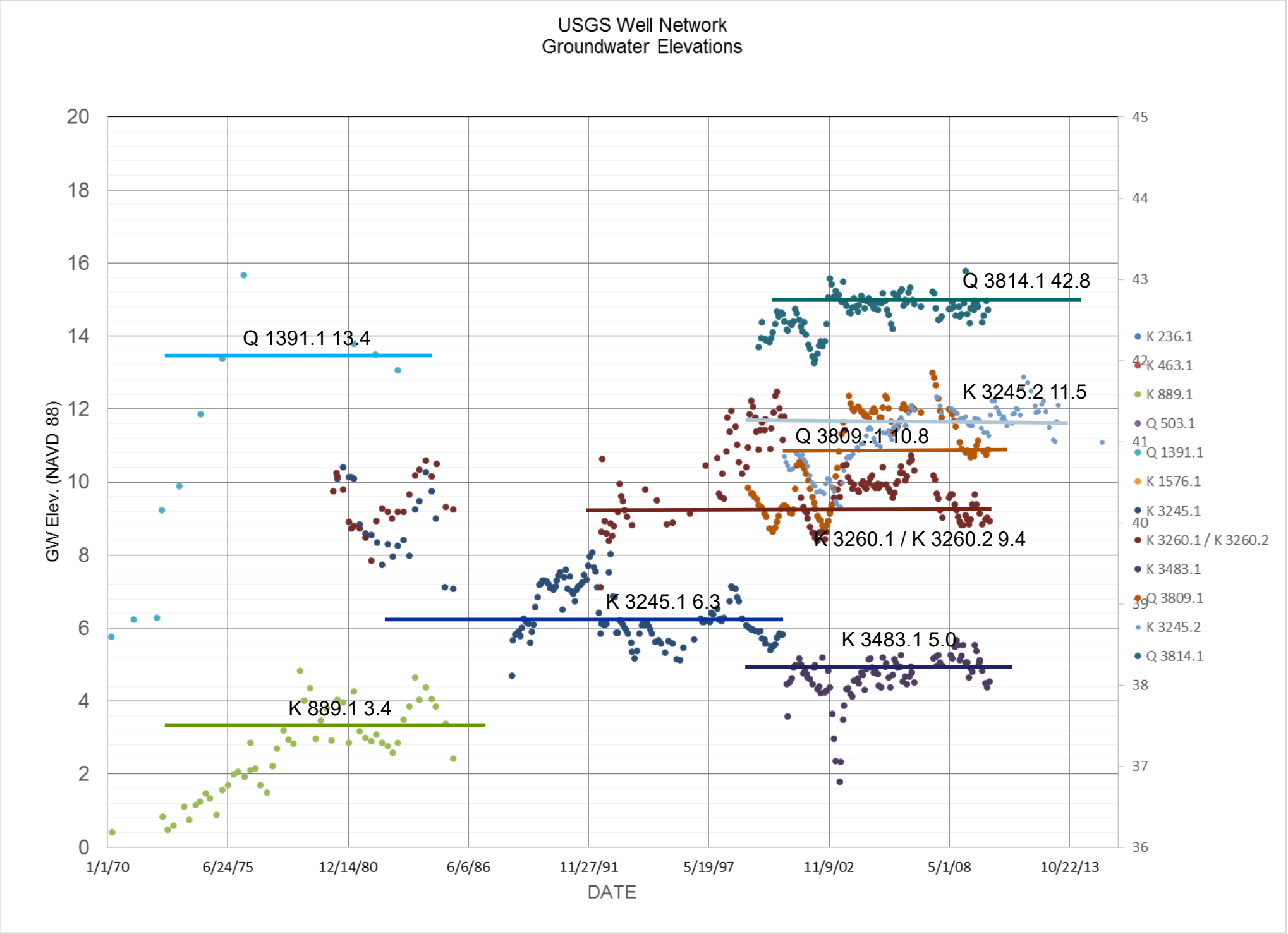
Project 125180

**REGIONAL GROUNDWATER
CONTOURS**

September 2019

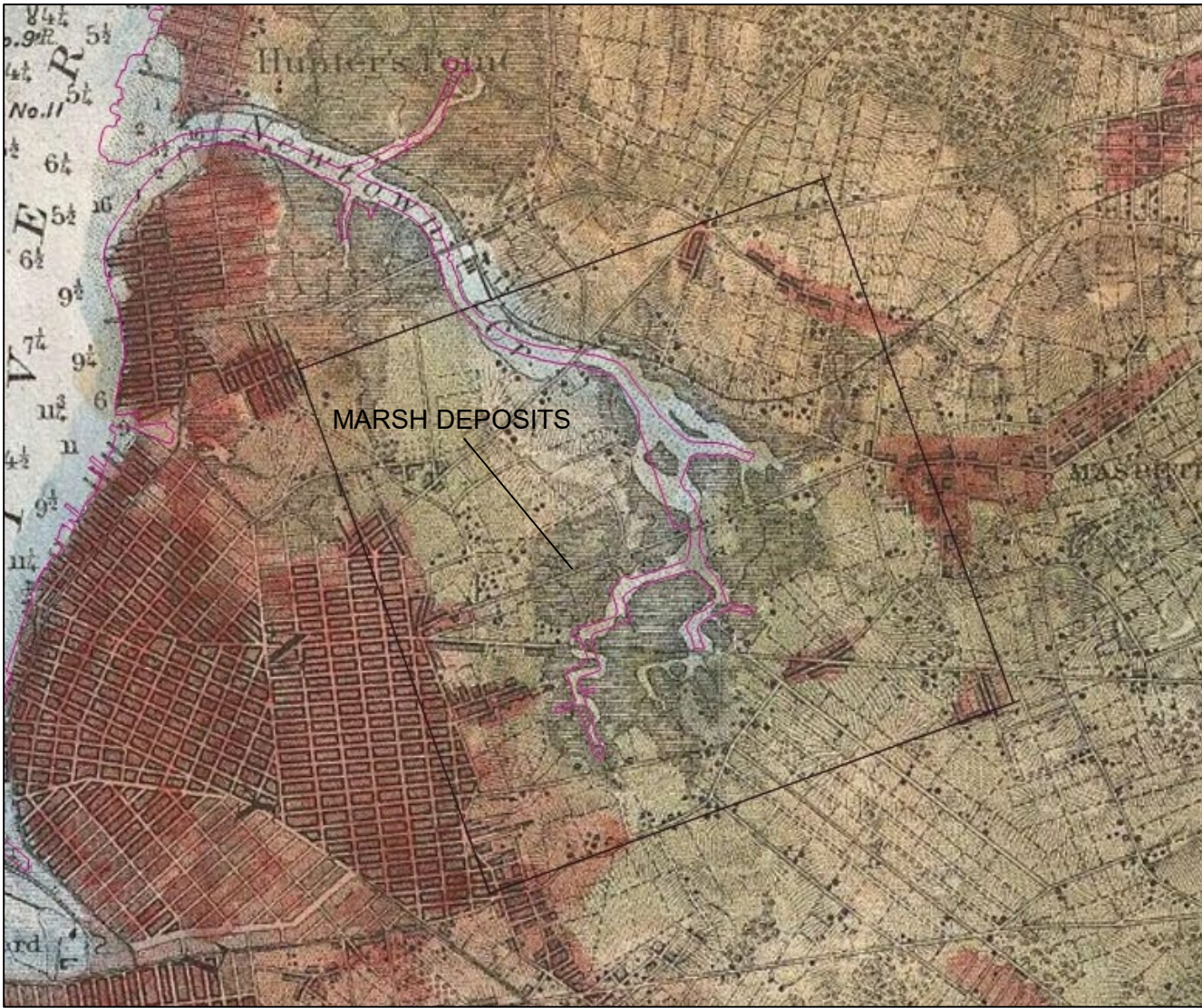
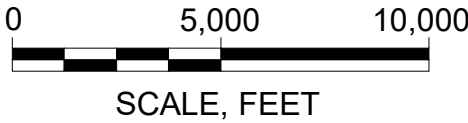
Figure L2-2



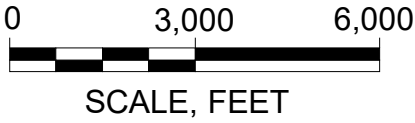




1781



1866



LEGEND



GROUNDWATER MODEL LIMIT

SOURCES:

1781: G. TAYLOR, A. SKINNER, MAP OF NEW YORK AND PART OF LONG ISLAND, SURVEYED BY ORDER OF HIS EXCELLENCY THE COMMANDER IN CHIEF OF HIS MAJESTY'S FORCES.

1866: COAST SURVEY OFFICE, COAST CHART NO. 20, NEW YORK BAY AND HARBOR, SURVEY OF THE COAST OF THE UNITED STATES.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



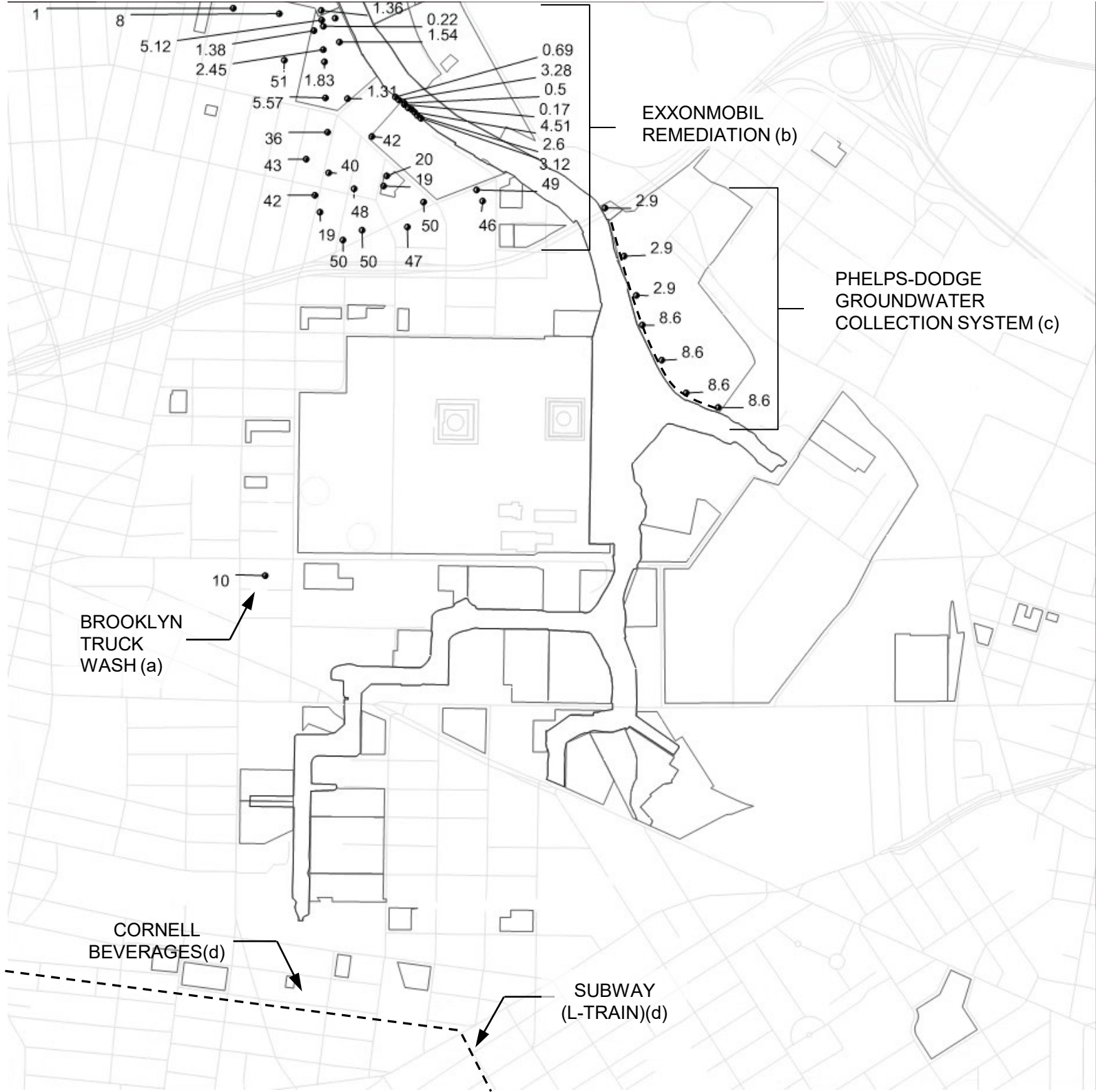
Project 125180

HISTORIC MAPS

September 2019

Figure L2-5

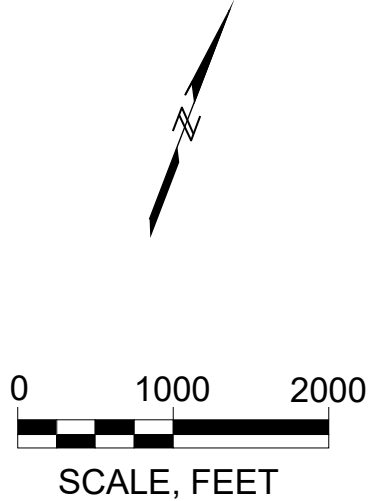
DRAFT



LEGEND

42

REPORTED TYPICAL PUMPING RATE
(GPM) (a)



NOTES:

- (a) PUMP RATE FOR BROOKLYN TRUCK WASH NOT REPORTED OR AVAILABLE. RATE APPLIED IN MODEL CONSIDERED TO BE CONSERVATIVE FOR INDUSTRY.
- (b) SOURCE FOR EXXONMOBIL PUMP RATES: SITE FREE-PRODUCT RECOVERY SYSTEMS, EXXONMOBIL GREENPOINT REMEDIATION PROJECT, ROUX ASSOCIATES, November 18, 2011.
- (c) SOURCE FOR PHELPS-DODGE PUMP RATES: ANNUAL OM&M REPORT (CRA 2008 AND 2012).
- (d) NO INFORMATION AVAILABLE AS TO WHETHER WITHDRAWALS OR DEWATERING AT THESE LOCATIONS ARE ONGOING WITHIN MODEL AREA.

GROUNDWATER EXTRACTION / WITHDRAWAL LOCATIONS IN MODEL

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



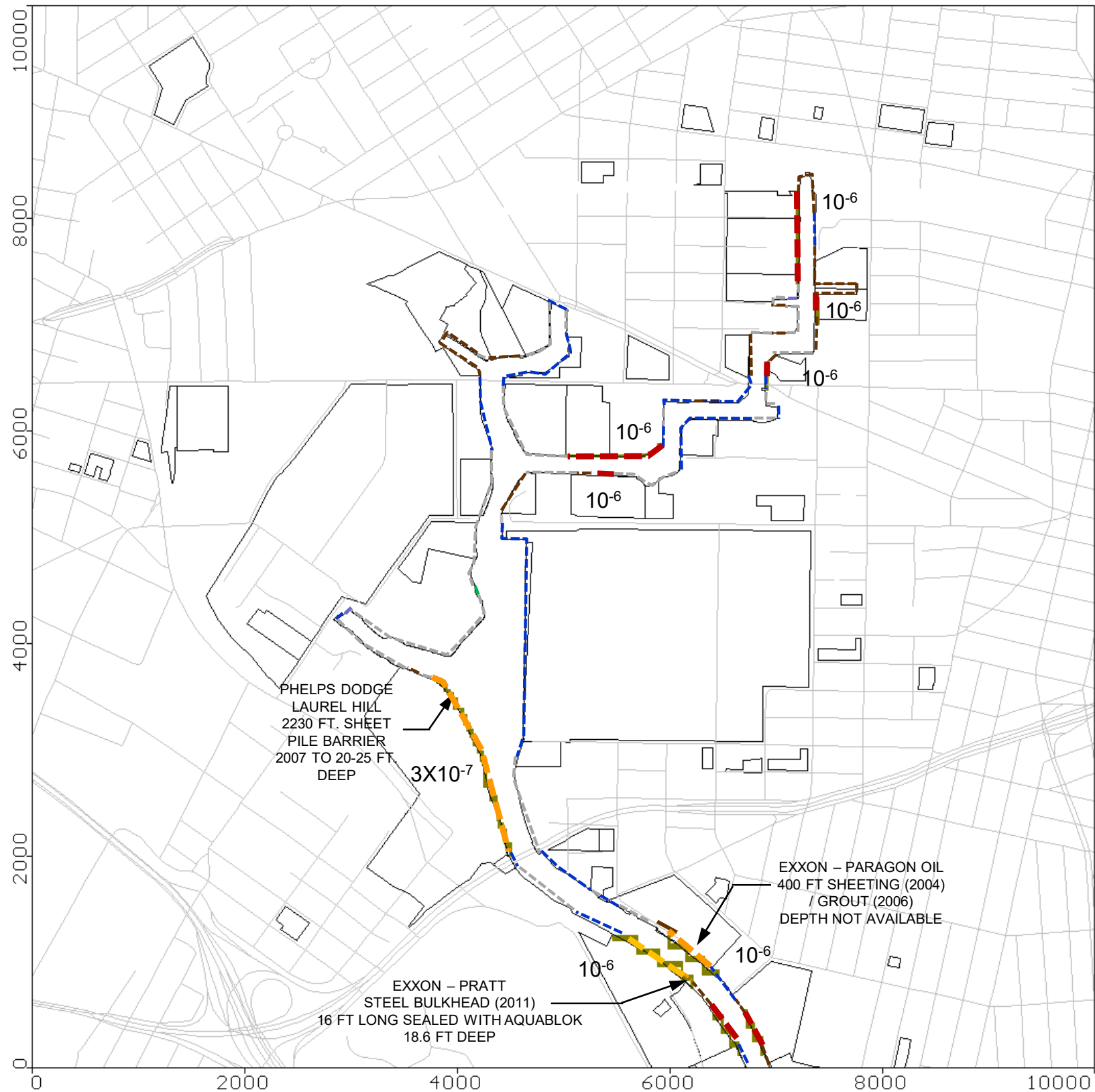
Project 125180

GROUNDWATER EXTRACTION LOCATIONS

September 2019

Figure L2-6

DRAFT



LEGEND

SHORELINE TYPE (ANCHOR, 2016)

MODELED AS WALL BOUNDARY

- REMEDIAL BARRIER WALL / CUTOFF
- STEEL SHEETPILE WITH HYDRAULIC CONDUCTIVITY USED IN MODEL (cm/s)

ASSUMED PERVIOUS WITH NO IMPEDENCE TO HORIZONTAL DISCHARGE, NOT MODELED

- BARE GROUND
- CONCRETE
- RIPRAP
- WOOD

MODELED WALL BOUNDARY

- SHEETPILE CUTOFF MODELED AS UNIT THICKNESS (1 FT.), HYD. COND = 0.001 FT./D (3E-7 cm/s)

NOTE: MODELED BULKHEAD THICKNESS = 0.4 FT.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



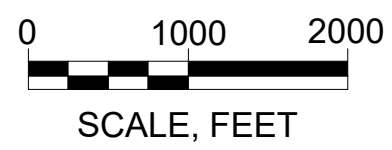
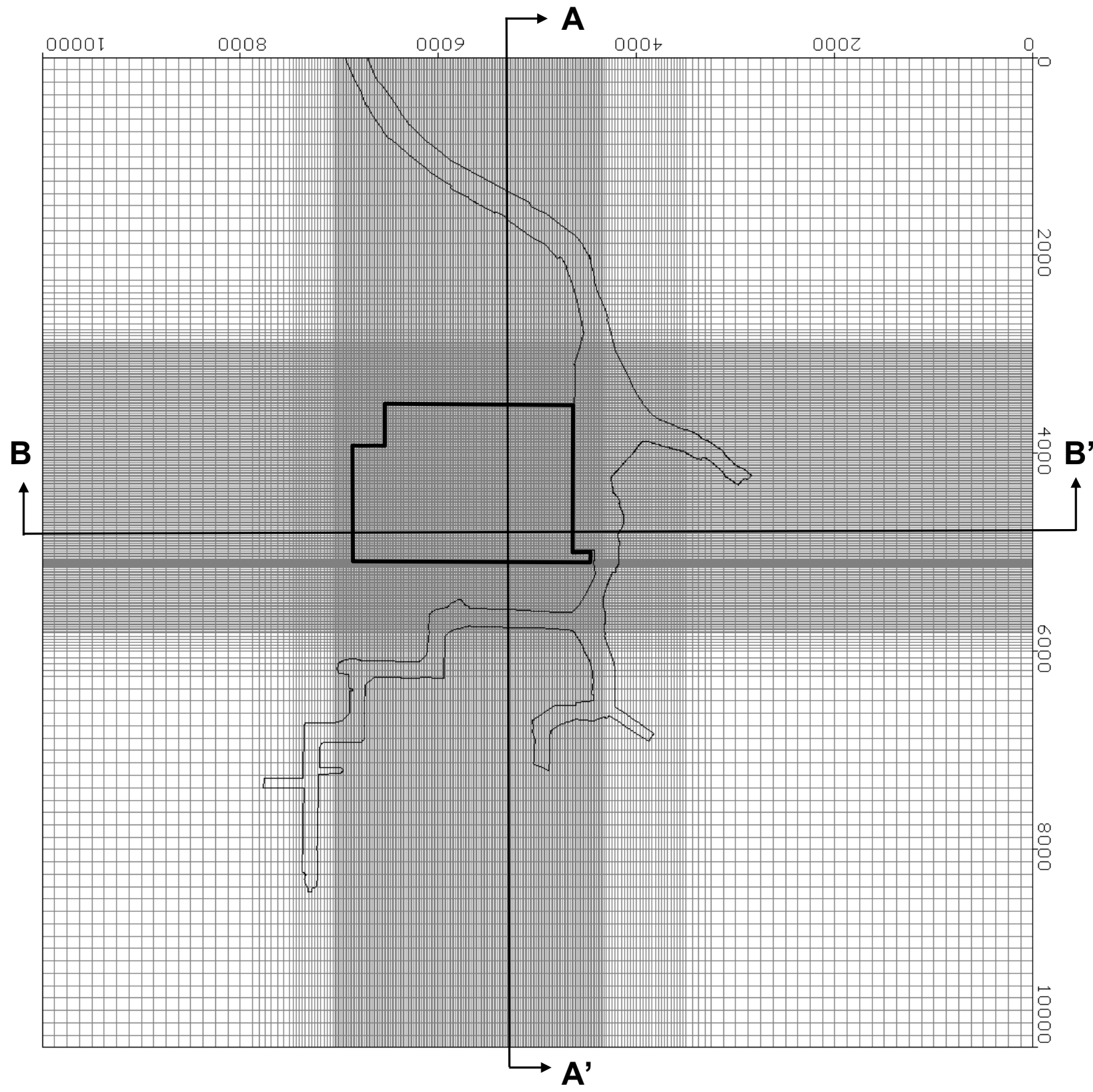
SHORELINE TYPE

Project 125180

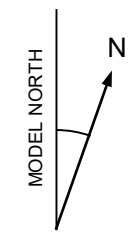
September 2019

Figure L2-8

DRAFT

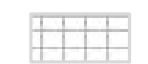


HORIZONTAL GRID SPACING:
15 FT. ONSITE
8 FT NORTH-SOUTH ALONG
MASPETH AVE.
124 FT. AT MODEL CORNERS



AXIS ROTATION 18.9°

LEGEND



GRID LINES



LOCATION OF CROSS-
SECTIONS (Figure L4)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



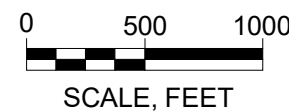
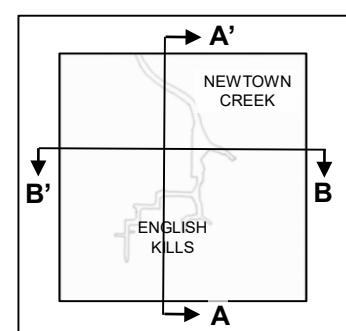
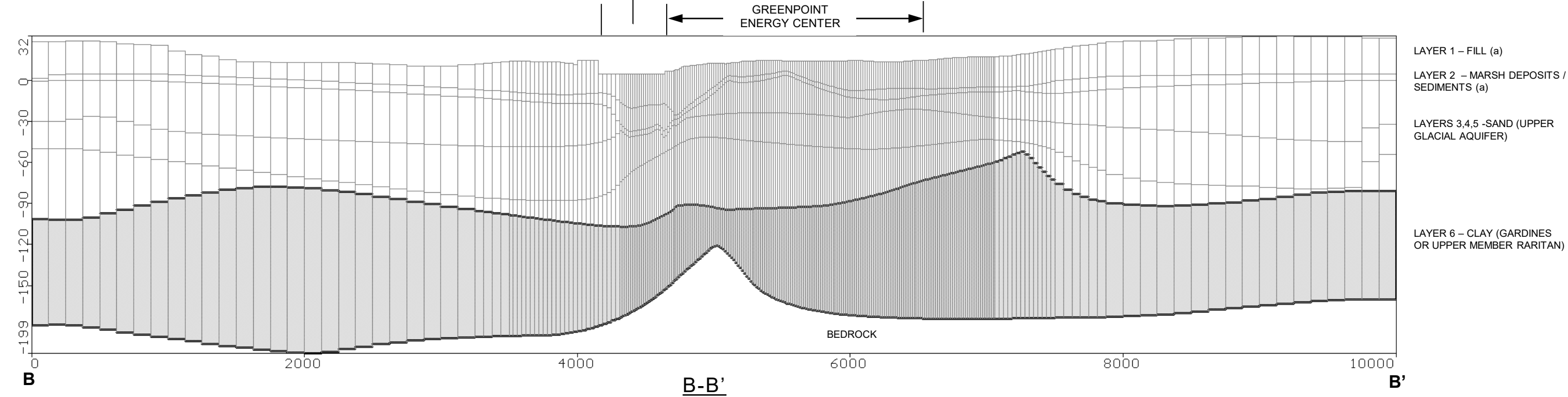
MODEL GRID

Project 125180

September 2019

Figure L3-1

DRAFT



10:1 VERTICAL
EXAGGERATION

LEGEND

- MODEL GRID LINES
- INACTIVE (NO-FLOW) CELLS

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



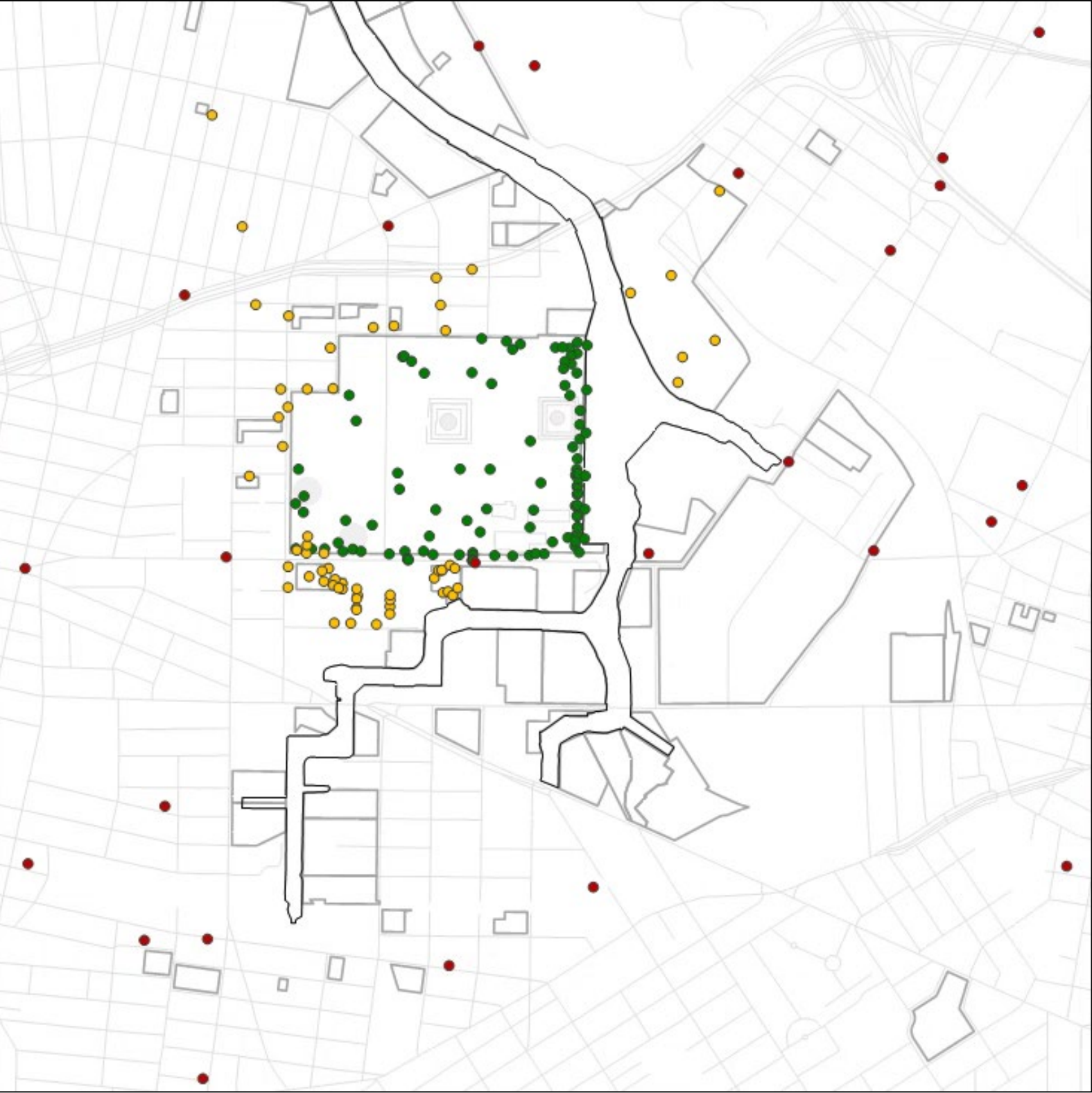
**MODEL GRID
CROSS-SECTIONS**

Project 125180

September 2019

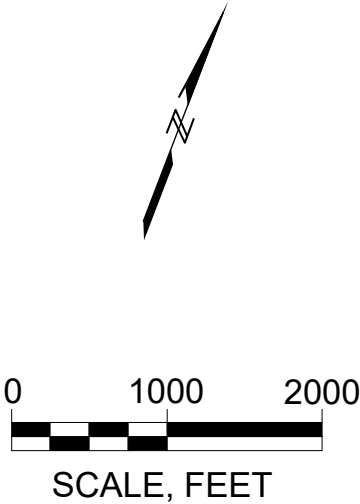
Figure L3-2

DRAFT



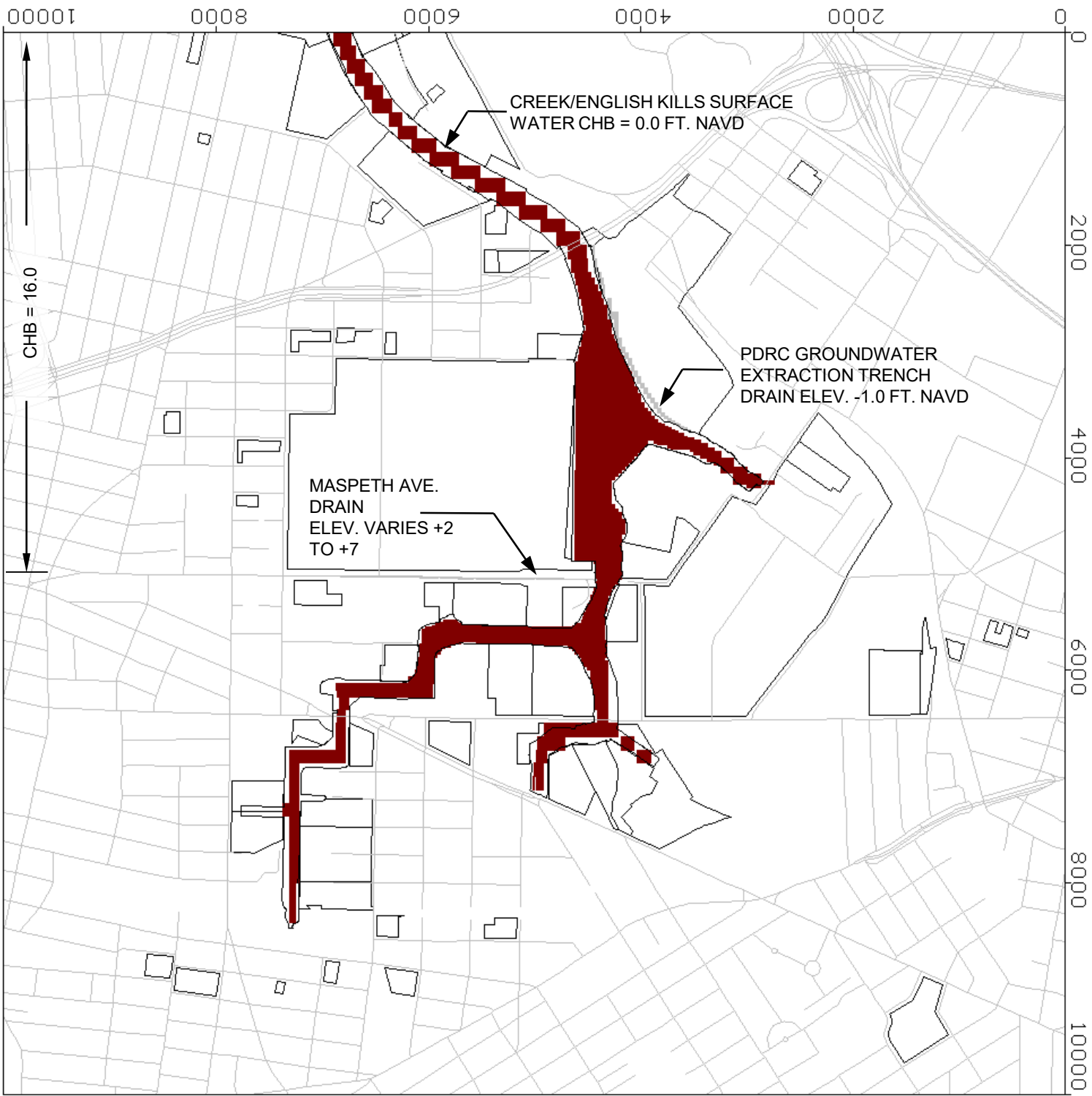
CALIBRATION DATA SOURCE

- GREENPOINT
- OTHER DAR SITES
- NEWTOWN CREEK
- USGS



Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	STRATIGRAPHIC INPUT SOIL BORING LOCATIONS	
		Project 125180	September 2019 Figure L3-3

DRAFT



LEGEND

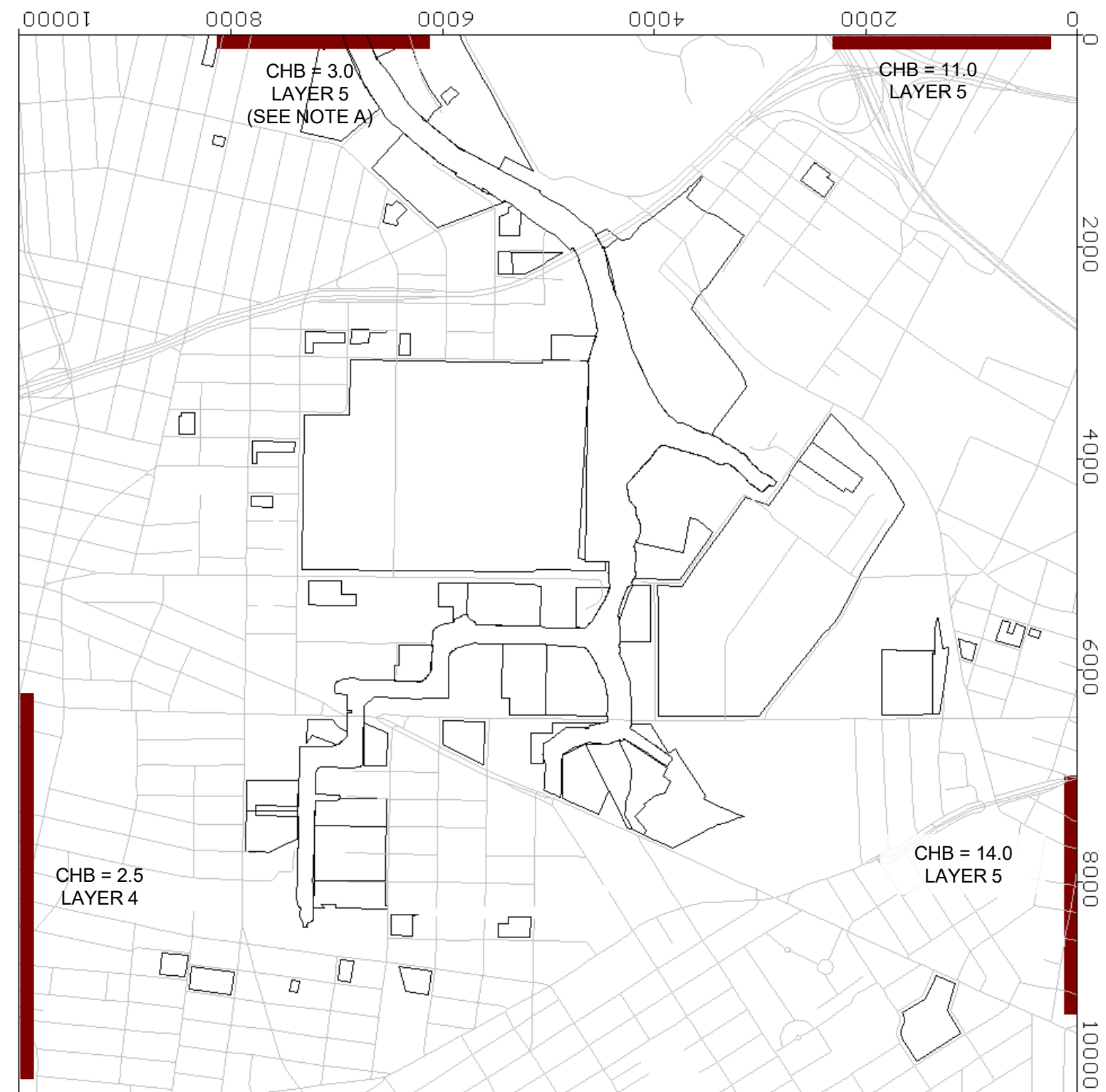
- CONSTANT HEAD
- DRAIN (MASPETH AVE. UTILITIES)



MODEL LAYER 1

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SHALLOW HEAD BOUNDARIES	
		Project 125180	September 2019 Figure L3-4

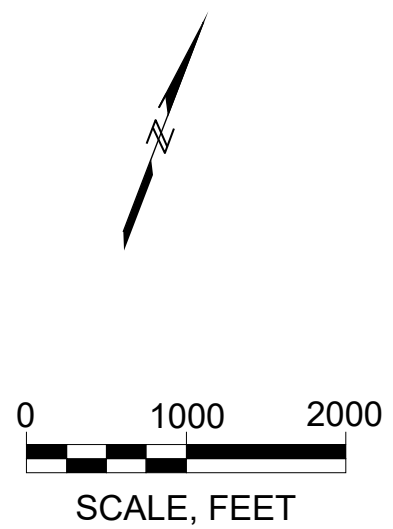
DRAFT



MODEL LAYER 5

LEGEND

CONSTANT HEAD BOUNDARY



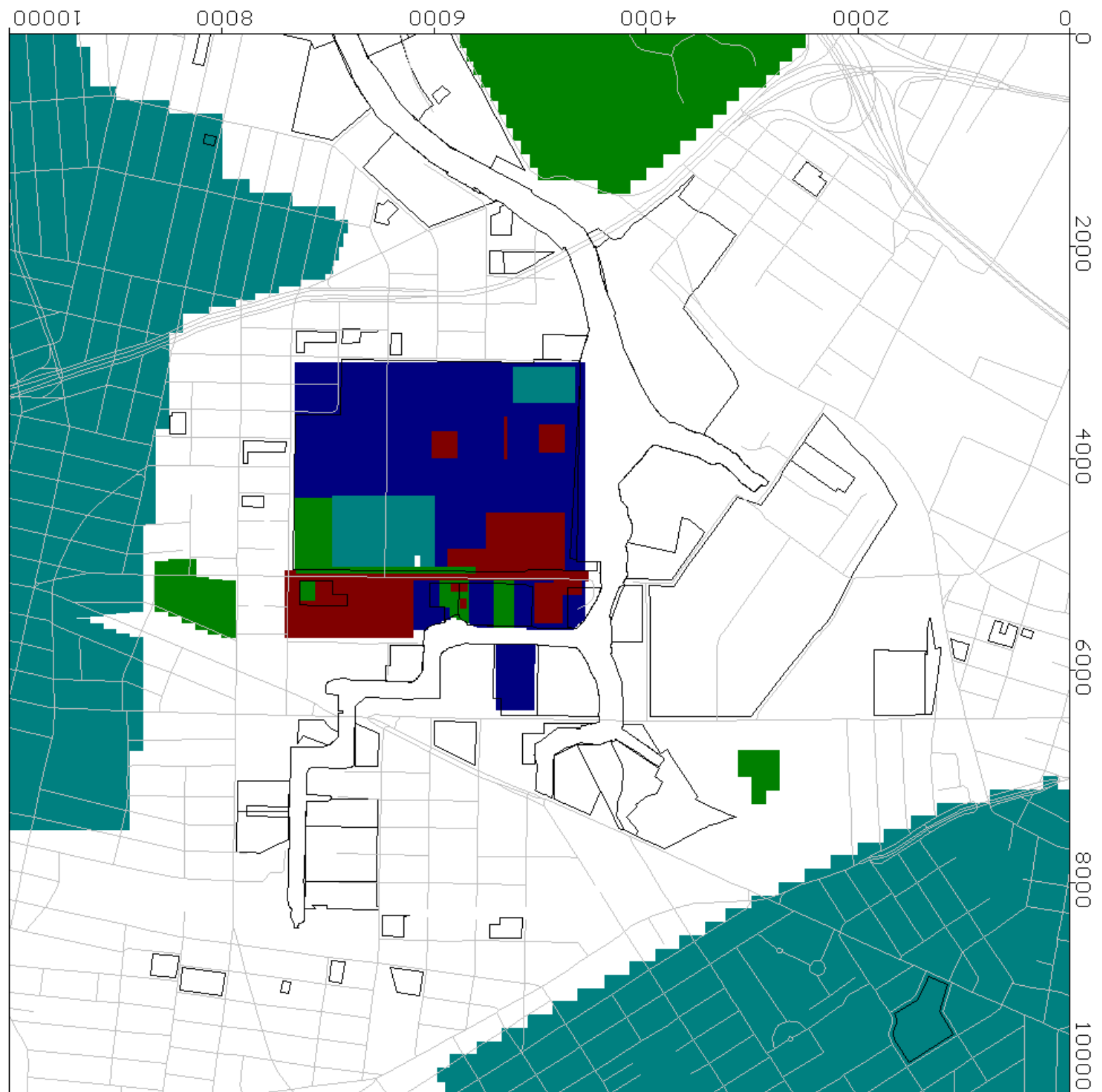
NOTE:
(a) HEAD BOUNDARY ASSIGNED HERE TO SIMULATE EFFECTS OF GROUNDWATER EXTRACTION IN AREA TO NORTH OUTSIDE MODEL LIMITS.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



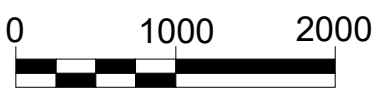
UPPER GLACIAL AQUIFER
CONSTANT HEAD BOUNDARIES

DRAFT



AREAL RECHARGE RATES

- COMMERCIAL/INDUSTRIAL 5 IN./YR(a)
- UNPAVED 9 IN./YR
- UNDEVELOPED / VEGETATED 16 IN./YR
- URBAN RESIDENTIAL 8 IN./YR
- DISCRETIZED IMPERVIOUS SURFACE / BUILDINGS 0.5 IN./YR



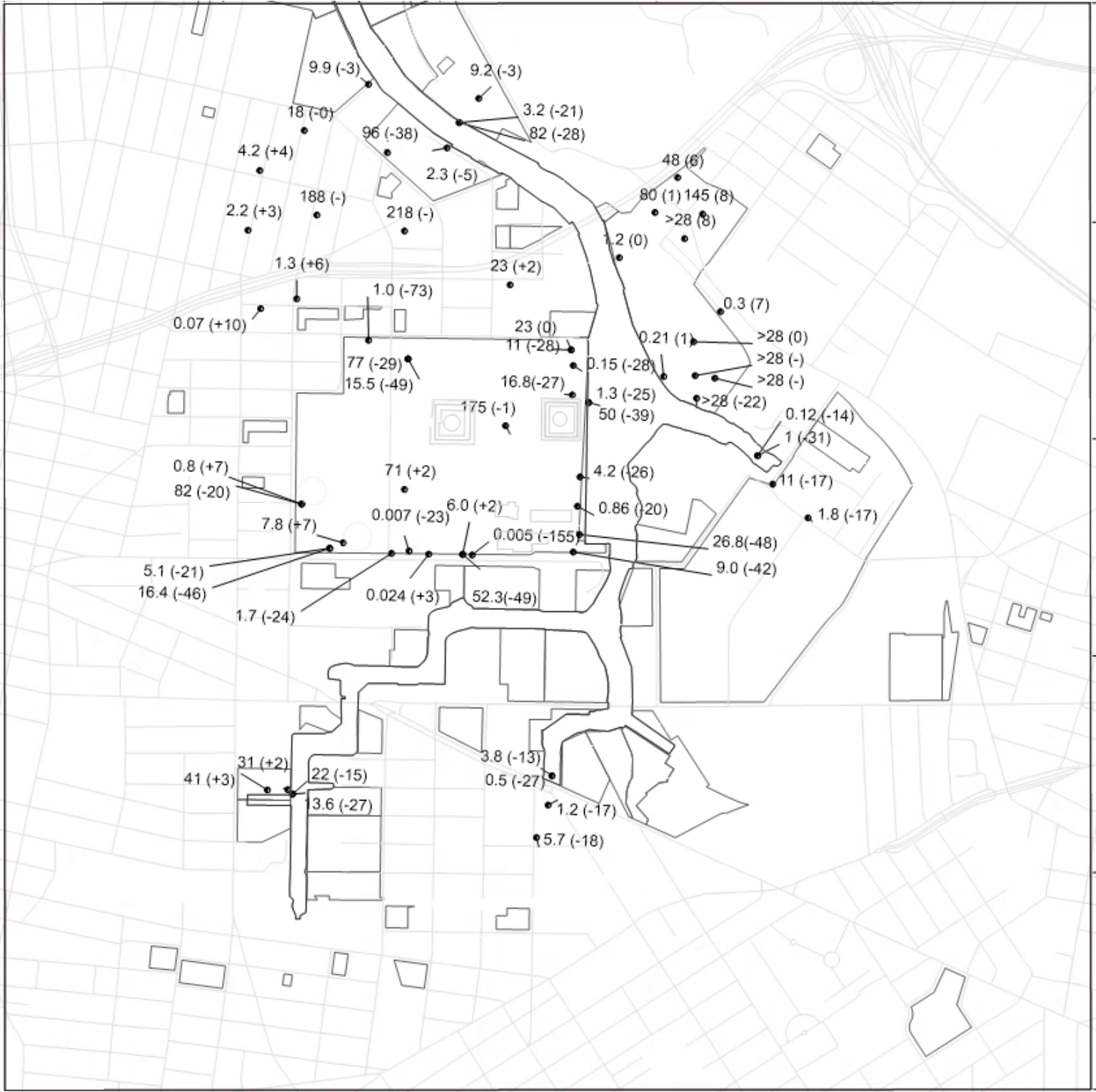
SCALE, FEET

FOOTNOTE:

- (a) COMMERCIAL/INDUSTRIAL RECHARGE USED AS DEFAULT OVER SURFACE WATER. APPLIED RECHARGE OVER SURFACE WATER DOES NOT AFFECT MODEL.

MODEL LAYER 1

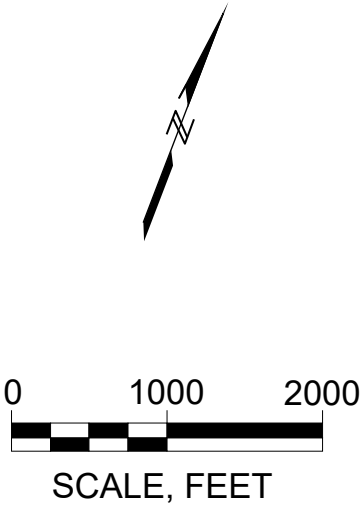
Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	RECHARGE BOUNDARIES	
		Project 125180	September 2019 Figure L3-6



LEGEND

15 (-12) REPORTED HYDRAULIC CONDUCTIVITY
IN FT./DAY (ELEVATION APPROX. MID-
POINT WELL SCREEN)

(-) WELL SCREEN ELEVATION NOT
AVAILABLE

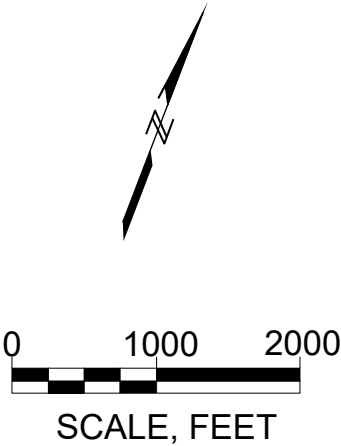


Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	HYDRAULIC CONDUCTIVITY MEASUREMENTS	
		Project 125180	September 2019 Figure L3-7

DRAFT

HYDRAULIC CONDUCTIVITY ZONES

- FILL ($K_H = 2, K_V = 0.2$)
- OPEN WATER ($K_H = K_V = 500$)
- FILL 1 – ASSUMED DENSE MATERIAL SOUTH OF MASPETH ($K_H = 0.1 K_V = 0.05$)
- FILL, MISCELLANEOUS POCKETS ($K_H = 0.5 K_V = 0.1$)
- MASPETH AVE. UTILITY CORRIDOR ($K_H = 50, K_V = 50$)
- UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
- MORAINE ZONE 1 ($K_H = 10, K_V = 0.5$)
- MORAINE ZONE 2 ($K_H = K_V = 0.012$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



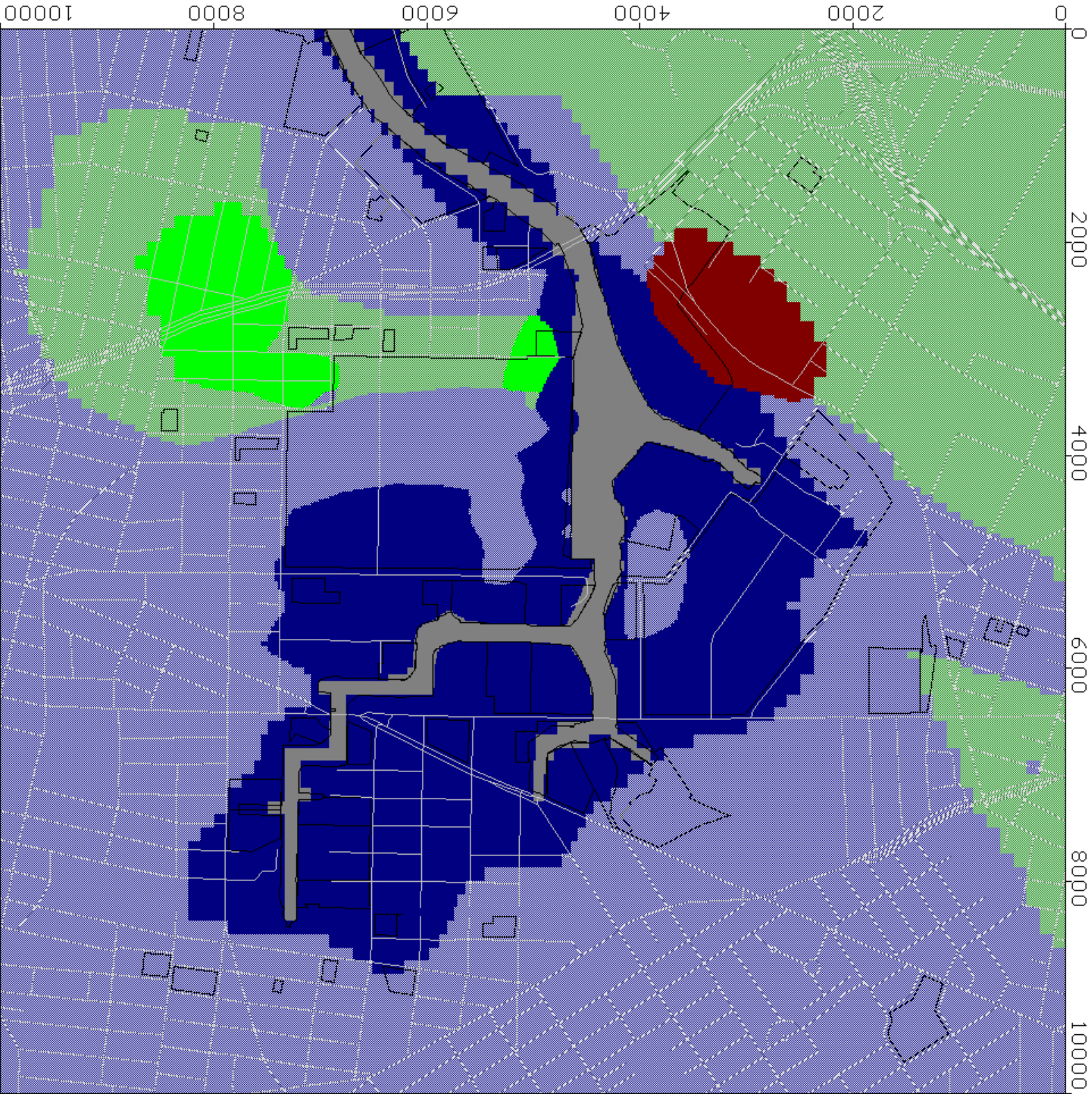
Project 125180

HYDRAULIC CONDUCTIVITY
LAYER 1

September 2019

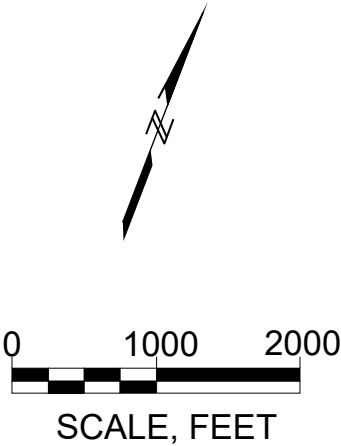
Figure L3-8a

DRAFT



HYDRAULIC CONDUCTIVITY ZONES

- MARSH DEPOSITS ($K_H = 0.1$, $K_V = 0.001$)
- SEDIMENTS ($K_H = 3$, $K_V = 0.3$)
- UPPER GLACIAL AQUIFER ($K_H = 80$, $K_V = 30$)
- MORAINE ZONE 1 ($K_H = 10$, $K_V = 0.5$)
- MORAINE ZONE 2 ($K_H = K_V = 0.012$)
- MORAINE ZONE 3 ($K_H = 0.4$, $K_V = 0.08$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

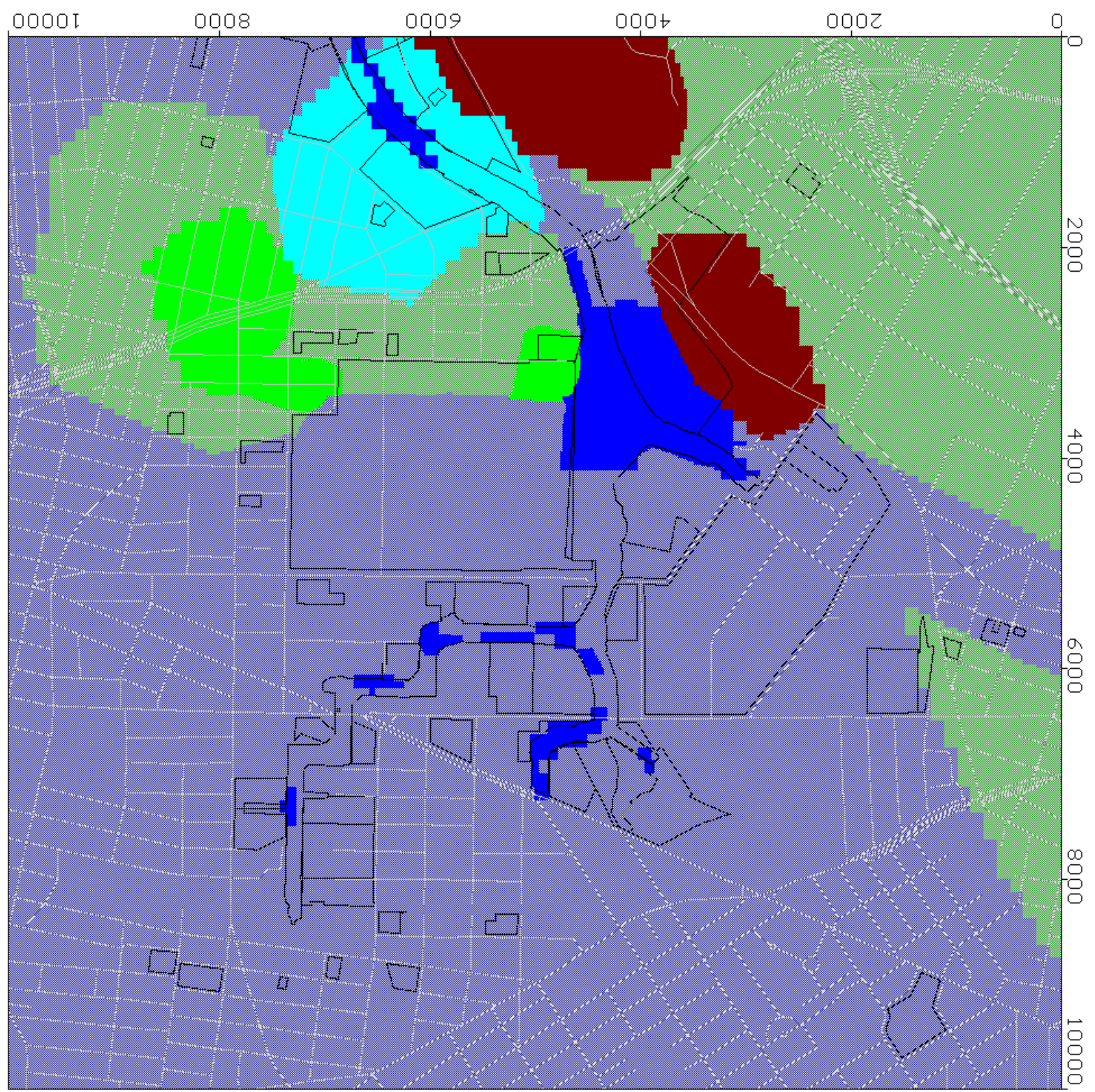


Project 125180

HYDRAULIC CONDUCTIVITY
LAYER 2

September 2019 Figure L3-8b

DRAFT



HYDRAULIC CONDUCTIVITY ZONES

- UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
- MORAINE ZONE 1 ($K_H = 10, K_V = 0.5$)
- MORAINE ZONE 2 ($K_H = K_V = 0.012$)
- MORAINE ZONE 3 ($K_H = 0.4, K_V = 0.08$)
- FINE-GRAINED NATIVE MATERIAL ($K_H = 30, K_V = 3$)
- COARSE DEPOSITS ($K_H = 250, K_V = 25$)

NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



HYDRAULIC CONDUCTIVITY
LAYER 3

Project 125180

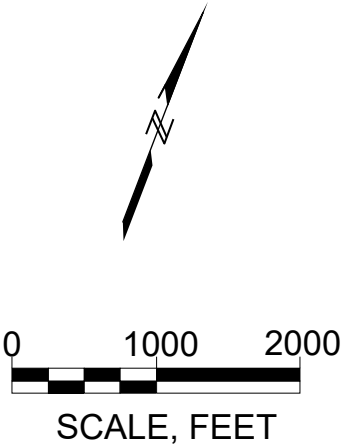
September 2019

Figure L3-8c

DRAFT

HYDRAULIC CONDUCTIVITY ZONES

- UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
- MORAINE ZONE 1 ($K_H = 10, K_V = 0.5$)
- MORAINE ZONE 2 ($K_H = K_V = 0.012$)
- MORAINE ZONE 3 ($K_H = 0.4, K_V = 0.08$)
- COARSE DEPOSITS ($K_H = 250, K_V = 25$)
- CLAY INTERBEDS ($K_H = 250, K_V = 25$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



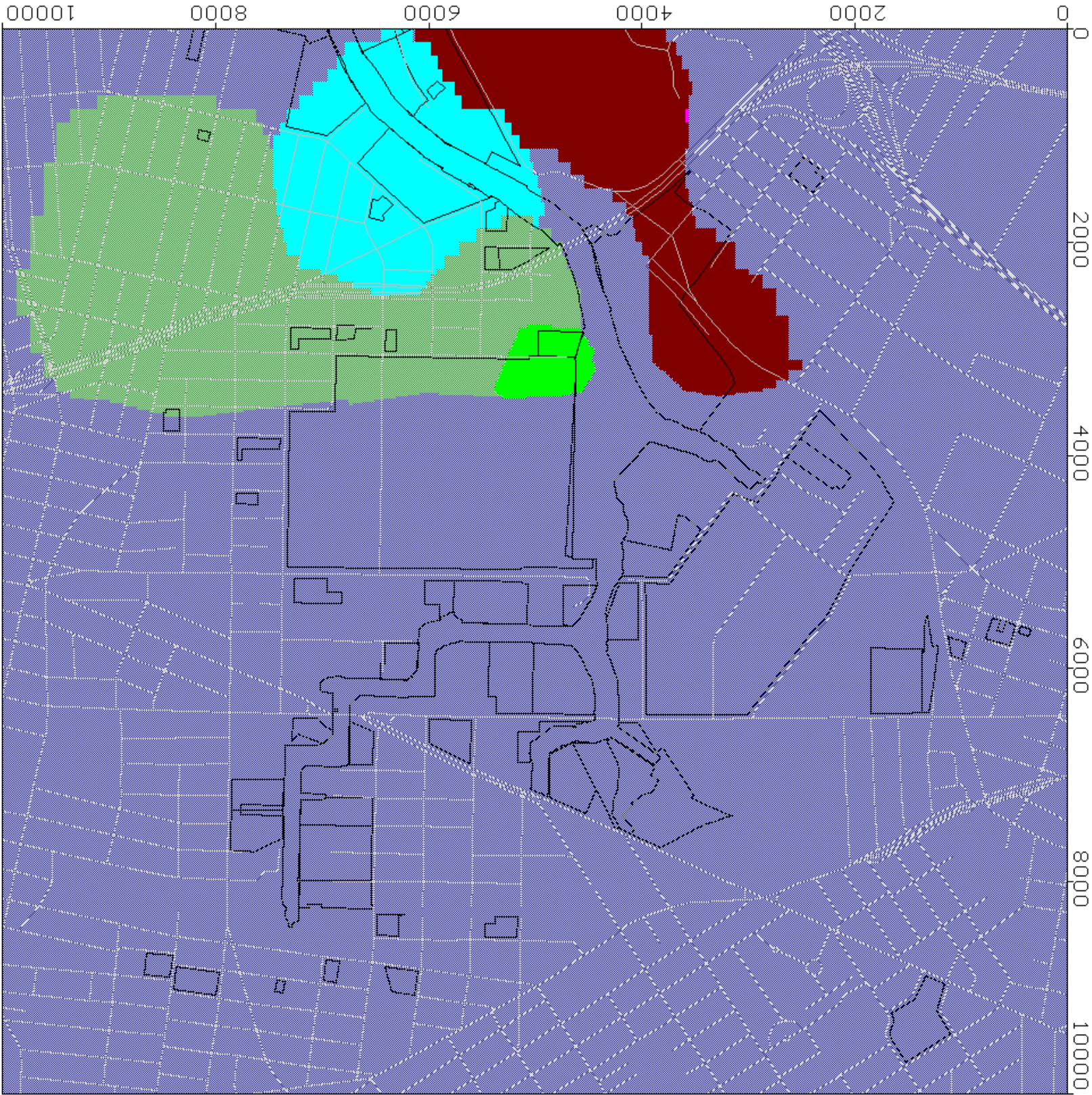
Project 125180

HYDRAULIC CONDUCTIVITY
LAYER 4

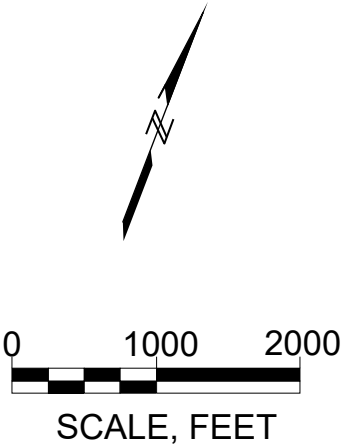
September 2019

Figure L3-8d

DRAFT



- HYDRAULIC CONDUCTIVITY ZONES
- UPPER GLACIAL AQUIFER ($K_H = 80$, $K_V = 30$)
 - MORAINE ZONE 1 ($K_H = 10$, $K_V = 0.5$)
 - MORAINE ZONE 2 ($K_H = K_V = 0.012$)
 - MORAINE ZONE 3 ($K_H = 0.4$, $K_V = 0.08$)
 - COARSE DEPOSITS ($K_H = 250$, $K_V = 25$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

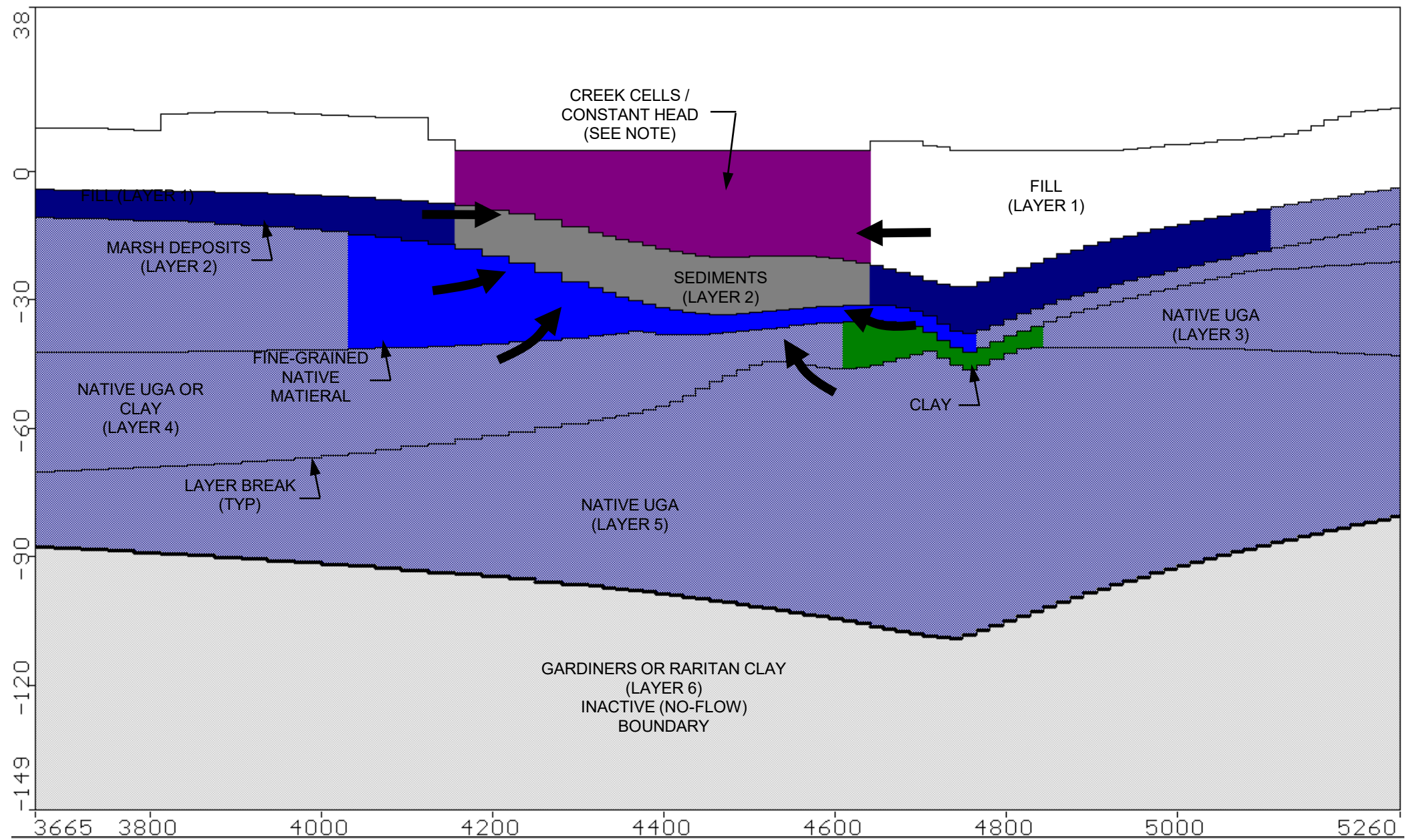
K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)



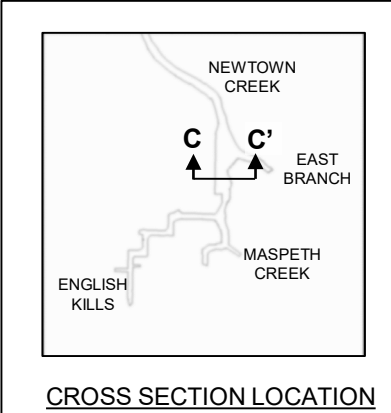
HYDRAULIC CONDUCTIVITY
LAYER 5

DRAFT



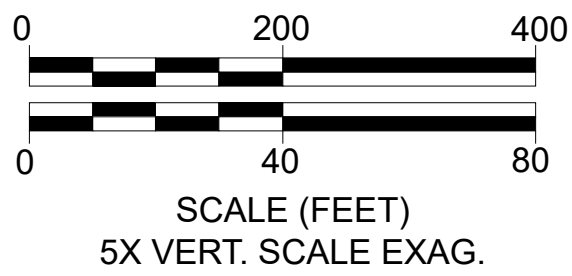
- HYDRAULIC CONDUCTIVITY ZONES
- FILL ($K_H = 2, K_V = 0.2$)
 - SEDIMENTS ($K_H = 3, K_V = 0.3$)
 - MARSH DEPOSITS ($K_H = 0.1, K_V = 0.001$)
 - FINE-GRAINED NATIVE MATERIAL ($K_H = 30, K_V = 3$)
 - CLAY INTERBEDS ($K_H = 250, K_V = 25$)
 - UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
 - OPEN WATER ($K_H = K_V = 500$)
 - GARDINERS OR RARITAN CLAY (INACTIVE)
- ← CONCEPTUAL GROUNDWATER DISCHARGE PATTERN

NOTE: HIGH HYDRAULIC CONDUCTIVITY IN CREEK CELLS (500 FT./DAY) CONTAIN CONSTANT HEAD BOUNDARY(CHB) CELLS. WHERE CHB CELLS NOT PRESENT, HIGH-CONDUCTIVITY CELLS ALLOW UNINHIBITED FLOW TO CHB. GROUNDWATER ENTERING CHB CELLS EXITS THE MODEL.



CROSS SECTION C-C'
(MODEL ROW 138)

HORIZ.
VERT.



NOTES:

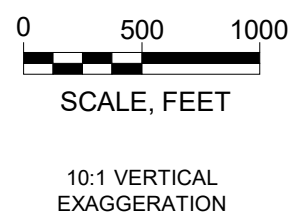
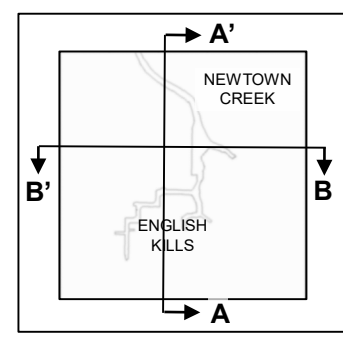
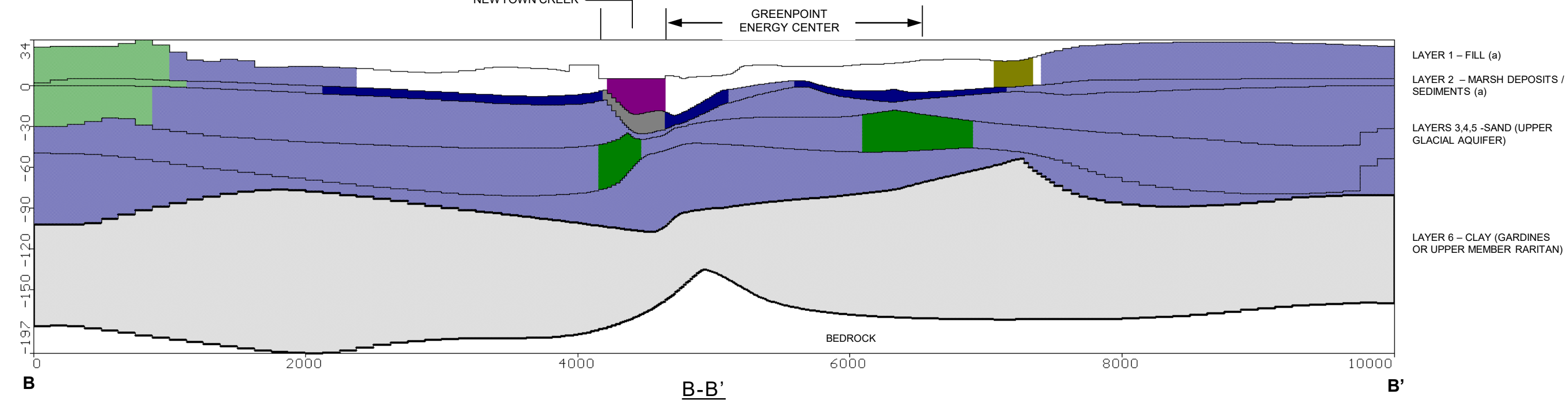
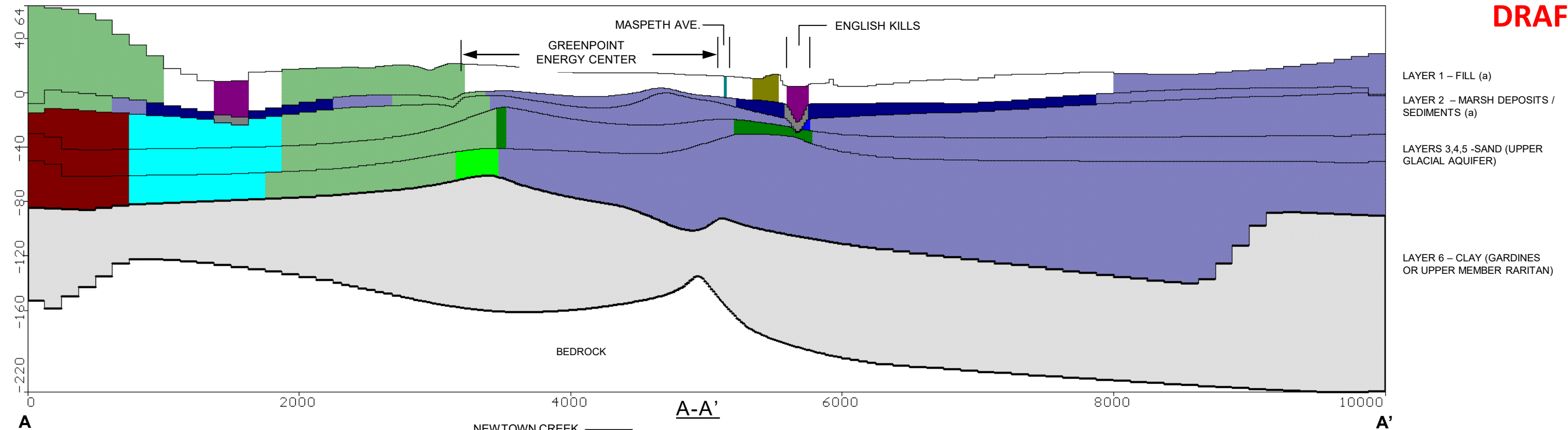
K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SHOREFRONT DETAILS	
		Project 125180	September 2019 Figure L3-9

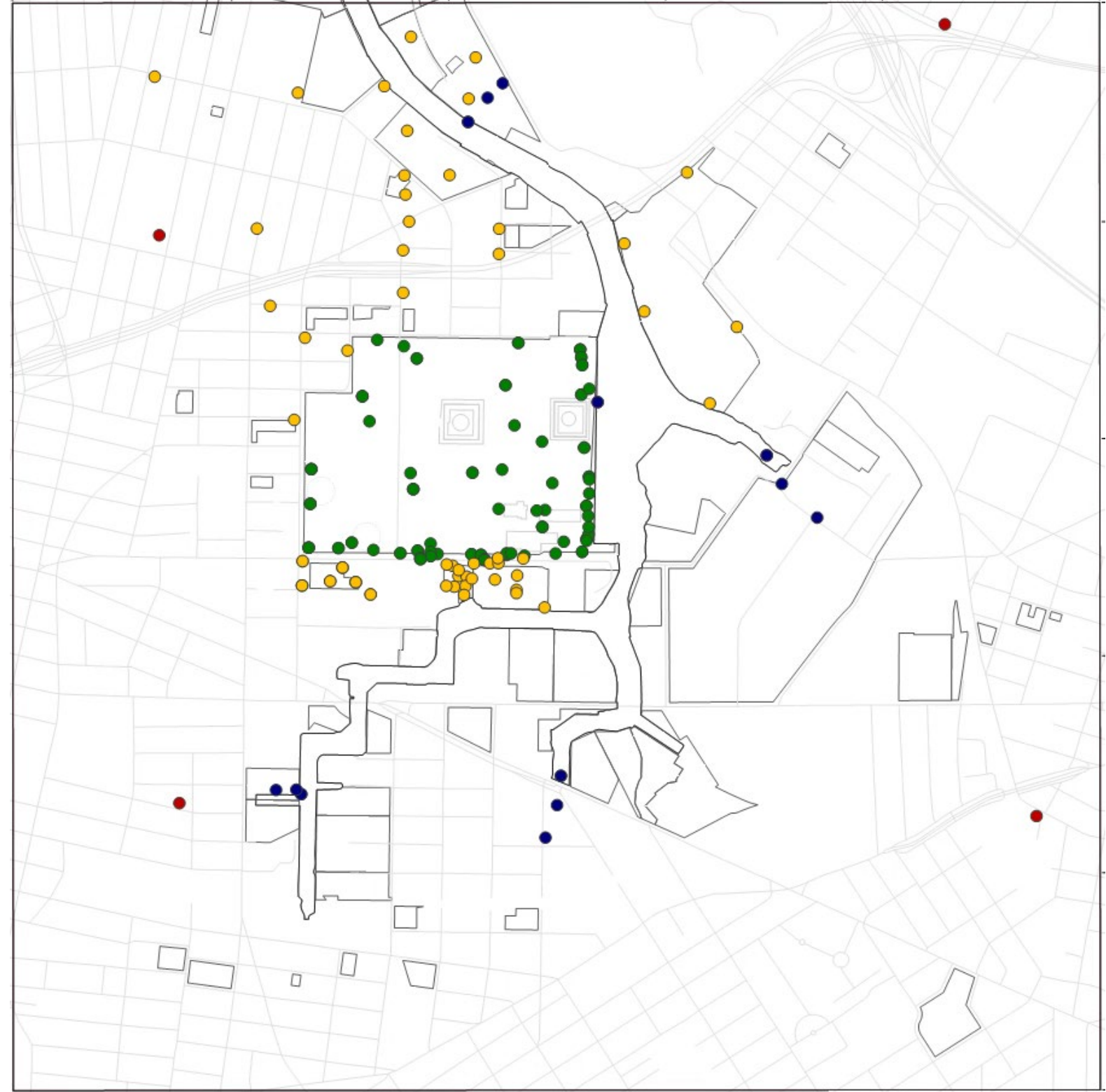
DRAFT



- LEGEND
- MODEL GRID LINES
 - INACTIVE (NO-FLOW) CELLS

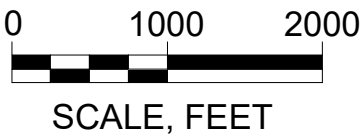
Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid		HYDRAULIC CONDUCTIVITY CROSS-SECTIONS	
		Project 125180	September 2019 Figure L3-10

DRAFT



CALIBRATION DATA SOURCE

- GREENPOINT
- OTHER DAR SITES
- NEWTOWN CREEK
- USGS



Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

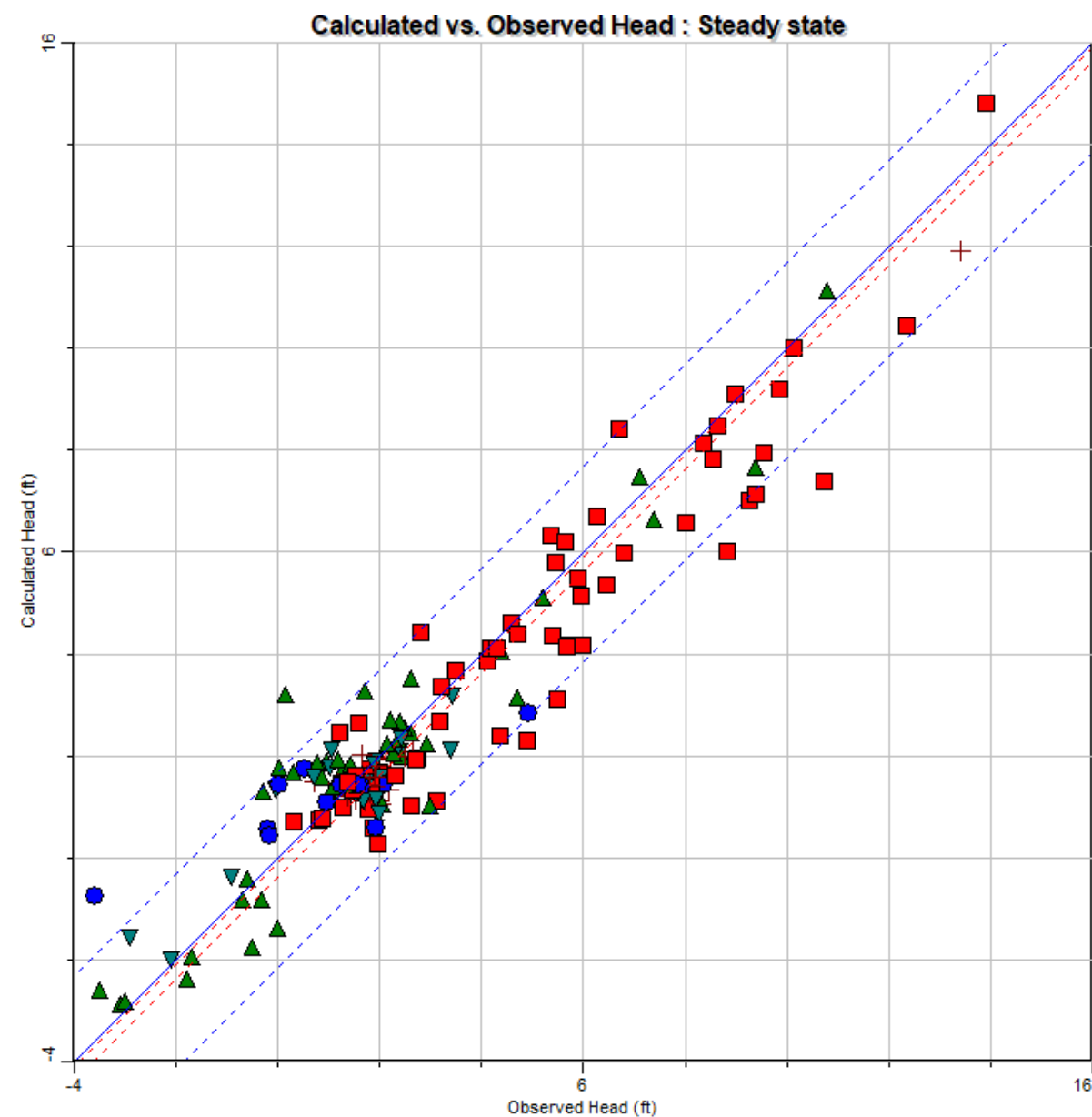


Project 125180

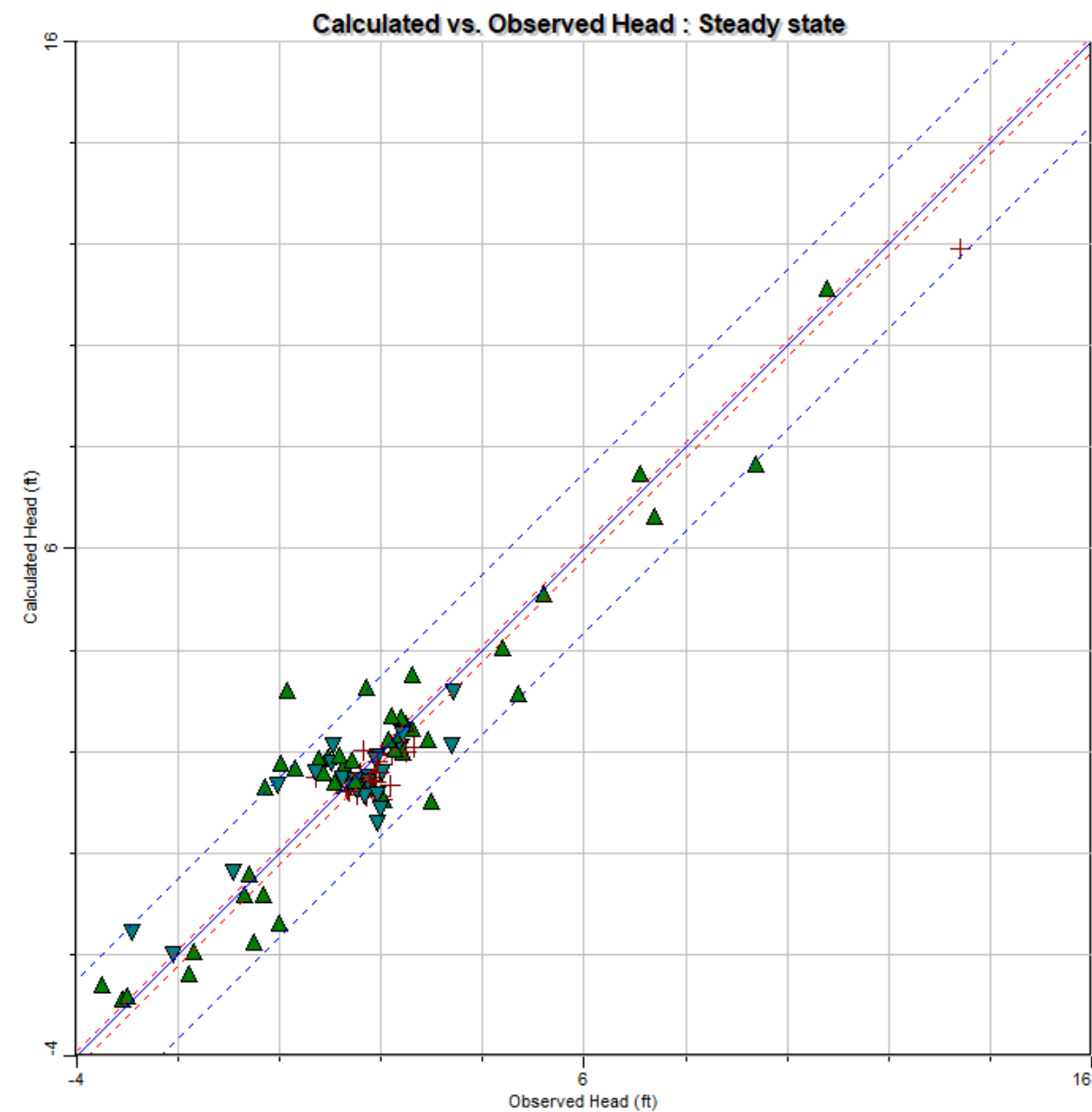
**CALIBRATION DATA
POINTS**

September 2019

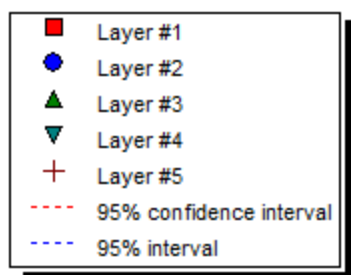
Figure L4-1



ALL MODEL LAYERS



UPPER GLACIAL AQUIFER LAYERS



95% Confidence Interval: Confidence that a calculated head for any given observed head would fall within the range shown.

95% Interval: Range in which 95% of data points are expected to fall, for example with an expanded calibration data set.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



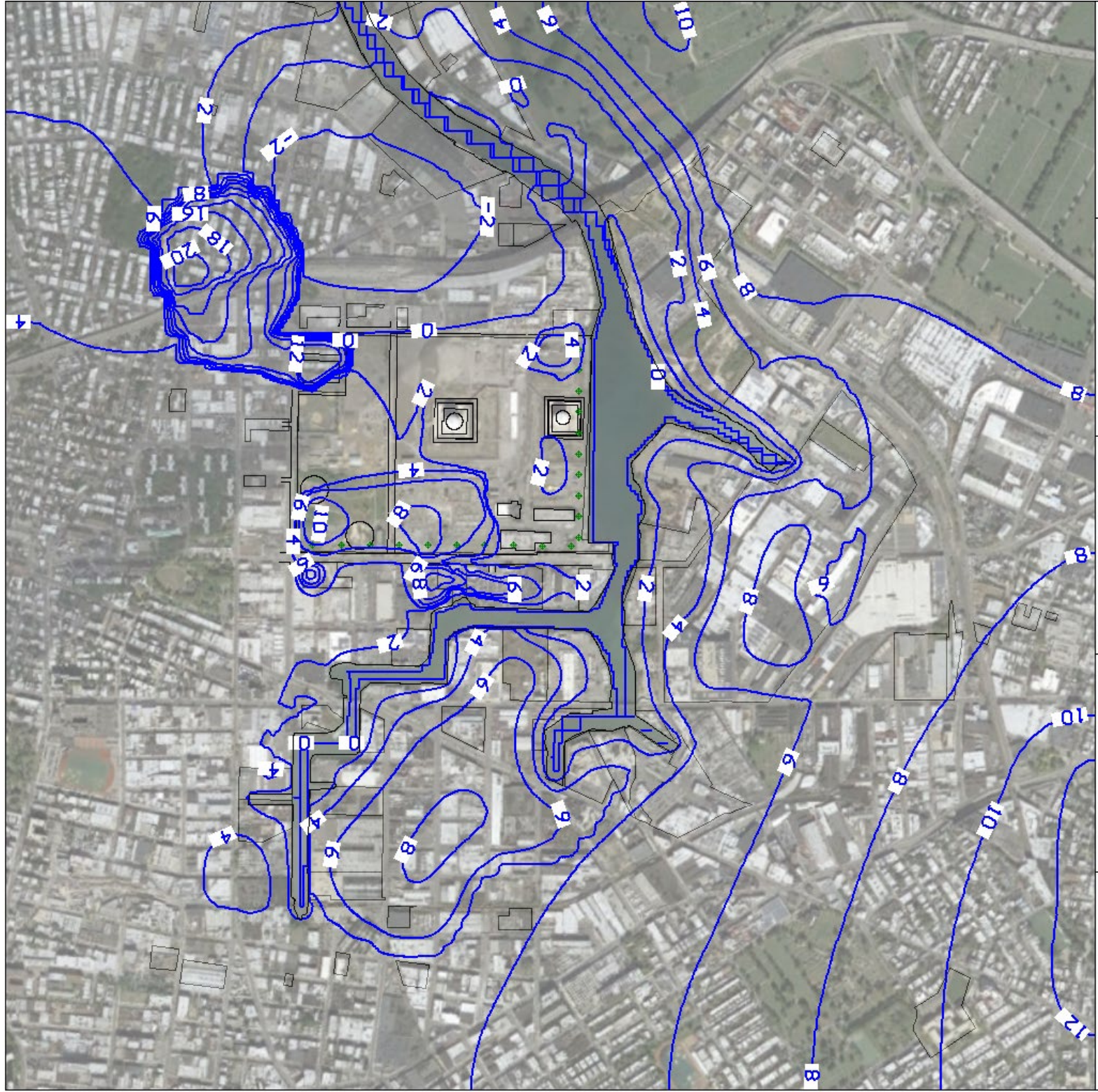
Project 125180

**CALIBRATION
RESIDUALS PLOTS**

September 2019

Figure L4-2

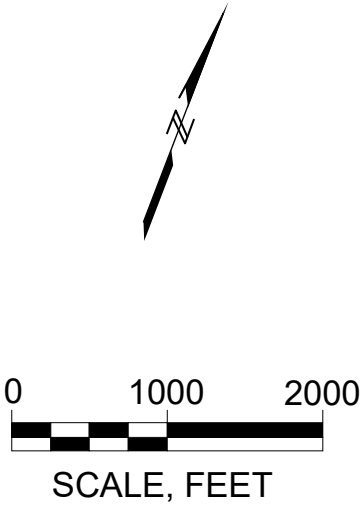
DRAFT



LEGEND

1.0

MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD



Groundwater Model Greenpoint Energy Center Brooklyn, New York	GEI Consultants	QUALITATIVE CALIBRATION – WATER TABLE	
		Project 125180	September 2019 Figure L4-3

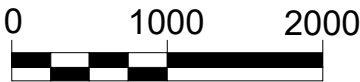
DRAFT



LEGEND

1.0

MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD



SCALE, FEET

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



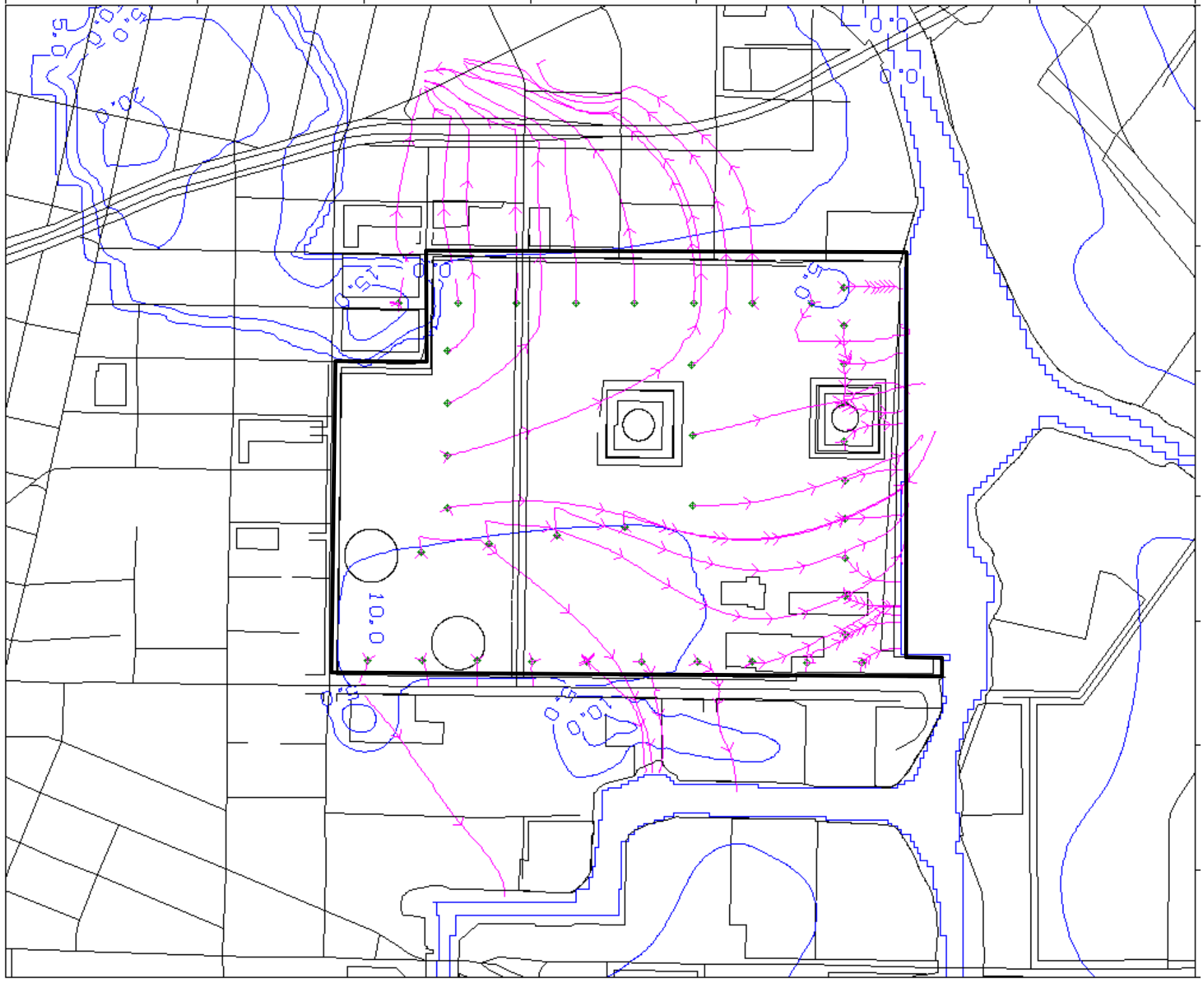
Project 125180

QUALITATIVE CALIBRATION –
UPPER GLACIAL AQUIFER

September 2019

Figure L4-4

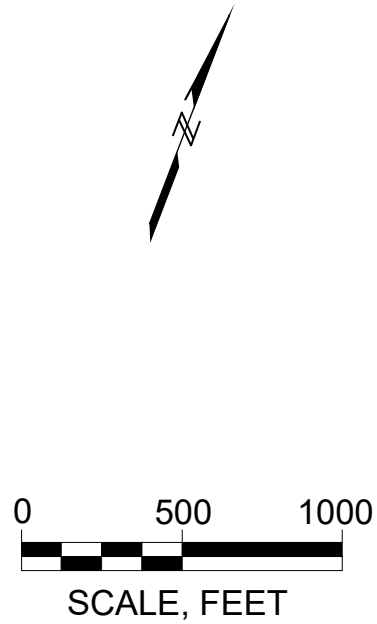
DRAFT



LEGEND

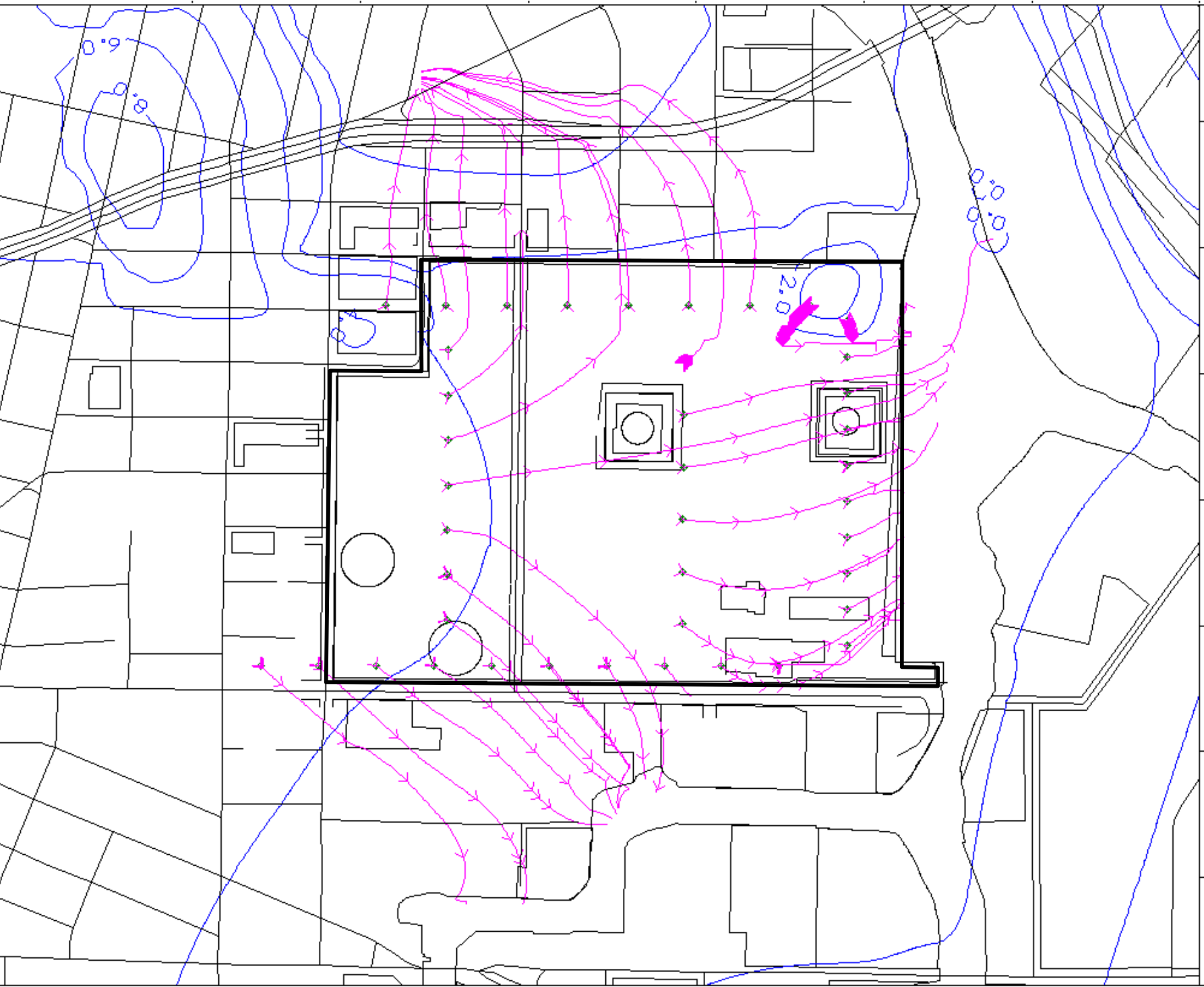
— 2 — MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD

→ PARTICLE FLOW PATH (5 YR
TICK SPACING)



Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	COMPUTED GROUNDWATER FLOW – WATER TABLE
nationalgrid	Project 125180	September 2019 Figure L5-1

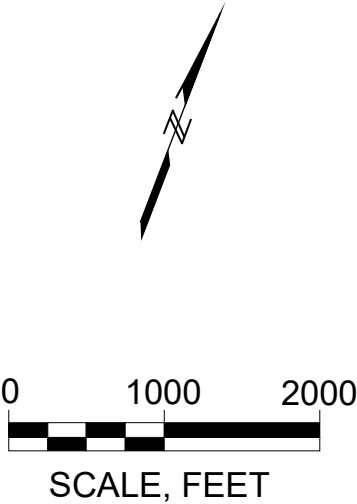
DRAFT



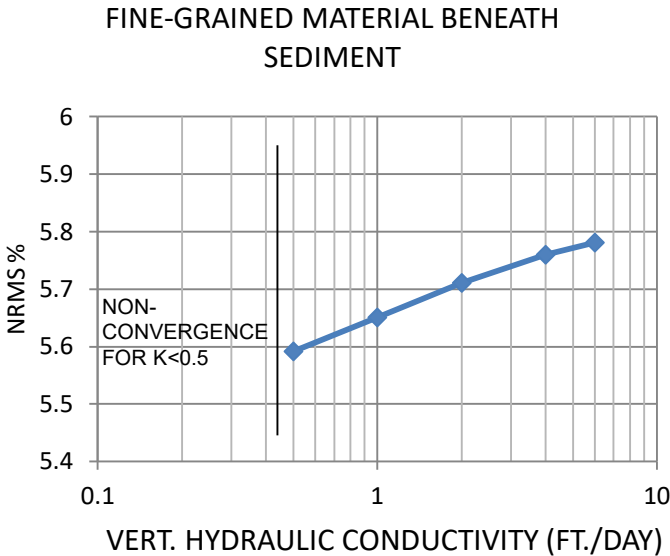
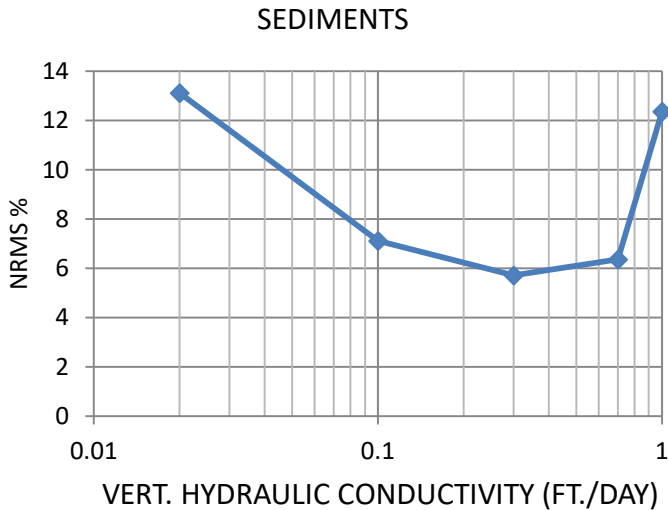
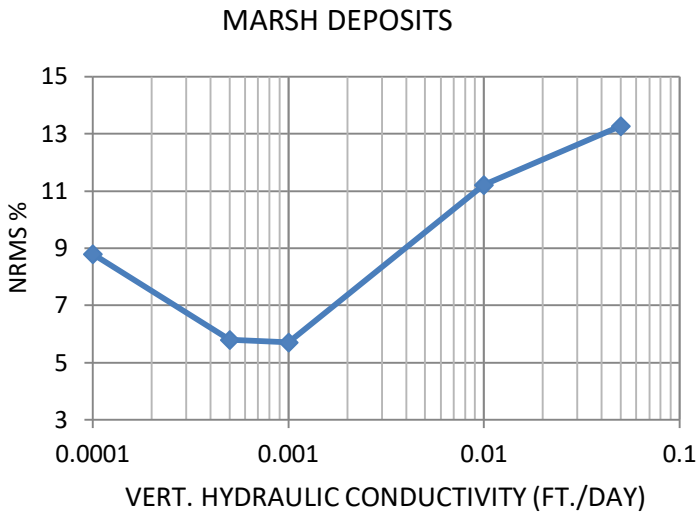
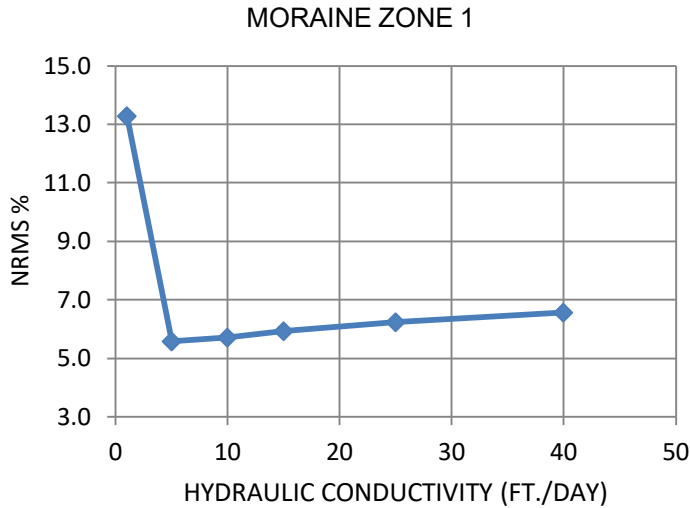
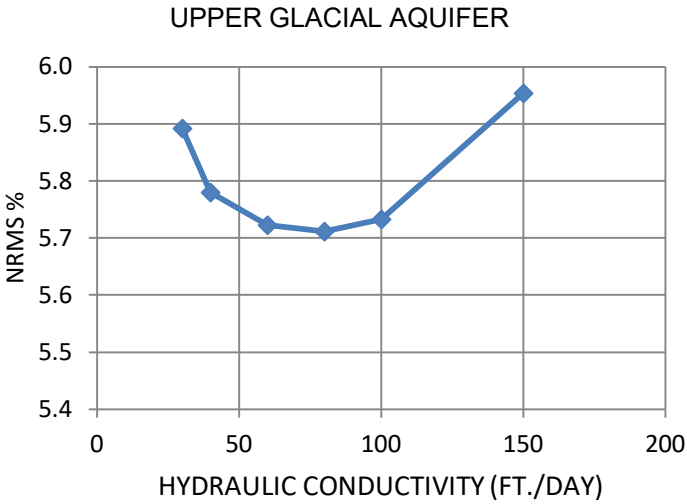
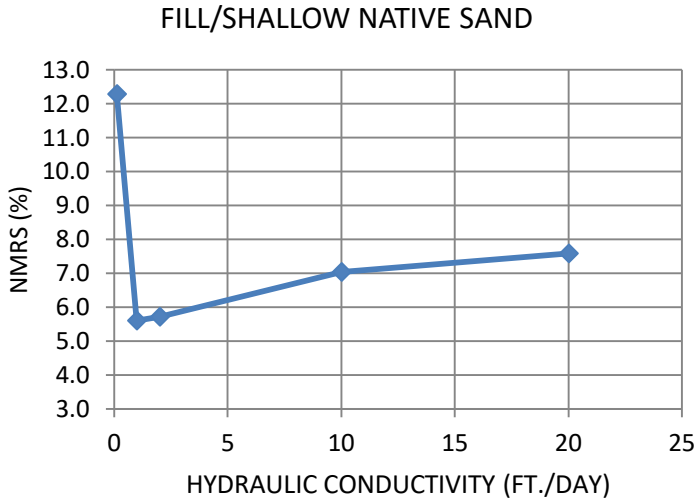
LEGEND

— 2 —

MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD



Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	COMPUTED GROUNDWATER FLOW – UPPER GLACIAL AQUIFER	
		Project 125180	September 2019 Figure L5-2



(a) EVERY 2nd CONTOUR REPORTED BY ANCHOR SHOWN FOR CLARITY.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

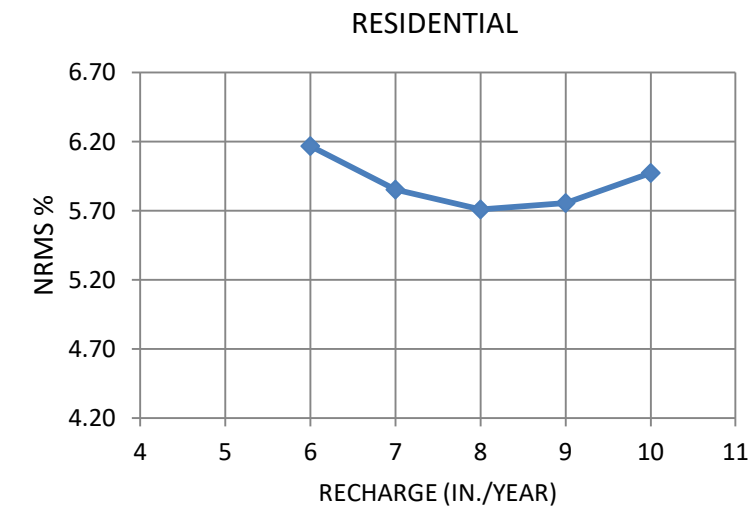
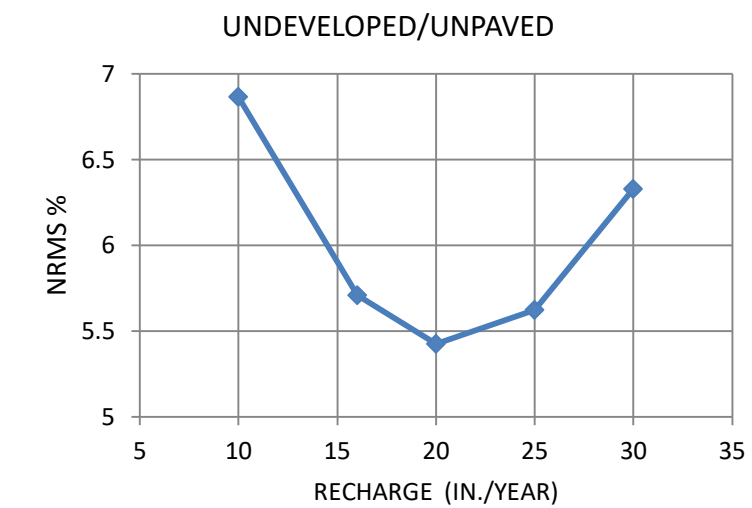
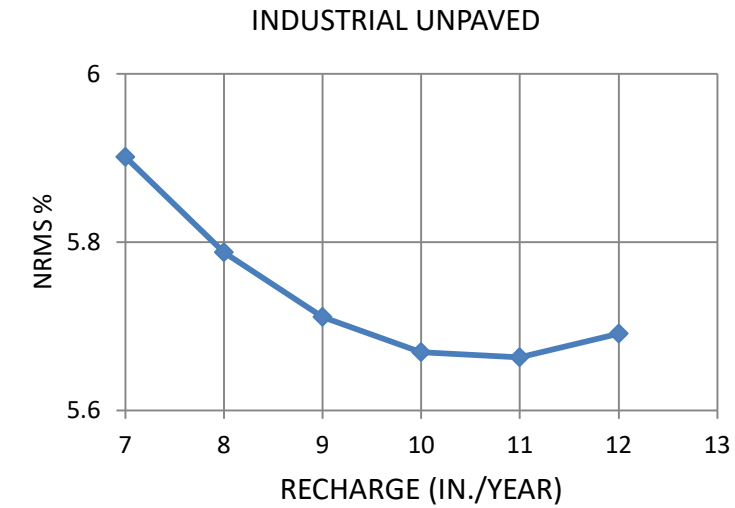
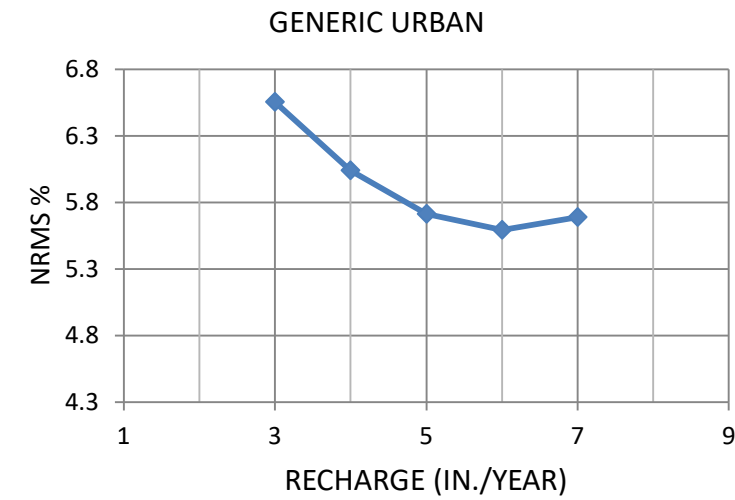


Project 125180

**SENSITIVY ANALYSIS
SOIL TYPE**

September 2019

Figure L5-3



(a) EVERY 2nd CONTOUR REPORTED BY ANCHOR SHOWN FOR CLARITY.

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SENSITIVY ANALYSIS RECHARGE	
		Project 125180	September 2019 Figure L5-4

DRAFT



LEGEND

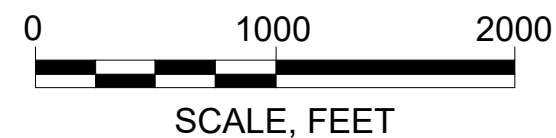
— 2 —

MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD

→

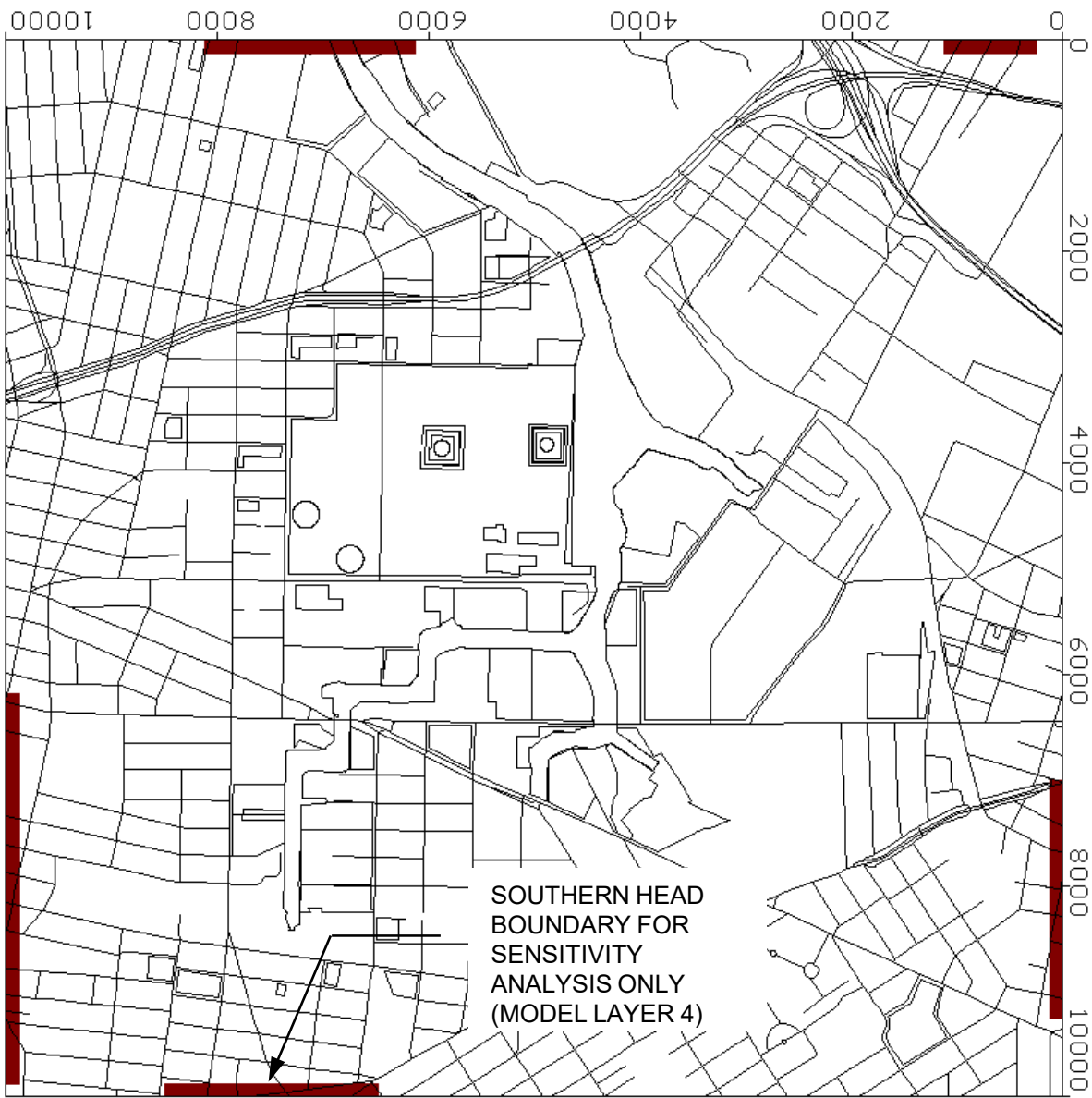
PARTICLE FLOW PATH

CAPTURE ZONE AS FUNCTION OF PUMPING RATE
SUPPLY WELL AT BROOKLYN TRUCK WASH



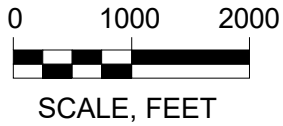
- NOTES:
- (a) PUMPING RATE AND EXACT WELL LOCATION NOT AVAILABLE. ASSUMED TO BE IN CENTER OF PROPERTY. PARTICLE PATH CAPTURE ZONE DELINEATION ANALYSIS PERFORMED TO ASSESS POTENTIAL INFLUENCE ON OFF-PROPERTY FLOW FROM GPEC.
 - (b) PUMP INTAKE SET IN MODEL LAYER 3, UPPER UGA. ABOVE GRAPHICS REPRESENT MODEL LAYER 3 EXCEPT THAT PARTICLE LINES TRAVEL DOWNWARD FROM RECHARGE SOURCES IN UPPER MODEL LAYERS.

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SENSITIVY ANALYSIS SUPPLY PUMPING	
		Project 125180	September 2019 Figure L5-5

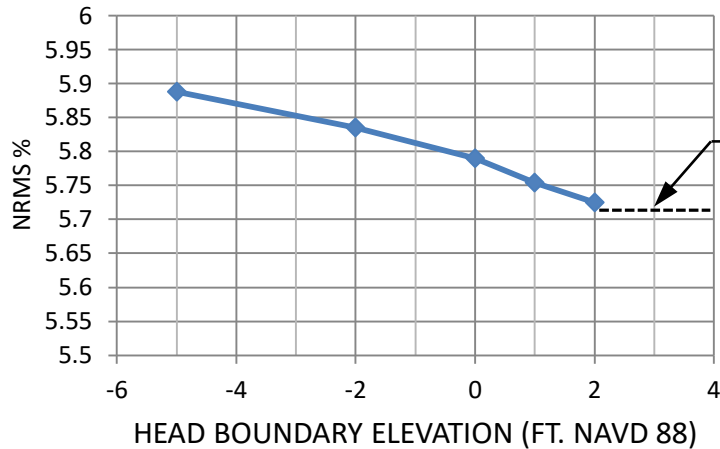


LEGEND

CONSTANT HEAD BOUNDARY



SOUTHERN HEAD BOUNDARY SENSITIVITY



MODEL-COMPUTED NMRS FOR CALIBRATED MODEL (WITH NO SOUTHERN CHB).

COMPUTED HEADS IN CALIBRATED MODEL WITH NO SENSITIVITY HEAD BOUNDARY ARE APPROXIMATELY 2 TO 4 FT. NAVD AT LOCATION OF SENSITIVITY BOUNDARY.

SENSITIVITY PLOT

NOTES:

- (a) HEAD BOUNDARY APPLIED AT LOCATION SHOWN TO ASSESS WHETHER PUMPING AT CORNELL BEVERAGES, OR TUNNEL DEWATERING AT MTA L-TRAIN SUBWAY MAY AFFECT MODEL. FOR SENSITIVITY ANALYSIS ONLY, EFFECTS OF PUMPING/DEWATERING MODELED AS HEAD BOUNDARY TO SIMULATE POTENTIAL NET EFFECTS ON CALIBRATION.
- (b) DUE TO LIMITED OR NO INFLUENCE OF HEADS AT SOUTHERN MODEL LIMIT IN RANGE EVALUATED, NO HEAD BOUNDARY IS USED OR CONSIDERED NECESSARY IN MODEL TO REPRESENT PUMPING WELL OR MTA SUBWAY TUNNEL.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



SENSITIVITY ANALYSIS
POTENTIAL PUMPING /
DEWATERING LOCATIONS

Project 125180

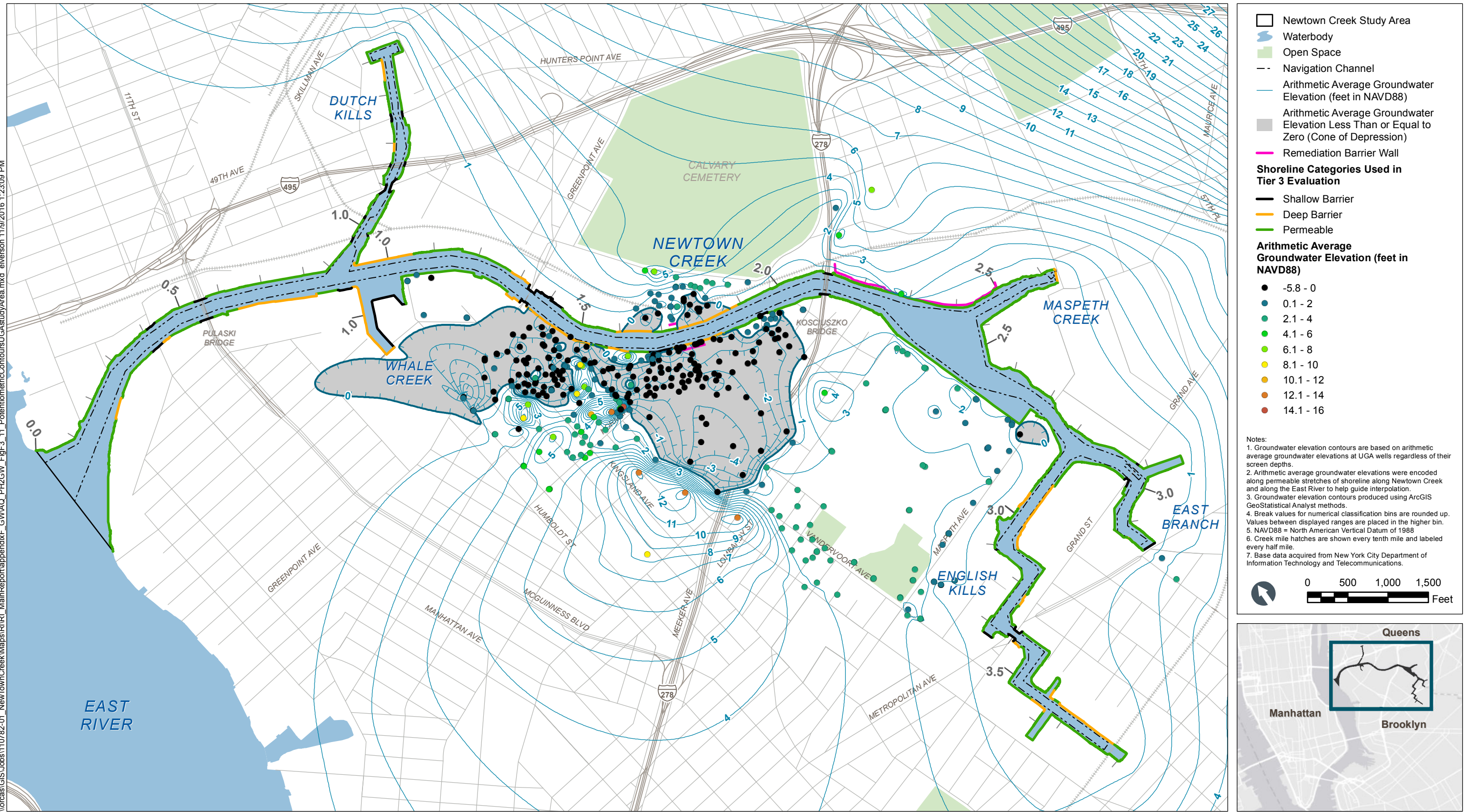
September 2019

Figure L5-6

Attachment A

Groundwater Contours

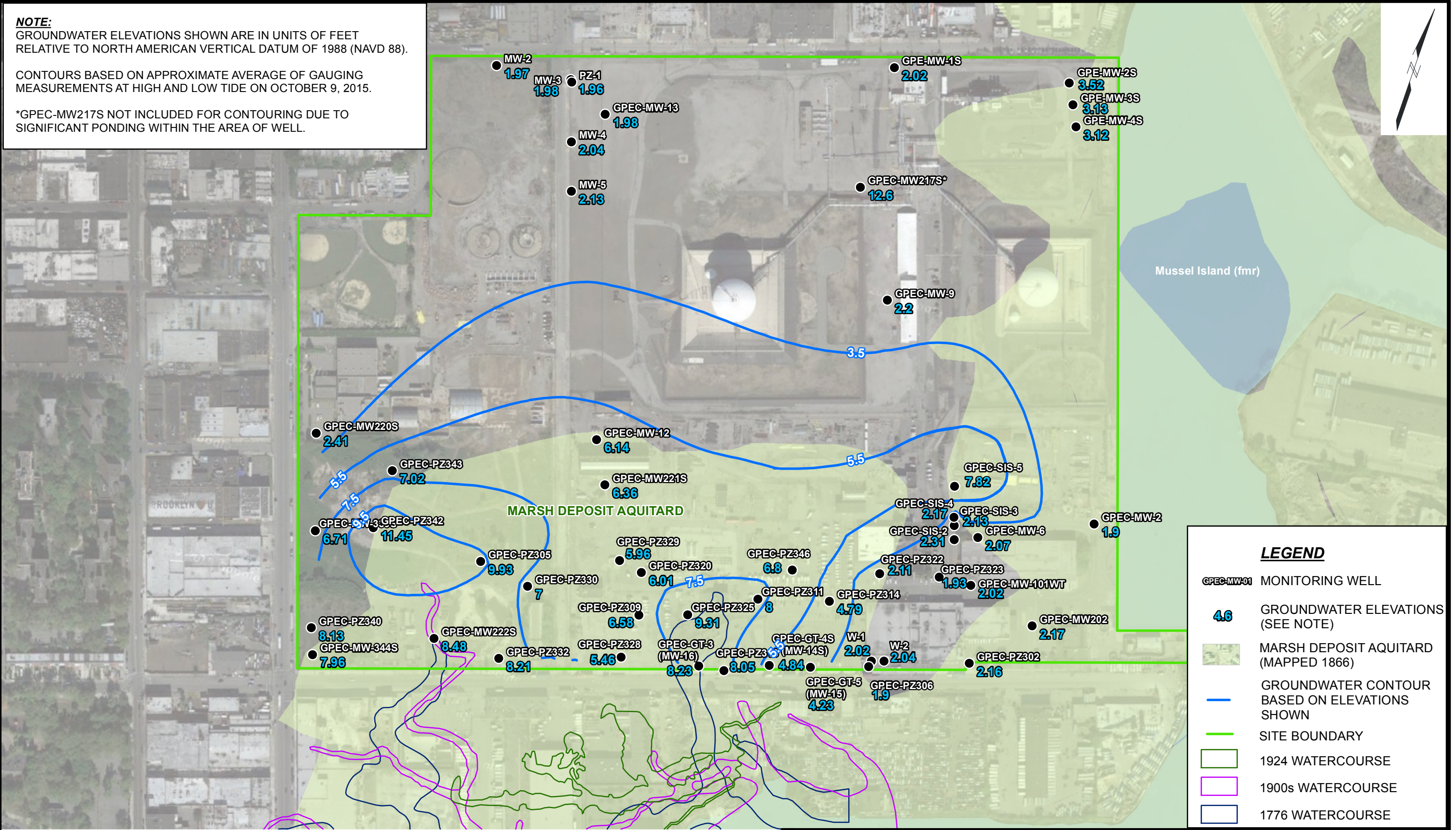
\\orca\GIS\Jobs\110782-01_NewtownCreek\Maps\RI\RI_MainReport\AppendixF_GWAQ_Ph2GW_FigF3_11_PotentiometricContoursUGAstudyArea.mxd everson 11/9/2016 1:23:09 PM



NOTE:
GROUNDWATER ELEVATIONS SHOWN ARE IN UNITS OF FEET
RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

CONTOURS BASED ON APPROXIMATE AVERAGE OF GAUGING
MEASUREMENTS AT HIGH AND LOW TIDE ON OCTOBER 9, 2015.

*GPEC-MW217S NOT INCLUDED FOR CONTOURING DUE TO
SIGNIFICANT PONDING WITHIN THE AREA OF WELL.



LEGEND

GPEC-MW-01

MONITORING WELL

4.6

GROUNDWATER ELEVATIONS
(SEE NOTE)

MARSH DEPOSIT AQUITARD
(MAPPED 1866)

GROUNDWATER CONTOUR
BASED ON ELEVATIONS
SHOWN

SITE BOUNDARY

1924 WATERCOURSE

1900s WATERCOURSE

1776 WATERCOURSE

SOURCES:
1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO
(<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. 1900, and 1776 MAPPED WATERCOURSES FROM BROOKLYN UNION GAS DRAWING 7C57,
1924 MAPPED WATERCOURSE FROM 1924 HISTORIC AERIAL PHOTO PROVIDED BY AECOM.
3. KS. ENGINNERS SURVEY MAY, AUGUST AND SEPTEMBER 2015.

0300600

SCALE: 1" = 300'

Interim Remedial Investigation Report
Greenpoint Energy Center
Brooklyn, New York

Project 125180

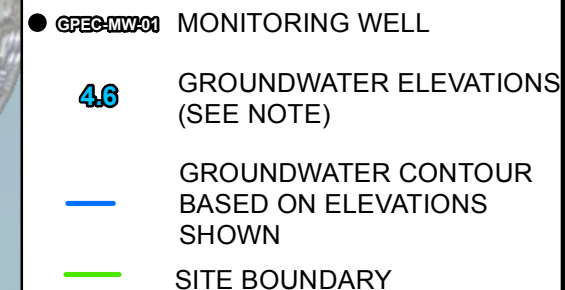
GROUNDWATER TABLE
ELEVATION CONTOURS
OCTOBER 2015

November 2016

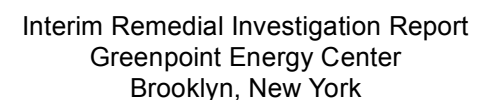
Fig. 19

GROUNDWATER ELEVATIONS SHOWN ARE IN UNITS OF FEET
RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

*GPEC-MW-8 NOT USED FOR CONTOUR PREPERATION DUE TO RAPID TIDAL RESPONSE IN WELL.



1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO (<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. KS. ENGINEERS SURVEY MAY, AUGUST AND SEPTEMBER OF 2015.



nationalgrid

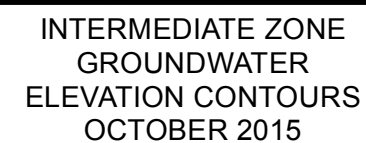


Fig. 20

NOTE:
GROUNDWATER ELEVATIONS SHOWN ARE IN UNITS OF FEET
RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

CONTOURS BASED ON APPROXIMATE AVERAGE OF GAUGING
MEASUREMENTS AT HIGH AND LOW TIDE ON OCTOBER 9, 2015.



SOURCES:
1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO
(<http://www.google.com/earth/>), IMAGERY DATE: 6/17/2010.
2. KS. ENGINEERS SURVEY MAY, AUGUST AND SEPTEMBER OF 2015.



Interim Remedial Investigation Report
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

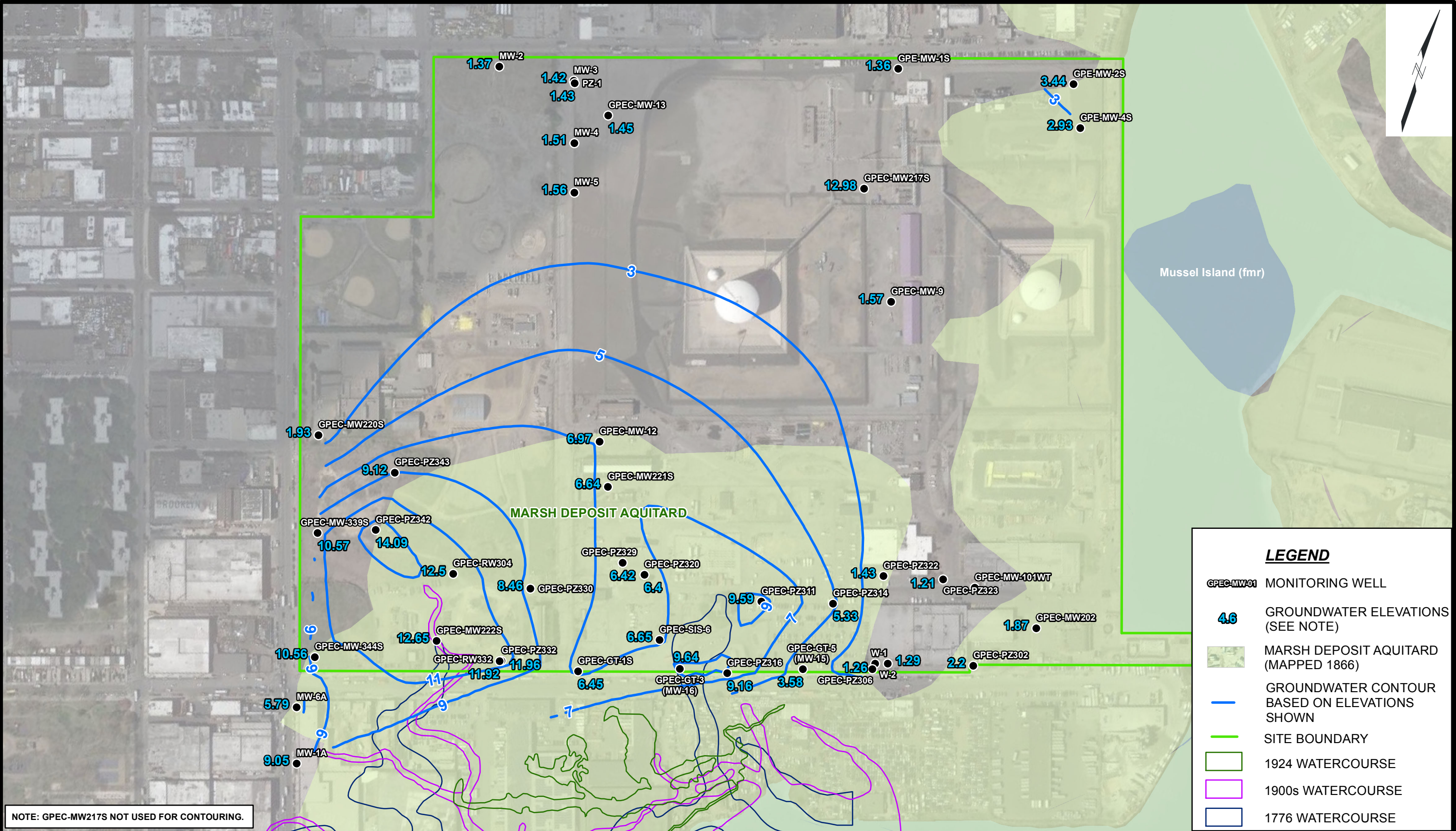
GEI Consultants

Project 125180

DEEP ZONE
GROUNDWATER
ELEVATION CONTOURS
OCTOBER 2015

November 2016

Fig. 21



SOURCES:

1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO (<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. 1900, and 1776 MAPPED WATERCOURSES FROM BROOKLYN UNION GAS DRAWING 7C57, 1924 MAPPED WATERCOURSE FROM 1924 HISTORIC AERIAL PHOTO PROVIDED BY AECOM.
3. KS. ENGINEERS SURVEY MAY, AUGUST AND SEPTEMBER 2015.

SCALE: 1" = 300'

Greenpoint Energy Center
Former Manufactured Gas Plant Site
Brooklyn, New York

Project 125180

SHALLOW ZONE
(0-25 FT BGS) ELEVATION
CONTOURS MARCH 2017

April 2017

Fig. 6





Geotechnical
Environmental
Water Resources
Ecological

**Remedial Investigation Report
Greenpoint Energy Center**

Appendix D – Groundwater Model

287 Maspeth Avenue
Brooklyn, New York
Site #224052

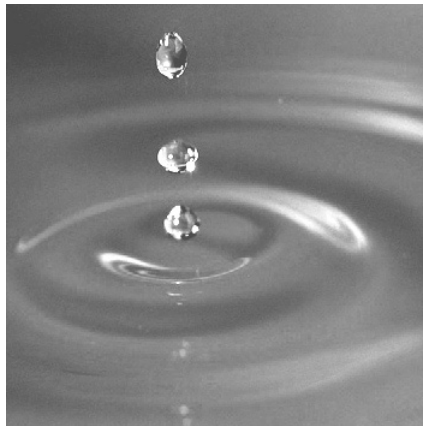


Table of Contents

1. Introduction	1
2. Conceptual Site Model	2
2.1 Upper Glacial Aquifer	2
2.2 Marsh Deposits	3
2.3 Moraine Ridge	3
2.4 Groundwater Extraction	4
2.5 Utility Infiltration	5
2.6 Shoreline Type	6
3. Computational Flow Model	7
3.1 Discretization	8
3.2 Stratigraphy	8
3.3 Constant Head Boundaries	9
3.4 No-Flow (Inactive) Boundaries	10
3.5 Drain Boundaries	10
3.6 Recharge	10
3.7 Bulkheads	11
3.8 Groundwater Extraction	12
3.9 Hydraulic Conductivity	13
4. Calibration	15
5. Results and Sensitivity Analysis	17
5.1 Hydraulic Conductivity Sensitivity	18
5.2 Recharge Sensitivity	18
5.3 Groundwater Withdrawal Sensitivity	18
References	20

Tables

- L1 Soil Boring Summary
- L2 Hydraulic Conductivity Measurements
- L3 Model Hydraulic Conductivity Zones
- L4 Calibration Data Set
- L5 Flow Model Mass Balance

Figures

- L1-1 Site Location
- L2-1 Site Reference Locations
- L2-2 Regional Groundwater Contours
- L2-3 North-South Conceptual Schematic of Hydrogeologic Units
- L2-4 USGS Calibration Wells
- L2-5 Historic Maps
- L2-6 Groundwater Extraction Locations
- L2-7 Maspeth Ave. Utilities
- L2-8 Shoreline Type
- L3-1 Model Grid
- L3-2 Model Grid Cross-Sections
- L3-3 Stratigraphic Input Soil Boring Locations
- L3-4 Shallow Head Boundaries
- L3-5 Upper Glacial Aquifer Constant Head Boundaries
- L3-6 Recharge Boundaries
- L3-7 Hydraulic Conductivity Measurements
- L3-8a Hydraulic Conductivity Layer 1
- L3-8b Hydraulic Conductivity Layer 2
- L3-8c Hydraulic Conductivity Layer 3
- L3-8d Hydraulic Conductivity Layer 4
- L3-8e Hydraulic Conductivity Layer 5
- L3-9 Shorefront Details
- L3-10 Hydraulic Conductivity Cross-Sections
- L4-1 Calibration Data Points
- L4-2 Calibration Residuals Plots
- L4-3 Qualitative Calibration – Water Table
- L4-4 Qualitative Calibration – Upper Glacial Aquifer
- L5-1 Computed Groundwater Flow – Water Table
- L5-2 Computed Groundwater Flow – Upper Glacial Aquifer
- L5-3 Sensitivity Analysis – Soil Type
- L5-4 Sensitivity Analysis – Recharge
- L5-5 Sensitivity Analysis – Supply Pumping
- L5-6 Sensitivity Analysis – Potential Pumping/Dewatering Locations

Attachments

Attachment A – Groundwater Contours

AnchorQEA, Figure F3-11, Arithmetic Average Groundwater Elevation Contours in Upper Glacial Aquifer

GEI Consultants, Inc.

2015 Groundwater Contours

2017 Groundwater Contours

H:\WPROC\Project\NationalGrid\ Model Rept 122211.docx

1. Introduction

As part of the remedial investigation for the Greenpoint Energy Center (GPEC) former Manufactured Gas Plant (MGP) site, GEI Consultants, Inc. (GEI) performed a groundwater modeling analysis. The groundwater model analysis included development of a three-dimensional groundwater flow model for the site and vicinity (Figure L1-1), and calculation of flow gradients and flux rates. The model provided a quantitative understanding of groundwater flow conditions, and provides additional confidence in the conceptual understanding of the complex groundwater system at the site.

This report appendix is organized as follows. Section 2 provides a conceptual model describing regional groundwater flow, and local conditions and features influencing groundwater flow in the vicinity of GPEC. Section 3 describes the flow model and the input data set. Section 4 describes the flow model calibration sensitivity analysis. Section 5 presents the groundwater mass balance analysis and sensitivity analysis.

2. Conceptual Site Model

A conceptual site model (CSM) was developed to describe regional and local groundwater flow for the purpose of constructing the three-dimensional computer model and defining boundary conditions. The CSM was developed using information obtained during remedial investigation for activities for the GPEC site, the Newtown Creek Superfund site, other investigated upland sites along Newtown Creek for which data were available, and regional publications. A map showing remedial investigation sites for which data were available is included as Figure L L2-1.

The model area is shown in Figure L1-1, and generally comprises the southern end of Newtown Creek and portions of the surrounding basin. Aquifer components and anthropogenic factors influencing groundwater flow at GPEC are described below.

2.1 Upper Glacial Aquifer

Groundwater flow within the model area occurs in unconsolidated deposits of outwash sand and moraine with till lenses known as the Upper Glacial Aquifer (UGA). Newtown Creek is located at the western end of the UGA, where the UGA is the uppermost surficial aquifer across most of Long Island, including all of Brooklyn and Queens (Buxton and Smolensky, 1999). The UGA is underlain by clay known as the Gardiner's Clay and the clay member of the Raritan Formation, that overlies southeastward-dipping bedrock (Buxton and Shernoff, 1999). Groundwater elevation contours for the Upper Glacial Aquifer reported by AnchorQEA (AQ) and the U.S. Geological Survey (USGS) are shown in Figure L2-2. For purposes of regional characterization, discontinuous post-glacial marsh and lacustrine deposits and anthropogenic fill within the UGA have been considered to be part of the UGA (Misut and Monti, 1999). A conceptual profile of the aquifer components at GPEC and the surrounding area is shown in Figure L2-3.

Regional flow in the UGA in the area of GPEC originates as recharge from precipitation in upland areas, then converges toward Newtown Creek and its tributaries, as can be inferred from the regional groundwater contours shown in Figure L2-2. Groundwater discharges to Newtown Creek and its tributaries, and also exits the basin via localized influences including infiltration to utilities at shallow depths, groundwater extraction systems and pumping wells in the UGA, and pumping from subway tunnel dewatering systems in bedrock.

The UGA was widely used as a water supply source in the mid-1900s, causing a depression of water levels in the UGA [USGS, 1999]. Significant amounts of pumping ceased in the 1970s

after city water was supplied to the area via aqueducts. Historic measurements shown in Figure L2-4 indicate that water levels in the Upper Glacial Aquifer have recovered and remained stable over the past decade.

2.2 Marsh Deposits

Groundwater elevation measurements and soil boring observations show that the marsh deposits at and around GPEC serve as a semiconfining unit. The historic extent of marsh deposits as mapped in 1866 is shown on Figure L2-5. The entirety of the marsh area outside the present creek shoreline was subsequently filled in. The water table at GPEC appears to be mounded (perched) in fill above the marsh deposits, while the potentiometric surface below the marsh deposits is similar to that of the surrounding regional aquifer. The water table above the marsh deposits has been measured to be approximately 6 to 10 feet higher than the potentiometric surface below the marsh deposits.

Conceptually, recharge from precipitation enters surficial fill material in unpaved areas. Drainage through the fill is impeded laterally due to relatively low hydraulic conductivity of the fill, and vertically by the underlying marsh deposits (see Section 3.9 for a discussion of hydraulic conductivity). As a result, groundwater from local recharge is retained in a perched condition relative to the underlying and surrounding UGA. A series of groundwater contour maps representing aquifer depths above and below the marsh deposits as measured at GPEC, is included in Attachment A. The mounding condition is predominant in southern areas of GPEC, and is also apparent off-site in portions of the BCF Oil, Ditmas, and Equity Former MGP sites (Fig. L2-1) [MPI 2010, CEUS 2012, AECOM 2016]. Dense fill material may also contribute to the higher groundwater elevations between Maspeth Ave. and English Kills, where pavement rubble was reportedly imported during the 1970s to expand the usable area of the site (MPI, 2010).

2.3 Moraine Ridge

The Harbor Hill Moraine is a predominant geologic feature extending southwest to northeast across Long Island, located outside the model area about 1-2 miles south of GPEC (Figure L2-5). The UGA within the modeled area is considered by USGS to be ground moraine, whereas the aquifer south of the Harbor Hill moraine is considered outwash (Buxton and Shernoff, 1999). A ridge north of GPEC (Figure L2-5) coincides with a zone of relatively low permeability deposits within the UGA, of which evidence is apparent in various studies described further below. The water table in several areas along the ridge line shown in Figure L2-5, ranges up to several feet higher than water levels measured in the surrounding UGA. Regionally, anomalously high water levels in eastern Long Island have been attributed to zones of low conductivity in moraine deposits (Buxton and Shernoff, 1999). In general, localized high water levels can result from buildup of natural recharge in dense or fine-grained native

material that is relatively slow to drain. A groundwater contour map prepared for the Draft Newtown Creek RI report, Figure F3-11 shows steep contours primarily north/northwest of Greenpoint. A copy of the contour map is included in Attachment A.

Soil observations support the high water level conditions. Till and silt/clay interbeds were reported in the ExxonMobil offsite plume area (Figure L2-1; URS, 2009). In some instances, logs for wells having high water table elevations show little to no fines. It is assumed in these cases that the water level is controlled by low-permeability material near the well location, or that the sand is densely packed till with natural low permeability. Evidence of dense moraine (relatively high water table and/or fine-grained material) are also apparent at:

- The northeast corner of GPEC (GPE-series borings, GEI, 2011) where relatively high soil variability was observed, in contrast with sand and gravel with few clay interbeds observed within the majority of GPEC.
- A relatively large area of fine-grained material was identified beneath Newtown Creek, adjacent to the northeast corner of GPEC (AQ 2016, Fig. F5-5)
- Fine-grained native material beneath marsh deposits were identified at Phelps-Dodge Refining Company (PDRC), coinciding with relatively high groundwater elevations at the upland boundary of PDRC (CRA, 2012) approaching the hill at Calvary Cemetery.

North of the moraine ridge, the water table is drawn down as far as 4 feet below sea level from the remedial groundwater extraction system for the ExxonMobil off-site plume. The moraine ridge appears to be isolating or impeding groundwater flow at GPEC from pumping influences. Groundwater contours in AQ's Figure F3-11 (Attachment A) show a steep drop-off in groundwater elevations north/northwest of GPEC, suggesting a relatively sharp transition from dense moraine material to more permeable sand and gravel that would support high remedial extraction rates. The extraction system is described in the next section.

2.4 Groundwater Extraction

Groundwater extraction in the model area is performed for site remediation and supply purposes. Groundwater extraction locations within the GPEC model area are shown on Figure L2-6.

North of GPEC, groundwater extraction for recovery of separate-phase petroleum and impacted groundwater has been ongoing since 1978 (Delta, 2006). A groundwater recovery system now handles groundwater pumped from the ExxonMobil off-site plume, Former Paragon Terminal, and BP areas (Fig. L2-1). A combined extraction rate of 530 gpm for the three facilities was reported by AQ, representing averaged rates spanning from 2012 to 2014 (AQ, 2016). The groundwater is then treated onsite and discharged under permit to Newtown

Creek. Additional extraction systems are located further north (AQ, 2016) but are outside the GPEC model area.

Northeast of GPEC, a groundwater collection system with cutoff wall has been installed along the shoreline at the PDRC site. The extraction system consists of a series of collector wells, and is reported to be extracting about 40 gpm (CRA, 2012). According to a Record of Decision, the purpose of the extraction system is to intercept contaminated groundwater prior to reaching the creek, and the purpose of the barrier wall is to prevent excessive amounts of water from the creek from entering the extraction system (DEC, 2008).

Southeast of GPEC, a pumping well is used at the Brooklyn Truck Wash for washing operations (AECOM, 2016). No details are available for the pumping well, including depth and pumping rate. AECOM (2016) reports that at the Equity site, piezometric heads observed in two wells screened at mid-depth in the UGA are lower than those at other wells in the vicinity, by a few tenths of a foot. The subject monitoring wells are screened in sand between two clay lenses. AECOM attributed the lower water levels to the effects of pumping at the truck wash, which is likely drawing water from a similar depth interval. Although details of the pumping well are not available, a sensitivity analysis (Section 5) shows that assumptions made in the subject flow model regarding the well have no significant effect on the model.

Two features near the southern model boundary, for which no information is available, are assumed to have no significant effect on the model. South of English Kills, a nonpotable supply well permit is reported to be on file for the Cornell Beverages, Inc. (AQ, 2016). No additional information is available for this well. A Metropolitan Transit Authority (MTA) subway tunnel is located south of English Kills, where shown on Figure L2-6. No information is available as to whether leakage or interception of groundwater is occurring due to the subway tunnel within the model area. A sensitivity analysis (Section 5) showed that drawdown effects of these two features, if any, would not affect groundwater flow at GPEC.

2.5 Utility Infiltration

Infiltration of groundwater into buried utility lines, or associated bedding material, can occur in low-lying developed areas where utilities intersect the water table. Along Maspeth Ave., shallow groundwater flow appears to be influenced by a storm drain and/or sanitary sewer line. Water table elevations measured in wells along Maspeth Ave. are a few feet lower than those measured on abutting properties including GPEC to the north, and BCF Oil, Ditmas, and Equity Former MGP. The high surrounding water table is attributed to water retention above marsh deposits and dense fill material as described in Section 2.1.2. The Maspeth Ave. utilities are shown on Figure L2-7.

Within Maspeth Ave., wells were installed at locations near the curb and in the travel lane north of the street centerline (SIS-100 and 200-series wells), in which measurements showed horizontal gradients toward the centerline (GEI, 2017). The sewer runs approximately along the centerline, and the drain is south of the centerline. The drain is relatively shallow and appears to straddle the water table. The sewer is several feet below the water table. Based on observed elevations of marsh deposits in surrounding areas, it is likely that marsh deposits were removed to install the sewer where shown on Figure L2-7. The water table depression along Maspeth Ave. most likely results from a combination of infiltration to the drain or bedding, and equilibration of water levels with the underlying UGA in areas where the marsh deposits are absent either naturally or by removal. It is less likely that the sewer itself has an effect, because the sewer is pressurized. The drain discharges to Newtown Creek and English Kills at outfall locations shown on Figure L2-7, allowing a potential flow path along bedding to equilibrate with surface water.

Other than along Maspeth Ave., water table elevations measured within and around GPEC show no other evidence of utility infiltration having an effect on groundwater flow patterns.

2.6 Shoreline Type

Groundwater seepage from GPEC into Newtown Creek and English Kills is assumed to be unimpeded by shoreline structures. The creek-side loading platform is a pile-supported structure, extending approximately 40 feet inland from its water-facing edge and has a large rip rap wedge surrounding its terminal landside edge (GEI, 2016). The English Kills shoreline in the area of GPEC is comprised of mainly of riprap, with shorter segments of concrete and wooden bulkheads. An approximately 100-foot length of steel sheetpile is located along the shoreline at the Ditmas property. Shoreline types within the model area as reported by AQ (2016) are shown on Figure L2-8.

Remedial barrier walls are located along the Newtown Creek shoreline at the ExxonMobil, Pratt Terminal, and Phelps-Dodge sites where shown in Figure L2-8. Sheetpile walls for structural purposes along Newtown Creek and English Kills are expected to affect groundwater discharge in the fill only, assuming the sheeting does not penetrate to depths that would alter flow in the underlying UGA. Sheetpile walls for remedial purposes penetrate partially into the UGA, at depths that are assumed to have local effects on groundwater flow and discharge to the creek.

3. Computational Flow Model

The three-dimensional groundwater model was constructed using Visual MODFLOW version 2010.0 from Schlumberger Water Services (SWS). MODFLOW is an industry standard program used for numerical groundwater modeling, developed by the United States Geological Survey (USGS) [McDonald and Harbaugh, 1988]. MODFLOW is a modular finite-difference flow model, which is a computer code that solves the general groundwater flow partial differential equation. The groundwater flow equation is a mathematical relationship which is used to describe the flow of groundwater through an aquifer. Visual MODFLOW is a graphical user interface which facilitates model input and output. The model domain is discretized into a number of three-dimensional blocks (rectangular cells) and boundary conditions are applied. For each cell, MODFLOW computes the hydraulic head using a number of hydrogeologic input parameters such as hydraulic conductivity. The site MODFLOW model was run in steady-state mode. In steady-state mode, model inflows, outflows, and heads do not vary over time. Steady-state results consist of a single flow field representing a stable condition over time. Three-dimensional particle tracking was used in the model to depict the predicted flow paths and velocities within the steady-state flow field. Elevations in the model are relative to the North American Vertical Datum of 1988 (NAVD).

General assumptions inherent to MODFLOW are:

- Groundwater flow occurs within a three-dimensional heterogeneous, anisotropic, saturated porous medium.
- Groundwater flow is laminar.
- Groundwater is incompressible.

Assumptions used in the development of the groundwater model that are specific to the Site are:

- Groundwater flow conditions are at steady-state for calibration purposes.
- The calibration data set and interpreted groundwater flow directions and gradients represent conditions typical of long-term present-day conditions, and are adequate for evaluation and comparison of potential future remedial alternatives.
- The calibration data set is assumed to represent mid-tide conditions. The groundwater elevation data set represents a multitude of investigations and gauging events, at varying or unreported times within the tide cycle. Tidal fluctuations adjacent to the canal were assumed to not affect net long-term flow directions or discharge rates to the canal.

- To model the net long-term effect of the canal surface elevation on groundwater, the head boundary within Newtown Creek and its tributaries was assumed to be Mean Sea Level.
- Each stratigraphic layer can be modeled as a homogeneous and horizontally isotropic unit, with the following localized variations in hydraulic conductivity
 - Fill material consists of sand containing silt, debris, gravel, and buried structures. It is assumed that the net effect of this condition can be represented as zones with varying hydraulic conductivity.
 - A series of clay lenses in the UGA approximately 40 feet below ground was apparent in several borings and are discretized in Layer 4 of the model. The hydraulic effects of other inter-bedding of fines or coarser material within the UGA within each layer can be approximated in the model by assigning a vertical anisotropy to hydraulic conductivity values.
- It is assumed that the Gardiners and Raritan clay units are impermeable and contributes no significant groundwater flow or pressure head to the overburden aquifer modeled.

3.1 Discretization

The model is comprised of a grid 10,000 by 10,000 feet in area with depths ranging from 100 to 330 feet deep in the southeast model corner where bedrock is deepest and ground elevation is highest. (Figures L3-1 and L3-2). Horizontal grid spacing ranges from 8 feet along Maspeth Ave., to 15 feet within and surrounding GPEC, and transitioning to 124 feet at the model corners.

The model grid is defined in North American Datum (NAD) 1983 New York State Plane East. The model axis is rotated 18.9 degrees west of north. The model axis was rotated for alignment with the GPEC property boundaries and with assumed principle flow directions of groundwater off-property towards Newtown Creek and English Kills.

3.2 Stratigraphy

Model layer elevations were defined by mapping the observed top and bottom elevations of each stratigraphic unit. For discontinuous units, dummy layer elevation points were assigned for numerical layer continuity where the geological unit is absent. The point elevations were imported to MODFLOW to define the numeric layers by interpolation.

The active model consists of five numerical layers representing seven geologic units (fill, marsh deposits, sediments, the UGA, and moraine). The model base is the Gardiners/Raritan clay, assumed to be impervious relative to the overlying UGA:

- Model Layer 1: Primary purpose is fill in and around GPEC. Also contains creek surface water boundary cells, and moraine and native UGA materials outside the filled areas.
- Model Layer 2: Primary purpose is marsh deposits and creek sediments. Also contains and moraine and native UGA materials beyond the creek and marsh deposits.
- Model Layer 3: Primary purpose is UGA. Includes moraine where inferred, and fine-grained native materials beneath sediments as mapped by AQ (2016).
- Model Layer 5: Primary purpose is UGA. Includes moraine where inferred.
- Model Layer 6: Gardiners Clay/Raritan Clay (inactive layer).

Lithology and hydrogeologic data used in defining layer elevation boundaries were obtained from boring logs as listed in Table L1. The locations of soil borings used for strata discretization are shown on Figure L3-3. Artificial elevation points were added to the data set for areas not covered by borings, mainly near the model corners to avoid excessive extrapolation during the import process. Within and along Newtown Creek and its tributaries, detailed bathymetry and sediment thickness contours reported by AQ (2016) were digitized at a spacing denser than the sediment core spacing, to produce consistent resolution and shoreline definition along the creek.

3.3 Constant Head Boundaries

Constant head boundaries (CHBs) were assigned along the model limits to represent the interface with the surrounding regional aquifer system. CHBs consist of potentiometric head elevations assigned to specific cells in the model. Groundwater can flow into and out of CHB cells, depending upon whether the neighboring groundwater is under a higher or lower potentiometric head, respectively. CHBs are commonly needed to represent conditions at the model limits where models do not extend to basin or groundwater divides.

Constant head cells were assigned in Layer 1 with head values at elev. 0.0 NAVD (Mean Sea Level) within the Newtown Creek and its tributaries (Fig. L3-4). CHB cells allow groundwater to enter the creek vertically from cells representing sediments and the underlying aquifer, and horizontally from fill through the banks or bulkheads.

A CHB was assigned along the southeastern model boundary in Layer 5 to represent a westerly component of UGA flow toward the creek consistent with regional contours. A head boundary of Elevation 14 NAVD was assigned where shown in Figure L3-5.

A CHB was assigned to the southwestern model boundary extents, where a trough in regional contours (Fig. L2-2) indicate a transition of UGA flow to a westerly direction toward the East

River. A head boundary of Elevation 2.5 NAVD was assigned to Layer 4 where shown in Figure L3-5.

A CHB was assigned along the northern model boundary where it intersects Newtown Creek. Groundwater extraction is occurring in that area outside the model limit, having an effect on UGA groundwater elevations within the model. A head boundary of Elevation 3 NAVD was assigned to model layer 5 where shown on Figure L3-5.

3.4 No-Flow (Inactive) Boundaries

No-Flow (Inactive) boundaries are located at the model limits where no head boundaries are present, and at the base of the model. At the model limits and the base of the model, where head boundaries are not present, no groundwater flow occurs in or out of the model. Flow occurs parallel to or radially outward from the inactive boundaries. At the model limits where no CHBs are shown on Figure L3-4 or L3-5, the model calibrated within tolerances without the need for CHBs. Groundwater flow patterns originating at the no-flow boundaries are governed in the model by recharge.

3.5 Drain Boundaries

Infiltration to the Maspeth Ave. drain was assumed in the model as described in Section 2.5 and where shown in Figure L2-7. Infiltration is modeled as “drain” cells with assigned head elevations, where surrounding groundwater computed to have higher head elevations can enter the drain cells, causing a flow gradient toward the drain cells. Model cells were assigned elevation values ranging from 1 to 7 feet NAVD where shown in Figure L2-7.

The drain elevations used in the model were determined by trial-and-error, where drain elevations were varied until well in the vicinity were within calibration tolerances. Where the storm drain is above the water table approaching Newtown Creek, the invert elevation was assigned, to the drain cells. Drain cells above the computed water table have no effect in the model. No drain cell elevations are below the drain invert.

3.6 Recharge

Five aquifer recharge zones were established for the model, to represent variations in ground cover (Figure L3-6). Aquifer recharge was set at:

- | | |
|---------------------------------|----------------|
| ▪ Generic Commercial/Industrial | 5 inches/year |
| ▪ Unpaved/gravel | 9 inches/year |
| ▪ Urban Undeveloped/Vegetated | 16 inches/year |
| ▪ Urban Residential | 8 inches/year |

- Impervious/Buildings 0.5 inches/year

The modeled recharge rates are consistent with estimated recharge rates for urban areas in the northeastern United States. Recharge in undeveloped areas of Long Island was estimated to equal about 50 percent of mean annual precipitation, but recharge from precipitation in the highly urbanized and industrialized areas of Kings and Queens Counties is reported to be far less because the large amounts of impervious surfaces impede infiltration (Cartwright, 2002). Buxton and Shernoff (1995) reported an annual recharge for Kings County of 15 percent of precipitation. Average annual precipitation for the New York City area for the years 1961 through 1991 was reported to be 40 to 50 inches per year [USGS, 2005]. Fifteen percent of annual precipitation would yield 6 to 7.5 inches/year of recharge to the aquifer system. AQ (2016) reported an average recharge over the potential groundwater recharge area for Newtown Creek of 8-9% of annual precipitation, using both regional recharge values scaled for land cover types within the Newtown Creek area, and separately using a more comprehensive method based on land cover. Eight to nine percent of annual precipitation would yield 3.2 to 4.5 inches/year of recharge to the aquifer system. Recharge rates in the model vary relative to the reported county-wide values to reflect local changes in infiltration rates based on ground cover. The above-average value of 20 inches/year applied in the model to some pervious areas represents a relatively small coverage of the model. The model-wide average recharge is about 6.3 inches/year. Other values reported from studies of urban areas in the region are similar, where recharge in urbanized areas near Pennsauken, New Jersey, and Allentown, Pennsylvania, were reported to range from 0 to 9 inches per year, and 0.11 to 11 inches per year, respectively [New Jersey Department of Environmental Protection (NJDEP), 2000; USGS, 2008].

Recharge values used in the model were determined by trial-and-error adjustment across a range supported by the above literature. The values used at GPEC and areas between GPEC and English Kills were discretized to capture localized influences. The Generic Commercial/Industrial value represents an average recharge for paved, unpaved, and built areas, where further discretization of recharge was not considered necessary for model calibration.

3.7 Bulkheads

Sheetpile bulkheads inhibit or potentially inhibit groundwater flow to and from the canal, where the sheeting are less permeable than the adjacent upland soil. Sheetpile bulkheads along the canal are modeled as Horizontal Flow Boundaries (“wall” boundaries). Wall boundaries were placed in the model between cells representing the creek (and sediments), and cells representing upland soil.

Hydraulic conductivity values were assigned based on literature. Field studies performed at the University of Waterloo, Ontario, resulted in reported sheetpile hydraulic conductivity estimates (Starr, 1992):

- Cold-rolled sheetpile 1×10^{-4} cm/s
- Hot-rolled sheetpile $1.5\text{--}5 \times 10^{-7}$ cm/s

No information regarding sheetpile type was available. It was assumed that cold-rolled sheetpiling was used for non-remedial bulkhead construction, and hot-rolled sheetpiling was used for remedial barrier walls. The above hydraulic conductivities were assigned in the model at the respective locations shown on Figure L2-8.

3.8 Groundwater Extraction

Groundwater extraction described in Section 2.4 was included in the model using the MODFLOW well package. Wells were assigned pumping rates shown on Figure L2-6.

Extraction rates at the ExxonMobil (including the BP and Paragon terminals) and Phelps-Dodge remedial systems appear to be consistent in the last several years such that steady-state pumping conditions can be assumed. Roux Associates (2011) provided a summary drawing with well locations and extraction rates for ExxonMobil (including the BP and Paragon terminals) totaling 707 gpm, used in the model, while rates reported by AnchorQEA (AQ, 2016, Figure F4-8) total at 580 gpm. Similar drawdowns, on the order of 3 to 4 feet below sea level, are reported for the area by both Roux Associates and AnchorQEA.

Extraction rates at the Phelps-Dodge site are consistent based on annual Operations, Monitoring & Maintenance (OM&M) reports by Conestoga-Rovers & Associates (CRA) representing years 2008-2009 and 2010-2011 (May to April cycles). A chart in the 2008-2009 OM&M report showed a breakdown in which the combined flow rate for the three southernmost extraction wells was about 20% that of the four northern wells. Flow was split evenly in each set of wells in the model, for a combined rate of 43 GPM, the approximate monthly value reported for 2010-2011 (CRA, 2012). A combined rate of 40 GPM for the site was reported by AnchorQEA.

The pumping well at Brooklyn Truck Wash described in Section was modeled as a 10 gpm well screened in the upper UGA. The rate used is assumed to support pressure washers used in the truck washing bay. It is likely that the facility recycles wash water, creating less of a demand for pumped groundwater. The truck wash pumping well in the model lowers the water table slightly in its vicinity, but does not draw in water from GPEC or significantly alter its flow path toward English Kills.

3.9 Hydraulic Conductivity

Hydraulic conductivity values used in the model were assigned based on the characteristics of the geologic units represented, using hydraulic conductivity measurement results and literature-based values as guidance.

- Table L2 lists hydraulic conductivity measurement results obtained from available sources.
- Table L3 lists hydraulic conductivity values used in the model, in comparison to the range of available measurement and literature-based values.
- Figure L3-7 shows hydraulic conductivity test locations, values, and elevation of the test zone for each respective result.
- Figures L3-8a through L3-8e show the hydraulic conductivity zones assigned to each model layer.
- Figure L3-9 shows model hydraulic conductivity zones in cross-section.
- Figure L3-10 provides cross-sectional detail at Newtown Creek.

Hydraulic conductivities were selected based on field measurements, published values for the regional formations, and published ranges for the observed soil types [Anderson, 1992; USGS, 1999], and calibration of the model to observed water level elevations. Field measurements represent hydraulic conductivity values. Vertical anisotropy was assigned during the calibration process, using literature ranges as guidance where available.

A relatively high degree of water table mounding and water level variability is apparent in areas of fill and dense moraine, as compared to a flatter water table within the bulk of the UGA. As described in the CSM, greater variability in water levels is attributed to relatively slow aquifer drainage through low hydraulic-conductivity material. Localized subunits of fill and dense moraine were assigned, in combination with adjusting recharge values, resulting in higher computed water table elevations.

No hydraulic conductivity measurements were available for the marsh deposit unit. Hydraulic conductivity of the marsh deposit aquitard was assigned using an iterative approach, where the aquitard must maintain heads in the overlying fill that are above those within the underlying UGA.

Creek sediments include soft recent organic deposits and, where present, underlying native silt and peat. In the model, the sediment column is represented as a single layer. Although discharge upwelling is likely not uniform, no trends were identified in sediment core descriptions that would justify a basis for delineation of preferential upwelling areas. It is assumed therefore that the spacing of preferential upwelling locations, if any, is uniform and proximate to the degree that upland groundwater flow is not significantly deflected. A uniform horizontal hydraulic conductivity of 3 feet/day was assigned to the sediments, which is

a typical value reported by Anchor (2016). A vertical anisotropy ratio of 10:1 showed the best calibration fit and was used in the model.

The UGA is modeled as a zone of uniform hydraulic conductivity, with the exception of moraine ridge and an intermediate clay layer. A value of 80 ft./d is used in the model, as arrived at in the calibration process (Section 4). The UGA in general is expected to have a relatively high hydraulic conductivity. Wells in the region have been reported to yield between 60 and 300 gallons per minute (NYSDEC, 1937, 1938, 1944, and 1947). AnchorQEA (2016) cited a range of hydraulic conductivities reported by others for UGA moraine deposits as being 20 to 140 ft./day. The horizontal hydraulic conductivity used in the model is in the range of published values for clean sand (Anderson & Woessner, 1992).

4. Calibration

The groundwater model provides a calculated steady-state groundwater flow field representing long-term average groundwater elevations. The objectives of model calibration consisted of matching model-calculated heads to observed heads at monitoring wells, and qualitatively matching model-calculated groundwater elevation contours to reported local and regional contours. All available groundwater elevations for GPEC were used in the calibration data set. Off-site, a high density of data points were available, in which case a subset of wells representing elevations typical for those reported in their respective vicinities were selected as calibration points. Calibration data point locations are shown on Figure L4-1.

The model was calibrated by adjustment of soil and sediment conductivities, head boundary values, and areal recharge. The calibration data points with observed and final (calibrated) water level elevations for each calibration point are shown in Table L4. Calibration residuals plots for the entire model and the UGA are shown in Figure L4-2. Computed potentiometric head contours representing the water table and UGA in Figures L4-3 and L4-4, respectively. The computed relative difference of potentiometric elevations above and below the marsh deposits are consistent with measured differences and with the conceptual flow model as described in Section 2.2.

For purposes of site characterization in the GPEC remedial investigation, the UGA was subdivided into shallow, intermediate, and deep zones. The shallow zone represents the aquifer above the marsh deposits. The intermediate and deep zones represent the UGA below the marsh deposits. Monitoring wells representing the intermediate zone are screened in the approximate range of 25 to 60 feet below ground surface. Monitoring wells representing the deep zone are screened below 60 feet below ground surface. There is no geologic strata break between the zones. As can be seen by comparison of the shallow/deep contours in Attachment A, groundwater elevations appear to be similar between the two zones. A vertical gradient analysis was done as part of the Interim RI, where measured differences between intermediate and deep piezometric heads in well clusters were on the order of 0.02 ft., with a maximum difference of 0.52 ft (GEI, 2016). Measured gradients were both downward and upward, suggesting minor transient or tidally-influenced trends. In the model, a slight computed downward gradient in upland areas occurs due to recharge influence. Computed gradients shift upward beneath Newtown Creek where discharge occurs.

The calibration data set includes measurements taken at remedial investigation sites between 2008 and 2017, and at regional USGS locations from the 1990s through about 2013. Discrete measurements were used for all locations except:

- Newtown Creek site, tidally-averaged values based on continuous logging reported by AnchorQEA (AQ 2016, Table F3-4).
- Regional USGS locations, long-term regional stabilized groundwater elevations (Figure L2-4).
- For wells installed along the Maspeth Ave. utility corridor (Section 2.5), approximate average values from a continuous logging event were used (National Grid, 2017a).

On the calibration plots it can be seen that high heads were computed by the model where high heads were observed (at shallow depths near Maspeth Ave; the dense moraine area, and USGS locations further from the creek) and low heads were computed where low heads were observed (along the creek and in the ExxonMobil groundwater extraction area). The primary statistical goal for model calibration was to obtain a normalized root mean square of the residuals of less than 10%. The normalized RMS for the model calibration is approximately 5.4%, for all calibration points, and 6.6 % for the UGA calibration points, which are well below this statistical objective, and thus shows that the model is well calibrated.

The dominant trends in the conceptual site model are considered to be qualitatively met: upward preferential discharge zones with relatively low heads in the Upper Glacial Aquifer are represented by the lower observed and calculated heads (Figure L4-4), where the potentiometric surface within the Upper Glacial Aquifer at GPEC is relatively flat, ranging primarily between elevations 1 and 2.5 NAVD. Similarly, calibration residuals for the shallow zone (Figure L4-2, Layer 1) indicates that higher groundwater elevations are being maintained in areas at and south of GPEC above the marsh deposit unit.

A water budget for the model is presented in section I of Table L5. As shown in Table L5, the percent difference between calculated flow rates entering and leaving the model are within a fraction of a percent, which is considered acceptable. The model was run with head change and residual criterion between numerical iterations set to 0.01 feet using the Newton-Raphson solver for MODFLOW 2005 (MODFLOW-NWT).

5. Results and Sensitivity Analysis

Model output was evaluated using computed potentiometric contours, particle tracking, and Zone Budget flow rate calculations. Particle tracks were used to evaluate flow paths toward potential receptor locations. Zone Budget is a post-processing feature used to compute volumetric flow rates across user-defined horizontal and/or vertical planes in the model, based on the computed flow field.

Figures L5-1 and L5-2 show the computed potentiometric contours and particle paths for Layers 1 and 4 which represent the water table and intermediate-zone UGA, respectively. On Figure L5-1, computed shallow groundwater elevations are highest in the northeast and southwest areas of GPEC. In the northeast, the high elevations are associated with water retention in dense moraine material. In the southwest, the marsh deposits impede drainage of recharge in the fill, resulting in water table mounding above the marsh deposits. Groundwater flow occurs laterally above the marsh deposits, until connecting hydraulically with the UGA where the marsh deposits are absent. Particle paths depict this pattern on Figure L5-1. The model shows that shallow groundwater flowing off-property flows northward to the ExxonMobil extraction system; easterly toward Newtown Creek (discharging through or beneath the pervious loading platform support), and southerly toward English Kills. Groundwater divides, where flow splits between the three principle offsite flow directions, can be inferred in central areas of GPEC from the particle paths. Some shallow groundwater is captured by the Maspeth Ave. utilities. Although some particle tracks terminate along Maspeth Ave., some shallow groundwater may bypass the utilities.

On Figure L5-2, the computed heads in the UGA within GPEC are in the 1.0 to 2.0 ft elevation range. Computed flow directions are similar to those described for the shallow zone (except for mounded water above marsh deposits), where on-property flow splits toward the northern, eastern, and southern property boundaries.

The results of the Zone Budget flow analysis are shown in Section II of Table L5. In general, recharge originating within GPEC constitutes most (73%) of the computed groundwater flow occurring within GPEC. A lesser amount (24%) enters GPEC as UGA flow from areas further upland to the north. A relatively small amount of flow (4%) enters GPEC as northeasterly flow from eastern areas of Maspeth Ave. Flow leaving the GPEC site occurs at relatively similar computed rates across the northern (34%), eastern (42%), and southern (24%) property boundaries.

An analysis was performed to evaluate the sensitivity of input parameters on model calibration. Hydraulic conductivity and recharge would have the greatest effect on modeled groundwater

flow at the Site. Additional sensitivity analyses were performed due to uncertainties in water withdrawals or potential water withdrawals, where model calibration was compared to varying water withdrawal effects. The analysis was performed by comparing the change in calibration residuals with changes in input parameters.

Calibration error, as measured by the normalized root mean square (NRMS) of the calibration residuals (calculated minus observed heads) for the sensitivity runs are shown in Figures L5-3 and L5-4. The NRMS is a measure of the correlation between observed and predicted heads. In general, the NRMS varies as the parameters change, and the lowest NRMS value corresponds to the most accurate parameter value for the model. Therefore, as the parameter is varied further from its most accurate value, the NRMS increases, and the plot of NRMS vs. parameter value would be a curve where the low point corresponds to the value most appropriate for use in the system modeled. However, if the calibrated model is not sensitive to a parameter, the NRMS may not change, and a sensitivity analysis for the subject parameter would be recommended for the predictive model.

5.1 Hydraulic Conductivity Sensitivity

Hydraulic conductivity for key strata in the model (fill, UGA, marsh deposits, sediments, native fine-grained material beneath sediments, and moraine subunits) were increased and decreased to values within ranges reasonable for the soil type. Sensitivity analysis for vertical hydraulic conductivity was run for strata in which vertical hydraulic conductivity governs flow more so than horizontal (marsh deposits, sediments, and fine-grained material beneath sediment). Calibration showed that the model was sensitive to variation of each parameter.

5.2 Recharge Sensitivity

The annual recharge rate for each recharge zone in the model was varied over a range of several inches. The model was roughly equally sensitive to changes in each recharge zone. Based on the quantitative sensitivity analysis results shown on Figures L5-3 and L5-4, and qualitative model calibration where no data points exist, it is expected that the model inputs are reasonably accurate.

5.3 Groundwater Withdrawal Sensitivity

In the Conceptual Site Model description (Section 3.8), potential groundwater withdrawal sources were described, for which no information is available to confirm or quantify the sources. The two sources include: a pumping well at Brooklyn Truck Wash, a permitted non-potable well at Cornell Beverages, and the MTA L-Train subway tunnel (Figure L2-6).

At the Brooklyn Truck Wash, a withdrawal of 5 gpm was assumed in the calibrated model. As the actual rate is unavailable, a capture zone analysis was performed to evaluate whether the well or its pumping rate could potentially affect groundwater flow at GPEC. The modeled value was based on a review of commercial pressure-washer capacities, where washer models appear to have a 3 to 5 gpm capacity. Assuming that the truck wash does not operate full time annually, and that two pressure washers are used, and filtration/recycling of wash water is employed, it is unlikely that the withdrawal exceeds 5 gpm. A capture zone analysis was performed assuming 10 and 50 gpm continuous withdrawal rates. On Figure L5-5, particle tracks show that at the modeled pumping rates, the well does not capture groundwater from GPEC even at 50 gpm. With a higher pumping rate, groundwater flowing off-property from GPEC may deflect slightly, but would still discharge to English Kills.

The potential effects of Cornell Beverages pumping and MTA dewatering were analyzed as a single source, as drawdown from both or either would have similar effects on groundwater flow approaching English Kills and GPEC. Water withdrawals at those distances (about 1 mile from GPEC) would need be substantial to affect flow at GPEC. Drawdown was modeled by adding a head boundary where shown on Figure L5-6, and adjusting the head value to simulate drawdown up to several feet below the static condition in the area. Drawdown was stepped up (i.e. the CHB elevation lowered) incrementally and the effect on model calibration was compared. The graph on Figure L5-6 shows that calibration error increases with increasing drawdown. The increase in calibration error indicates that water withdrawals in the area of Cornell Beverages or the MTA tunnel, if any, are below levels that affect groundwater flow at GPEC.

References

AECOM, 2016. Draft Remedial Investigation Report, Former Equity Works MGP Site, 222-254 Maspeth Ave., Brooklyn, Kings County, New York, AECOM, March 2016.

AnchorQEA, 2016. Draft Remedial Investigation Report, Remedial Investigation / Feasibility Study, Newtown Creek, AnchorQEA, LLC, November 2016.

Anderson & Woessner, 1992. Applied Groundwater Modeling: Simulation of Flow and Advective Transport. Anderson M.P. and Woessner, W.W., Academic Press, Inc., 1992.

Buxton and Shernoff, 1999. Ground-Water Resources of Kings and Queens Counties, Long Island, New York, by Herbert T. Buxton and Peter K. Shernoff, Water-Supply Paper 2498, U.S. Geological Survey, 1999.

Buxton and Smolensky, 1999. Simulation of the Effects of Development of the Ground-Water Flow System of Long Island, New York, Water-Resources Investigations Report 98-4069. Buxton, H.T. and Smolensky, D.A., U.S. Geological Survey, 1999.

Cartwright, R. A., 2002. History and Hydrologic Effects of Ground-Water Use in Kings, Queens, and Western Nassau Counties, Long Island, New York, 1800s through 1997. United States Geological Survey Water-Resources Investigations Report 01-4096.

CEUS, 2012. Second Quarter 2012 Status Report, Former Ditmas Oil Terminal, 364 Maspeth Avenue, Brooklyn, New York, Spill Number 90-06603, CEUS Engineering, P.C. & Advanced Site Restoration, LLC., July 20, 2012.

CRA, 2012. Operations, Maintenance, and Monitoring Report – May 1, 2010 to April 30, 2011, Barrier Wall and Groundwater Collection/Treatment System, Laurel Hill Site, Maspeth, New York. Conestoga-Rovers & Associates, January 2012.

Delta, 2006. Remediation System Installation Summary and Annual System Status Report, BP Bulk Petroleum Storage Terminal, 125 Apollo Street, Brooklyn, New York, NYSDEC MOSF #02-1200, Delta Environmental Consultants, March 29, 2006.

DEC, 2008. Record of Decision, Phelps Dodge (Laurel Hill) Site, Maspeth, Queens County, Site Number 2-41-002. New York State Department of Environmental Conservation, January 2003.

Fetter, 1994. Applied Hydrogeology, Third Edition. Fetter, C.W. Prentice-Hall, Inc., 1994.

GEI, 2011. Remedial Investigation Work Plan, Greenpoint Energy Center Former Manufactured Gas Plant Site, 287 Maspeth Avenue, Brooklyn, New York 11211, ACO Index No. A2-0552-0606, site #224052. GEI Consultants, Inc., November 28, 2011.

GEI, 2016. Interim Remedial Investigation Report, Phases 1 and 2, Greenpoint Energy Center, 287 Maspeth Avenue, Brooklyn, New York 11211, Site #224052, GEI Consultants, Inc., November 2016.

HYDROQUAL, 2000. Remedial Investigation Report, Operable Unit 1A, Laurel Site, Maspeth, New York, Hydroqual/EEA, November 2000.

McDonald and Harbaugh, 1988. A modular three-dimensional finite-difference ground-water flow model, Techniques of Water-Resources Investigations 06-A1, USGS.

Misut and Monti, 1999. Simulation of Ground-Water Flow and Pumpage in Kings and Queens Counties, Long Island, New York, by Paul E. Misut and Jack Monti, Jr., Water-Resources Investigations Report 98-4071, U.S. Geological Survey.

MPI, 2010. Remedial Investigation Report, BCF Oil Site, Brooklyn, New York, Site #2-24-024, Malcolm Pirnie, Inc., December 2010.

National Grid, 2017a. Additional Investigation Report, Phase 2/3 Remedial Investigation, Greenpoint Energy Center Former Manufactured Gas Plant, 287 Maspeth Avenue, Brooklyn, New York, Site No. 224052, 2017.

National Grid, 2017b. Loading Platform Area Investigation Report, Remedial Investigation Areas 1 and 2, Greenpoint Energy Center Former Manufactured Gas Plant, 287 Maspeth Avenue, Brooklyn, New York, Site No. 224052. National Grid, 2017.

NJDEP, 2000. Ground-Water-Recharge Rates and Selected Open Space in the Rancocas, Pennsauken and Cooper Watersheds, New Jersey, Open-File Map OFM-32, Mark A. French and Jeffrey L. Hoffman, New Jersey Department of Environmental Protection, 2000.

NYSDEC, 1937. Record of Wells in Kings County, N.Y., State of New York Department of Conservation, by the United States Geological Survey, Bulletin GW-3, 1937.

NYSDEC, 1938. Record of Wells in Queens County, N.Y., State of New York Department of Conservation, by the United States Geological Survey, Bulletin GW-6, 1938.

NYSDEC, 1944. Record of Wells in Kings County, N.Y., State of New York Department of Conservation, by R.M. Leggette and M.L. Brashears, Jr., Bulletin GW-8, 1944.

NYSDEC, 1947. Record of Wells in Queens County, N.Y., Supplement 1, State of New York Department of Conservation, by the United States Geological Survey, by C.M. Roberts and Marion C. Jaster, Bulletin GW-6, 1947.

Roux, 2011. Recovery Well RW-26 Aquifer Test Report, ExxonMobil Greenpoint, Petroleum Remediation Project, Greenpoint, Brooklyn, New York, Roux Associates, Inc., April 11, 2011.

URS, 2009. Site Characterization, Phase IV Data Summary Report, Prepared for New York State Department of Environmental Conservation, Work Assignment D004433-22, Site No. 2-24-121, URS Corporation, May 2009.

USGS, 2005. New York Average Annual Precipitation, 1961-1990, in National Atlas of the United States, <http://nationalatlas.gov>

USGS, 2008. Spatial Distribution of Ground-Water Recharge Estimated with a Water-Budget Method for the Jordan Creek Watershed, Lehigh County, Pennsylvania. Scientific Investigations Report 2008-5041, U.S. Geological Survey, 2008.

Tables

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
UPLAND BORINGS												
GPEC	GPEC-SB01B/MW-01/1D	651236.8	687779.0	8.2	99.0	-21.8		-25.8				
GPEC	GPEC-SB02/MW-02	651144.0	688035.5	7.5	100.0			-30.6			-90.6	
GPEC	GPEC-SB03/MW-03D	651051.4	688300.9	6.9	115.0	-22.3		-31.1			-99.1	
GPEC	GPEC-MW-04/4D	650941.5	688532.8	6.1	115.0	-28.9		-40.9	-29.3	-40.9		
GPEC	GPEC-MW5D/D2	650755.9	688966.9	6.8	190.0	-14.2		-27.2			-107.2	-180.2
GPEC	GPEC-SB06/MW-06	650799.7	687870.6	12.3	50.0			1.3				
GPEC	GPEC-SB07/MW-07	650777.9	688126.2	7.3	114.0	-6.1		-18.7			-88.7	
GPEC	GPEC-SB08/MW-08	650558.5	688452.1	5.7	80.0							
GPEC	GPEC-SB10/MW-10	650394.3	687734.6	13.5	70.0			4.5				
GPEC	GPEC-SB12/MW-12	649520.1	687767.4	16.6	64.0	-6.0		-10.4				
GPEC	GPEC-SB13/MW-13	649202.1	688779.6	51.1	70.0							
GPEC	GPEC-SB101A/MW-101D	650823.0	687711.1	12.6	120.0			-5.4				-102.4
GPEC	GPEC-SB102/MW-102D	651026.4	687528.0	11.8	112.0	-8.2		-14.5	-18.2		-95.2	
GPEC	GPEC-SB103	651253.5	687792.3	7.3	120.0							
GPEC	GPEC-SB104	651193.2	687953.4	8.0	107.0	-25.0		-27.0			-94.0	
GPEC	GPEC-SB105/MW-02D	651161.1	688040.6	7.2	105.0			-25.8			-94.8	
GPEC	GPEC-SB106/MW-03WT	651074.8	688297.3	6.3	107.0						-97.1	
GPEC	GPEC-SB107/MW-11D	650043.2	687995.2	13.5	100.0	2.4		-2.6			-72.4	
GPEC	GPEC-SB-201/MW-201	649960.4	687570.6	12.5	75.0	-7.5		-12.5	-27.5			
GPEC	GPEC-SB-202/MW-202	651060.8	687655.6	9.8	83.0	-7.9		-20.2			-71.0	
GPEC	GPEC-SB-203	651266.0	687689.8	8.4	87.0	-20.3		-24.3				
GPEC	GPEC-SB-204	651178.7	687740.1	8.8	87.0	-8.2		-15.3				
GPEC	GPEC-SB-205/MW-205	651230.3	687861.2	8.4	97.0	-24.4		-27.6			-87.6	
GPEC	GPEC-SB-206	651125.5	688139.4	6.8	87.0	-21.7		-27.7				
GPEC	GPEC-SB-207	651100.1	688206.1	6.6	87.0	-22.9		-30.4				
GPEC	GPEC-SB-208	651041.9	688352.3	4.9	87.0	-25.1		-29.7	-29.7			
GPEC	GPEC-SB-209	651016.8	688445.9	5.9	87.0	-21.2		-23.2	-23.2			
GPEC	GPEC-SB-210	650976.6	688621.9	6.7	87.0			-33.3				
GPEC	GPEC-SB-211	650931.7	688746.5	6.5	80.0	-28.5		-30.4				
GPEC	GPEC-SB-212	650891.7	688868.4	6.1	87.0	-21.9		-26.9	-26.9			
GPEC	GPEC-SB-213	650682.6	689037.0	5.0	87.0			-27.9				
GPEC	GPEC-SB-214	650746.0	689179.9	5.9	87.0				-40.5		-67.9	
GPEC	GPEC-SB-215	650688.7	689349.4	7.2	87.0			-27.8	-24.8		-69.8	
GPEC	GPEC-SB-216	650656.4	689443.5	6.7	87.0				-30.3		-66.8	
GPEC	GPEC-SB-217/MW-217S.I.D	650048.9	688824.3	21.8	87.0			6.8	9.8		-52.5	
GPEC	GPEC-SB-218/MW-218I.D	649213.6	688790.1	51.1	117.0						-53.4	
GPEC	GPEC-SB-219/MW-219S.I.D	648863.2	688284.2	39.5	133.0						-58.0	
GPEC	GPEC-SB-220/MW-220S.I.D	648658.7	687492.9	21.9	97.0	3.7		-1.5			-57.1	
GPEC	GPEC-SB-221/MW-221S.I.D	649585.3	687634.6	14.7	95.0	-2.3		-12.3	-18.0		-76.6	
GPEC	GPEC-SB-222/MW-222S.D	649226.3	686985.6	13.9	100.0	-4.7		-23.2	-23.2		-67.4	
GPEC	GPEC-SB302	650904.6	687469.7	11.8	75.0	-9.0		-13.2				
GPEC	GPEC-SB304B	649221.2	687199.9	14.4	30.0	-6.6		-9.6				
GPEC	GPEC-SB306	650607.2	687360.3	12.0	75.0			-1.0				
GPEC	GPEC-SB314	650409.9	687516.7	13.1	15.0	0.4		-2.6				
GPEC	GPEC-SB317	650410.9	687317.3	11.9	15.0	-1.4		-4.4				
GPEC	GPEC-SB319	649983.7	687177.1	12.3	80.0	-8.5		-27.7	-27.7	-61.7		
GPEC	GPEC-SB325	649987.1	687324.0	12.2	30.0	-14.8		-17.8				
GPEC	GPEC-SB326	649371.5	686975.0	13.0	30.0	-13.7		-16.7				
GPEC	GPEC-SB328	649824.7	687119.1	11.7	75.0	-5.9		-28.3	-28.3	-48.3		

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
GPEC	GPEC-SB330	649463.5	687242.3	14.4	30.0	-8.1		-11.1				
GPEC	GPEC-SB331	649292.8	686925.4	13.9	75.0	-11.1		-24.1	-24.1			
GPEC	GPEC-SB332	649448.9	686982.6	13.5	90.0	-9.7		-28.2	-28.2	-56.5	-72.9	
GPEC	GPEC-SB333	649128.7	686891.9	14.2	80.0	-7.1		-26.0	-25.8	-47.1		
GPEC	GPEC-SB334	649017.0	686850.3	14.8	75.0	-10.8		-19.2	-19.4	-37.7		
GPEC	GPEC-SB339	648739.3	687188.5	15.1	85.0			-6.2			-49.9	
GPEC	GPEC-SB341	648833.6	687138.4	20.8	30.0	-5.2		-8.2				
GPEC	GPEC-SB344	648882.4	686805.2	15.2	85.0	-11.6		-18.8	-12.6	-18.8	-64.8	
GPEC	GPEC-SB346	650262.4	687573.7	12.6	20.0	-2.2		-5.2				
GPEC	GPEC-SB349	648788.5	687278.9	14.2	30.0	-2.6		-5.6				
GPEC	GPEC-MW401	649002	688086	30.0	100.0						-56.0	
GPEC	GPEC-MW402	650301	688085	13.5	100.0							
GPEC	GPEC-MW403	651255	687736	7.9	50.0	-18.1						
GPEC	GPEC-MW404	651232	687857	8.5	55.0							
GPEC	GPEC-MW405	651191	687955	8.6	70.0	-22.4						
GPEC	GPEC-MW406	651161	688048	7.4	80.0							
GPEC	GPEC-MW407	651129	688153	7.3	50.0							
GPEC	GPEC-MW408	651101	688218	6.9	50.0							
GPEC	GPEC-MW409	651085	688274	6.9	80.0							
GPEC	GPEC-MW410	651068	688321	6.5	55.0							
GPEC	GPEC-SB701	649846.2	688858.4	25.4	102.0	24.4		-5.0			-48.1	
GPEC	GPEC-SB708	649439.2	688706.5	49.3	30.0	49.3						
GPEC	GPEC-SB709	649292.8	688768.6	50.2	30.0	26.2		-5.0				
GPEC	GPE-MW-1S/1D	650044.9	689233.8	11.0	50.0	-7.0		-15.0				
GPEC	GPE-MW-2S/2D/D2	650606.2	689370.9	11.3	52.0	-24.7		-26.7			-76.2	
GPEC	GPE-MW-3S/3D	650643.6	689307.4	10.8	50.0	-7.7		-28.7				
GPEC	GPE-MW-4S/4D	650671.9	689241.0	11.1	52.0	-18.9		-22.9				
GPEC	GPEC-07	650483.9	689332.2	5.9	50.0	-7.1		-12.1				
GPEC	GPE-08	650543.9	689356.2	7.3	50.0	-12.8		-22.8				
GPEC	GPESB-18	650608.6	689240.9	5.7	50.0	-12.3		-28.3	-21.6	-30.3		
GPEC	GPESB-22	650618.2	689175.5	5.7	50.0	-10.8		-12.8	-20.3	-30.3		
GPEC	GPESB-25	649824.3	689180.5	28.7	48.0	5.7		-1.3				
GPEC	GPESB-27	650172.4	689252.2	22.1	30.0			-2.9				
GPEC	GPESB-28	650122.0	689183.5	22.7	30.0			-3.6				
GPEC	GPEC-GT01(MW)	649699.0	687047.4	10.7	62.0	-9.3		-17.3	-28.8			
GPEC	GPEC-GT03(MW)	650075.7	687177.6	12.7	52.0	-7.3		-25.8	-25.8			
GPEC	GPEC-GT04D(MW)	650302.1	687257.6	12.1	72.0	-9.9		-20.4				
GPEC	GPEC-GT05/5D	650420.6	687292.8	12.0	177.0	3.0		0.0			-117.5	
GPEC	GPEC-GT07D(MW)	650762.8	687412.0	12.4	52.0							
GPEC	GPEC-GT08	650951.2	687503.2	10.3	57.0	-1.7		-15.6	-17.7	-33.2		
GPEC	GPEC-GT10D(MW)	651321.9	687649.4	8.1	121.9			-28.5				
GPEC	GPEC-GT12	651325.2	687782.5	-14.9	66.0		-14.9	-38.4				
GPEC	GPEC-GT14	651237.3	688036.1	-16.1	52.0		-16.1	-39.6				
GPEC	GPEC-GT16	651138.3	688324.0	-16.0	102.0		-16.0	-39.5	-39.5	-49.5	-109.5	
GPEC	GPEC-GT18	651010.6	688694.4	-15.1	57.0		-15.1	-34.6	-34.6	-53.6		
GPEC	GPEC-GT20	650882.8	689065.1	-19.4	66.8		-19.4	-35.4	-35.4	-67.9		
GPEC	GPEC-GT22	650748.6	689448.9	-16.5	52.0		-16.5	-29.5	-29.5	-52.5		
GPEC	GPEC-SIS101S	649869.7	687064.9	11.5								
GPEC	GPEC-SIS102S	649876.5	687054.8	12.0								
GPEC	GPEC-SIS102I	649881.6	687056.3	12.0								

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
GPEC	GPEC-SIS103S	650430.7	687257.8	11.6								
GPEC	GPEC-SIS104S	650430.4	687247.9	11.9								
GPEC	GPEC-SIS104I	650436.3	687249.8	11.9								
BCF / Ditmas	BCF-SB-E13	650160.0	686979.5	11.0	30.0	-17.0			-17.0			
BCF / Ditmas	BCF-SB-G9	650173.0	687058.5	13.0	20.0	-6.0						
BCF / Ditmas	BCF-SB-I9	650202.1	687068.5	11.8	30.0	-6.7		-9.7				
BCF / Ditmas	BCF-SB-I9A	650199.1	687071.7	13.0	35.0	-18.0			-18.0	-21.0		
BCF / Ditmas	BCF-SB-I19A	650279.7	686881.3	10.9	20.0	-5.1		-9.1				
BCF / Ditmas	BCF-SB-K19	650319.4	686906.9	17.0	30.0	0.5						
BCF / Ditmas	BCF-SB-M7	650254.2	687137.8	12.0	15.0	1.0		-2.0				
BCF / Ditmas	BCF-SB-N21A	650371.5	686888.6	16.0	25.0	-6.0		-9.0				
BCF / Ditmas	BCF-SB-O8	650305.4	687127.7	12.0	20.0	-7.0		-10.0				
BCF / Ditmas	BCF-SB-Q17	650390.9	686967.0	15.9	20.0	-1.1		-4.1				
Equity MGP	SB-3B/MW-3B(Eq)	649224.2	686735.7	12.1	48.0	-1.9		-11.9	-25.9			
Equity MGP	SB-4C/MW-4C(Eq)	649387.3	686648.6	12.9	87.0	-9.1		-14.1	-31.1	-74.1		
Equity MGP	SB-6B/MW-6B(Eq)	648871.9	686625.0	13.2	55.0	-4.8		-18.8	-22.8	-26.8		
Equity MGP	SB-7B(Eq)	649404.9	686600.2	12.5	46.0	-2.5		-12.8				
Equity MGP	SB-11(Eq)	649222.8	686609.4	13.6	64.0	-4.4		-12.4	-30.6			
Equity MGP	SB-12B(Eq)	649313.7	686661.3	12.3	54.0	-5.7		-13.7				
Equity MGP	SB-14B(Eq)	649081.9	686605.7	12.9	56.0	-6.1		-11.6	-31.1			
Equity MGP	SB-15(Eq)	649175.8	686693.1	11.9	54.0	-4.6		-11.8	-30.1			
Equity MGP	SB-17(Eq)	649316.5	686604.6	12.8	50.0	-5.2		-11.7	-33.2			
Equity MGP	SB-18(Eq)	649370.5	686598.4	12.5	52.0	-3.1		-12.8	-27.6			
Equity MGP	SB-1C/MW-1C(Eq)	648934.5	686446.7	12.9	100.0	-7.1		-11.1			-84.0	
Equity MGP	SB-25	649555.8	686593.1	11.1	110.0	-8.9		-18.9	-26.9	-78.9	-93.4	
Equity MGP	SB-27	648987.0	686797.5	14.0	100.0	-10.5		-13.3	-22.0	-59.0	-82.0	
Equity MGP	SB-28	649137.1	686851.3	13.4	100.0	-9.6		-15.6	-23.6	-51.6	-84.6	
Equity MGP	SB-33	648966.5	686867.9	15.3	100.0	-2.7		-20.7	-20.7	-31.7	-67.7	
Equity MGP	SB-34	648894.4	686792.4	15.1	100.0	-7.9		-13.9			-63.4	
Equity MGP	SB-35	648944.6	686944.9	16.2	50.0	-9.8		-28.8	-28.8	-32.8		
Equity MGP	T1-SB1	649528.8	686647.2	11.0	0.0	-9.0		-14.0				
Equity MGP	T1-SB5	649558.0	686562.2	10.8	0.0	-6.2		-13.0				
Equity MGP	T1-SB10	649585.8	686481.7	10.7	0.0	-10.3		-12.3				
Equity MGP	T2-SB1	649590.6	686467.7	11.0	0.0	-9.0		-13.0				
Equity MGP	T3-SB1	649442.0	686285.3	10.0	0.0	-4.5		-13.5				
Equity MGP	T3-SB5	649583.9	686334.1	10.4	0.0	-6.6		-14.1				
Equity MGP	T4-SB6	649807.4	686403.8	11.0	8.0							
Equity MGP	T5-SB1	649868.1	686599.1	11.4	30.0	-2.6		-8.6				
Equity MGP	T5-SB5	649848.6	686655.8	11.8	30.0	-0.7		-8.2	-8.2	-14.2		
Equity MGP	T5-SB8	649833.9	686698.3	11.6	30.0	-9.4		-15.4				
Equity MGP	T6-SB1	649890.3	686534.6	11.3	30.0	-14.7		-15.7				
Meeker Ave.	DEC-005	648098.8	688776.8	42.2	48.0			-5.0				
Meeker Ave.	DEC-006	648555.4	688631.9	48.9	56.0	20.9		-5.0				
Meeker Ave.	DEC-014	648374.6	687992.9	36.2	40.0	17.2		-5.0				
Meeker Ave.	DEC-018	649032.3	689018.2	53.2	92.0	24.2		-5.0				
Meeker Ave.	DEC-021	649527.0	689743.4	27.9	37.0			-5.0				
Meeker Ave.	DEC-024	646819.6	690261.3	20.2	55.0	19.2		-5.0	-39.8			
Meeker Ave.	DEC-029	648484.5	688206.8	38.9	51.0	24.9		-5.0				
Meeker Ave.	DEC-030	648258.5	688123.6	37.4	45.0	13.4		-5.0				
Meeker Ave.	DEC-031	648326.2	687876.8	34.7	45.0			-5.0				

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
Meeker Ave.	DEC-032	648452.0	687639.7	28.3	45.0			-5.0				
Meeker Ave.	DEC-041	648859.5	688940.3	54.5	63.0	19.5		-5.0				
Meeker Ave.	DEC-043	648704.1	688291.8	37.7	50.0			-5.0				
Meeker Ave.	DEC-048	648258.5	687281.6	28.7	45.0	19.7		-5.0				
Meeker Ave.	DEC-050	649245.8	689560.4	33.3	76.0			-5.0				
Meeker Ave.	DEC-051	649367.8	689340.1	39.3	81.0	22.3		-5.0				
Meeker Ave.	DEC-052	649489.8	689136.8	35.4	45.0	-5.6		-5.0				
Meeker Ave.	MW-19	647781.9	688771.6	37.8	35.0							
Meeker Ave.	MW-20	647424.8	689398.8	30.4	36.0							
PDRC	OW12-99	651406.033	691182.4	38.0	40.0							
PDRC	PD-17	650958.244	690032.3	9.0	71.0							
PDRC	PDW-13	651253.793	690308.5	11.0	70.0							
PDRC	PDW-36	651642.173	689412.1	10.0	72.0							
PDRC	B-5	651602.792	689643.9	8.0	101.0							
PDRC	PDI-31	651829.554	689887.2	13.0	72.0							
USGS	K37.1	647561.9	683272.3	25.0	130				-38.0	-76.0	-101.0	
USGS	K675.1	650462.6	687237.6	13.0	222.2						-87.0	-190.0
USGS	K677.1	648311.2	686515.3	19.0	215.2				-31.0	-75.0	-107.0	-176.5
USGS	K678.1	646621.8	685796.2	39.0	221.2				-46.0	-81.0	-81.0	-161.0
USGS	K679.1	647142.7	688633.0	35.0	218				-47.0	-85.0	-85.0	-163.0
USGS	K689.1	648674.7	689857.1	31.0	160				-44.0	-64.0	-89.0	-111.0
USGS	K889.1	648557.2	684189.4	15.0	74							
USGS	K893.1	648796.0	682976.6	20.0	118						-61.0	
USGS	K894.1	649726.7	681970.6	30.0	282				-57.0	-82.0	-82.0	
USGS	K1346.1	651486.7	683702.4	15.0	168						-147.0	
USGS	K3111.1	649333.8	683182.5	17.3	89							
USGS	Q390.1	648894.0	691680.1	23.0	211				-56.0	-76.0	-85.0	-171.0
USGS	Q431.1	653654.8	693532.8	104.0	242.7						-113.0	-118.7
USGS	Q432.1	653216.9	692156.8	115.0	301.8							-166.8
USGS	Q434.1	653280.6	691911.1	89.0	262.8				-30.0	-42.0	-53.0	-147.3
USGS	Q435.1	653054.4	691201.3	63.0	259.3							-176.3
USGS	Q436.1	651921.5	687854.3	8.0	217.2				-57.0	-112.0	-112.0	-189.2
USGS	Q437.1	653841.7	688575.4	5.0	260						-81.0	-206.5
USGS	Q438.1	652837.4	689074.7	4.0	207.6						-83.4	-183.5
USGS	Q603.1	649432.9	691683.6	69.0	202.2							-111.2
USGS	Q1068.1	654912.8	689594.5	20.0	42			0.0	-22.0			
USGS	Q1085.1	651513.4	691393.5	55.0	170			-5.0			-29.0	-114.0
USGS	Q1274.1	654761.5	689188.7	15.0	80			0.0	-40.0			
USGS	Q1412.1	656473.7	686467.9	42.0	140			-5.0			-95.0	
USGS	Q1947.1	652480.5	684822.1	14.2	83			-5.0				
SEDIMENT CORES												
GPEC	GPEC-SED01	651535.8	687819.1	-14.4	20.0		-14.4	-30.4				
GPEC	GPEC-SED02	651441.1	687786.8	-13.8	20.0		-13.8	-28.9				
GPEC	GPEC-SED03	651346.4	687754.6	-11.7	20.0		-11.7	-31.7				
GPEC	GPEC-SED04	651497.0	687937.8	-17.8	20.0		-17.8	-30.9				
GPEC	GPEC-SED05	651400.6	687905.6	-15.9	20.0		-15.9	-30.5				
GPEC	GPEC-SED06	651306.0	687873.3	-18.3	20.0		-18.3	-35.4				
GPEC	GPEC-SED07	651454.8	688056.6	-18.5	20.0		-18.5	-33.6				
GPEC	GPEC-SED08	651360.2	688024.3	-18.3	20.0		-18.3	-34.7				
GPEC	GPEC-SED09	651265.5	687991.0	-18.2	20.0		-18.2	-35.4				

Table L1
Soil Boring Summary
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Facility	Boring Location ID	Easting	Northing	Ground Surface Elevation (NAVD 88)	Borehole Depth (ft.)	Elevation Top Meadow Mat	Elevation Top Sediments	Elevation Top Upper Glacial Aquifer	Elevation Top Intermediate Clay	Elevation Bottom Intermediate Clay	Elevation Top Gardiner's / Raritan Clay	Elevation Top Bedrock
GPEC	GPEC-SED10	651445.1	688180.2	-22.4	20.0		-22.4	-40.2				
GPEC	GPEC-SED11	651329.6	688129.7	-17.8	20.0		-17.8	-35.8				
GPEC	GPEC-SED12	651225.0	688110.8	-16.9	20.0		-16.9	-33.8				
GPEC	GPEC-SED13	651373.9	688294.1	-22.0	20.0		-22.0	-36.1				
GPEC	GPEC-SED14	651279.2	688261.8	-19.8	20.0		-19.8	-35.4				
GPEC	GPEC-SED15	651184.6	688229.5	-18.4	20.0		-18.4	-33.4				
GPEC	GPEC-SED16	651333.4	688412.8	-22.0	20.0		-22.0	-35.7				
GPEC	GPEC-SED17	651239.0	688348.9	-22.1	20.0		-22.1	-39.0	-39.0	-42.1		
GPEC	GPEC-SED18	651144.1	688348.3	-16.8	20.0		-16.8	-32.1	-32.1	-36.8		
GPEC	GPEC-SED19	651105.5	688918.2	-23.0	20.0	-37.4	-23.0	-37.4	-39.6	-43.0		
GPEC	GPEC-SED20	650948.2	688859.3	-19.7	20.0		-19.7	-36.0				
GPEC	GPEC-SED21	651027.4	689603.8	-18.6	20.0		-18.6	-33.5	-33.5			
GPEC	GPEC-SED22	650735.8	689504.2	-13.8	20.0		-13.8	-27.9				
GPEC	GPEC-SED23	651128.1	689361.9	-25.8	20.0		-25.8	-37.0	-37.0			
GPEC	GPEC-SED24	651313.7	688744.6	-17.0	20.0		-17.0	-33.5				
GPEC	GPEC-SED25	651397.1	688335.2	-19.9	20.0		-19.9	-34.2				
GPEC	GPEC-SED26	651580.9	688083.4	-15.3	20.0		-15.3	-33.0				
GPEC	GPEC-SED27	651424.8	688346.0	-18.1	20.0		-18.1	-32.8				
GPEC	GPEC-SED28	651423.5	689098.0	-11.7	20.0		-11.7	-31.7				
GPEC	GPEC-SED29	651209.0	688539.5	-19.9	20.0	-32.4	-19.9	-32.4				
GPEC	GPEC-SED30	651210.0	688703.1	-21.5	20.0		-21.5	-36.2				
GPEC	GPEC-SED31	650976.0	689268.0	-26.9	20.0		-26.9	-34.1	-34.1			
Newtown Creek (NCG)	SD113	651002.1	689144.0	-25.0	11.9		-25.0	-33.4	-33.4			
Newtown Creek (NCG)	SD115	651512.5	689175.2	-10.7	16.3		-10.7	-27.0				
Newtown Creek (NCG)	SD128	651262.5	688501.0	-20.3	16.5		-20.3	-34.6	-34.6			
Newtown Creek (NCG)	SD129	651542.8	688016.8	-21.3	16.2		-21.3	-34.8	-34.8			
Newtown Creek (NCG)	SD141A&BCore	650780.9	689466.4	-20.6	6.9		-20.6	-27.5				
Newtown Creek (NCG)	SD146	651010.6	688916.9	-22.1	16.8	-35.1	-22.1	-35.1	-36.5			
Newtown Creek (NCG)	SD158A&BCore	650881.0	689143.5	-23.1	7.5		-23.1	-30.5				
Newtown Creek (NCG)	SD205	651100.0	688680.1	-17.7	16.6		-17.7	-30.5	-30.5			
Newtown Creek (NCG)	SD206	651176.1	688459.3	-18.3	15.7		-18.3	-30.5	-30.5			
Newtown Creek (NCG)	SD207	651273.6	688133.5	-17.0	16.0		-17.0	-30.9				
Newtown Creek (NCG)	SD211	651425.5	688259.8	-20.3	16.8	-29.8	-20.3	-29.8	-31.7			
Newtown Creek (NCG)	SD212	651581.7	688351.9	-2.8	15.9	-9.7	-2.8	-9.7	-10.1			
Newtown Creek (NCG)	NC066ASC	650754.4	689578.0	-13.0	19.0		-13.0	-13.0				
Newtown Creek (NCG)	NC069SC-A	650922.5	688980.3	-17.8	30.0		-17.8	-32.8				
Newtown Creek (NCG)	NC070ASC	651097.6	689044.9	-23.2	14.0		-23.2	-23.2				
Newtown Creek (NCG)	NC071ASC	651297.8	689068.2	-15.4	19.0		-15.4	-15.4				
Newtown Creek (NCG)	NC072SC-A	651162.0	688303.5	-18.1	19.0		-18.1	-27.8				
Newtown Creek (NCG)	NC075SC-A	651269.9	688060.8	-18.0	23.0		-18.0	-31.0				
Newtown Creek (NCG)	NC296SC-A	651058.8	688629.2	-20.0	22.0		-20.0	-34.0				
Newtown Creek (NCG)	NC298SC-A	651358.0	687849.4	-16.8	27.0		-16.8	-16.8				

General Notes:

1. Horizontal Coordinates in feet State Plane New York East, North American Datum 1983.
2. Elevations relative to North American Vertical Datum of 1988.
3. Blank or no data indicates strata not encountered, or boring terminated above respective stratum.

Table L2
Hydraulic Conductivity Measurements
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Well ID	Site	Screen Depth (ft. bgs)	Screen Top Elev. (ft. NAVD)	Screen Bot Elev. (ft. NAVD)	Avg Scrn elev.	K RH1	K RH2	K RH3	K FH1	K FH2	K Average	Reference
Fill												
GPEC-GT-3	GPEC	2 - 17	10.7	-4.3	3	0.024	NT	--	--	--	0.024	GEI (2016)
GPEC-GT-4S	GPEC	3 - 18	9.16	-5.84	2	5.1	6.9	--	--	--	6.0	GEI (2016)
GPEC-MW-221S	GPEC	8 - 18	6.79	-3.21	2	59.2	82.73	--	--	--	71.0	GEI (2017a)
GPEC-MW-222S	GPEC	2 - 12	11.89	1.89	7	7.8	7.7	--	--	--	7.8	GEI (2016)
GPEC-MW-339S	GPEC	3 - 13	11.8	1.8	7	1.33	0.3263	--	--	--	0.8	GEI (2017a)
GPE-MW-2S	GPEC	2 - 12	5.74	-4.26	1	19	27	--	--	--	23	GEI (2016)
OW3-90	PDRC	3 - 13	5	-5	0	>28.4	--	--	--	--	>28.4	CRA (1992)
OW7-90	PDRC	3 - 13	6	-4	1	0.21	--	--	0.24	--	0.2	CRA (1992)
W-8R	PDRC	3 - 13	5	-5	0	1.16	--	--	0.62	--	0.9	CRA (1992)
OW4-90	PDRC	(a)	(a)	(a)	NA	>28.4	--	--	--	--	>28.4	CRA (1992)
OW5-90	PDRC	(a)	(a)	(a)	NA	>28.4	--	--	--	--	>28.4	CRA (1992)
Upper Glacial Aquifer												
GPEC-MW-3S	GPEC	25 - 40	-18.09	-33.09	-26	3.2	2.8	--	5.2	5.6	4.2	GEI (2016)
GPEC-MW-5S	GPEC	28 - 38	-21.53	-31.53	-27	15	18	--	19	15	16.8	GEI (2016)
GPEC-MW-9	GPEC	10 - 25	6.42	-8.58	-1	230	120	--	NA	NA	175	GEI (2016)
GPEC-MW-103	GPEC	50 - 60	-42.67	-52.67	-48	25	24	--	25	33	26.8	GEI (2016)
GPEC-MW-218D	GPEC	95 - 105	-43.92	-53.92	-49	15.1	15.9	--	NT	NT	15.5	GEI (2017a)
GPEC-MW-218I	GPEC	75 - 85	-24.1	-34.1	-29	102	NT	--	52.31	NT	77.1	GEI (2017a)
GPEC-MW-333I	GPEC	30 - 40	-15.66	-25.66	-21	2.2	4.6	--	7.5	6	5.1	GEI (2016)
GPEC-MW-339I	GPEC	30 - 40	-15.08	-25.08	-20	88.7	74.8	--	NT	NT	81.8	GEI (2017a)
GPEC-MW-339D	GPEC	56 - 66	-40.78	-50.78	-46	12.2	20.6	--	NT	NT	16.4	GEI (2017a)
GPEC-GT-1S	GPEC	30 - 40	-18.9	-28.9	-24	0.12	3.25	--	NA	NA	1.69	GEI (2017a)
GPEC-GT-4D	GPEC	54 - 69	-41.88	-56.88	-49	53	50	--	54	NT	52.3	GEI (2016)
GPEC-GT-10D	GPEC	43 - 58	-34.95	-49.95	-42	9	13	--	6.7	7.2	9.0	GEI (2016)
MW003SC	NC	25 - 29.8	-14.1	-18.9	-17	0.82	1.02	--	1.25	1.53	1.16	AQ (2016)
MW004SC	NC	28.2 - 33	-15.5	-20.3	-18	5.39	6.52	--	4.82	5.95	5.67	AQ (2016)
MW005SC	NC	29.8 - 34.6	-15	-19.8	-17	10.8	14.7	--	8.50	10.8	11.2	AQ (2016)
MW006SC	NC	28.5 - 33.3	-11.3	-16.1	-14	1.19	1.45	--	1.98	2.44	1.76	AQ (2016)
MW-5	NC (Frito Lay)	7 - 17	6.8	-3.2	2	14.7	36.8	--	22.1	51.0	31.18	AQ (2016)
MW-6	NC (Frito Lay)	7.7 - 17.7	8	-2	3	25.8	56.7	--	NT	NT	41.24	AQ (2016)
NC056GWA	NC	10.9 - 15.9	-25.6	-30.6	-28	85	116	--	53.9	73.7	82.2	AQ (2016)
NC069GWA	NC	18.3 - 23.3	-36.1	-41.1	-39	36.8	51.02	--	48.2	65.2	50.31	AQ (2016)
OW1-90	PDRC	5 - 15	13	3	8	>28.4	--	--	--	--	>28.4	CRA (1992)
OW8-99	PDRC	17 - 27	13	3	8	145	--	--	--	--	145	CRA (2000)
OW10-99	PDRC	7.2 - 17.2	5.8	-4.2	1	94.8	65.4	--	--	--	80.1	CRA (2000)
OW11-99	PDRC	10.2 - 20.2	10.66	0.66	6	48.1	48.1	--	--	--	48.1	CRA (2000)
MW-9	ExxonMobil	18.1 - 33.5	7.51	-7.89	0	17.1	18.6	--	--	--	17.9	Roux (1991)
MW-14	ExxonMobil	18.3 - 33.7	11.2	-4.15	4	4.2	4.35	--	--	--	4.22	Roux (1991)
RW-A	ExxonMobil	NR	NR	NR	-16(b)	NA - Constant Rate Pump Test			--	--	188	Roux (2003)
RW-C	ExxonMobil	NR	NR	NR	-4(b)	NA - Constant Rate Pump Test			--	--	218	Roux (2003)
RW-26	ExxonMobil	43 - 73	-23.16	-53.16	-38	NA - Constant Rate Pump Test			--	--	96.0	Roux (2011)
Fine-Grained Native Material												
MW-1	ExxonMobil	8.2 - 23.6	4.46	-10.94	-3	--	--	--	--	--	9.88	
MW-2	ExxonMobil	2.74 - 22.94	4.78	-15.42	-5	--	--	--	--	--	2.33	
EB025GWA	NC	18.8 - 23.8	-24.6	-29.6	-27	0.31	0.43	--	0.48	0.68	0.47	AQ (2016)
EK098GWA	NC	15.5 - 20.5	-24.8	-29.8	-27	11.9	15.02	--	12.19	15.31	13.61	AQ (2016)
MC031GWA	NC	25.6 - 30.6	-28.4	-33.4	-31	0.79	1.13	--	0.85	1.22	1.00	AQ (2016)
OW2-99	PDRC	8 - 18	12	2	7	0.31	--	--	0.24	--	0.3	CRA (1992)
OW6-90	PDRC	25 - 30	-19.5	-24.5	-22	>28.4	--	--	--	--	>28.4	CRA (1992)
Dense Moraine												
GPE-MW-2D	GPEC	30.5 - 40.5	-22.87	-32.87	-28	12.5	10.13	--	NT	NT	11.3	GEI (2017)
GPE-MW-4D	GPEC	30 - 40	-22.59	-32.59	-28	0.11	NT	--	0.17	0.17	0.15	GEI (2016)
GPEC-MW-2	GPEC	20 - 35	-12.97	-27.97	-20	0.65	0.67	--	1.1	1	0.86	GEI (2016)
MW-4	ExxonMobil	14.5 - 29.6	9.29	-5.76	2	27.2	19.20	23.80	--	--	23.4	Roux (1991)
MW-18	ExxonMobil	29.2 - 44.1	13.5	-1.45	6	1.29	1.42	--	--	--	1.36	Roux (1991)

September 2019

C:\Users\laadinolfi\Desktop\temp local\GPEC\
Table L2 3D K measurements
Table 2

Table L2
Hydraulic Conductivity Measurements
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Well ID	Site	Screen Depth (ft. bgs)	Screen Top Elev. (ft. NAVD)	Screen Bot Elev. (ft. NAVD)	Avg Scrn elev.	K RH1	K RH2	K RH3	K FH1	K FH2	K Average	Reference
MW-19	ExxonMobil	20.5 - 35.3	17.57	2.77	10	0.08		--	--	--	0.077	Roux (1991)
MW-20	ExxonMobil	20.5 - 35.8	10.58	-4.72	3	2.06	2.26	--	--	--	2.16	Roux (1991)
MW-18	PDRC	17 - 37.1	6.6	-13.5	-3	6.80	10.49	--	7.94	11.62	9.21	
Clay Interbedding												
GPEC-MW-328I	GPEC	30 - 40	-18.14	-28.14	-23	7.50E-03	NT	--	6.90E-03	NT	7.20E-03	GEI (2016)
Gardiner's/Raritan Clay												
GPEC-GT-5D	GPEC	157 - 177	-144.78	-164.78	-155	4.71E-03		--	NT	NT	4.71E-03	GEI (2017)
MW-2D	GPEC	130 - 150	-72.98	-92.98	-83	1.01	1.006	--	NT	NT	1.01	GEI (2017)
Sediments												
DK052GWB	NC	2.4 - 7.4	-13.2	-18.2	-16	2.10	2.69	--	NT	NT	2.40	AQ (2016)
EB025GWB	NC	4.7 - 9.7	-10.5	-15.5	-13	3.40	4.54	--	3.12	4.25	3.83	AQ (2016)
EK098GWB	NC	4.7 - 6.7	-14	-16	-15	22.4	27.78	--	17.01	20.98	22.0	AQ (2016)
MC031GWB	NC	8.2 - 13.2	-11	-16	-14	0.09	0.12	--	0.12	0.15	0.12	AQ (2016)
NC056GWB	NC	3.4 - 8.4	-18.1	-23.1	-21	3.68	4.54	--	2.15	2.66	3.26	AQ (2016)
NC069GWB	NC	4.6 - 9.6	-22.5	-27.5	-25	1.28	1.67	--	0.96	1.28	1.30	AQ (2016)
NC320GWB	NC	8.1 - 13.1	-18.4	-23.4	-21	0.51	0.65	--	0.26	0.34	0.44	AQ (2016)

General Notes:

K = Hydraulic conductivity (horizontal) in units of feet per day.

FH, RH = Falling or Rising Head test used to measure hydraulic conductivity.

Footnotes:

- Well screen information not reported or available. Assumed fill because other OW-series wells screened across water table; and underlying material is fined-grained within general depth range of investigations.
- Well screen information not reported or available. Average screen elevation shown as being ~3 ft. below top of measured free product elevation 11/18/08.

References:

AQ (2016)	Interim Data Report,
CRA (1992)	Supplemental Remedial Program Final Report, Laurel Hill Site, Maspeth, New York, Conestoga-Rovers & Associates, March 1992.
CRA (2000)	Preliminary Site Assessment Report, Operable Units Nos. 2, 3, 4, and 5, Laurel Hill Site, Maspeth, New York, Conestoga-Rovers & Associates, March 1992.
GEI (2017a)	Data Report
GEI (2016)	Interim Data Report, Phases 1&2, Greenpoint Energy Center, 287 Maspeth Avenue, Brooklyn, New York 11211, Site #224052, GEI Consultants, Inc., November 2016.
Roux (2003)	Supplemental Investigation of the Off-Site Free Product Plume, Off-Site Free Product Recovery System, ExxonMobil Refining & Supply Company, Greenpoint, Roux Associates, Inc., January 24, 2003.
Roux (2011)	Recovery Well RW-26 Aquifer Test Report, ExxonMobil Greenpoint, Petroleum Remediation Project, Greenpoint, Brooklyn, New York, Roux Associates, Inc., April 19, 2011.

Table L3
Model Hydraulic Conductivity Zones
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Stratigraphic Unit	Hydraulic Conductivity (ft./day)				Anisotropy Ratio Used in Model	Literature Value for Soil Type
	Horizontal Used in Model	Vertical Used in Model	Slug Test Results (See Table 2)	Published USGS Regional (b)		
Fill	See Below	See Below	0.024 - 71		--	0.5 - 50
Fill 1 / Basin	2	0.2			10:1	
Subunit 1	0.1	0.05			10:1	
Subunit 2	0.5	0.1			10:1	
Marsh Deposits	0.1	0.001			10:1	10 ⁻⁶ - 1.0 (e)
Creek sediment	3	0.3	0.12 - 22		10:1	
Upper Glacial Aquifer	80	30	0.5 - 218	20-270 (a,b)	5:1	3 - 300 (d)
Fine-Grained Material near Cree	20	2				
Basin at ExxonMobil	250	25				
Clay beds	0.05	0.05	0.0069			
Gardiner's/Raritan Clay	Inactive	Inactive	4.7E-3 - 1.01(c)	0.001-0.0029 (b)	1:1	10 ⁻⁶ - 0.005 (f)
Sand Fringe					10:1	0.1 - 20
Dense Moraine	10	5	0.077 - 23.4			
Subunit 1	0.012	0.012				
Subunit 2	0.4	0.08				

- a. Misut and Monti (1999) reports 28-80 ft./d (moraine) and 200-300 ft./d (outwash). Buxton and Smolensky (1998) reports 200 - 270 ft./d for outwash south of moraines, and less than 135 ft./d for moraine deposits.
- b. Misut and Monti, 1999.
- c. Higher result of 1.01 ft./d attributed to sand lens in clay/silt unit.
- d. Reported by Fetter (1994) for glacial outwash.
- e. Published range for silt and clay (Anderson, 1992).
- f. Published range for clay (Anderson, 1992).

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
Calibration Wells																									
GPEC	GPEC-MW-1R	7.63	-46.99	651250	687751	GEI (2016)			1.14	0.30	1.55	-	-	-	-	-	-	1.55	-	1.40	0.30	--	--	1.31	
GPEC	GPEC-MW-1D	7.16	-57.62	651250	687751	GEI (2016)			1.29	1.29	1.29	-	-	NM	NM	NM	NM	NM	NM	--	--	--	--	1.29	1.29
GPEC	GPEC-MW-2	7.45	-22.97	651144	688036	GEI (2016)			1.76	1.14	2.42	-	-	2.03	1.69	1.55	1.93	1.14	2.37	2.42	1.38	--	--	1.31	
GPEC	GPEC-MW-2D	6.77	-77.79	651144	688036	GEI (2016)			1.33	0.88	1.77	-	-	-	-	-	-	0.88	1.77	--	--	--	--	NM	
GPEC	GPEC-MW-3WT	6.01	-1.74	651075	688297	See note b			1.28	-0.44	3.00	1.28	-	-	-	-	-	-	-	--	--	NM	NM	NM	
GPEC	GPEC-MW-3S	6.35	-28.09	651075	688297	GEI (2016)			0.95	-1.83	2.46	-	-	2.30	2.22	2.18	-1.83	0.70	-1.32	2.46	0.53	--	--	1.29	
GPEC	GPEC-MW-3D	6.42	-93.13	651075	688297	GEI (2016)			1.53	-0.08	2.85	-	-	2.85	2.40	1.91	-0.05	1.21	-0.08	2.44	1.57	--	--	NM	
GPEC	GPEC-MW-4	8.72	-53.19	650941	688533	GEI (2016)			2.00	1.00	4.49	-	-	2.33	2.33	2.40	1.00	1.16	1.27	4.49	1.71	1.37	--	1.91	
GPEC	GPEC-MW-4D	9.24	-88.93	650941	688533	GEI (2016)			1.72	1.48	1.95	-	-	-	-	-	-	-	--	--	--	1.48	--	1.95	
GPEC	GPEC-MW-5S	9.02	-28.10	650750	688982	GEI (2016)			2.06	1.43	2.62	-	-	2.62	2.45	2.37	1.57	1.43	2.01	2.31	1.91	--	--	1.74	2.16
GPEC	GPEC-MW-5D	9.61	-68.19	650750	688982	GEI (2016)			2.02	1.49	2.61	-	-	2.61	2.46	2.39	1.59	1.49	1.52	2.37	1.95	--	--	1.82	
GPEC	GPEC-MW-6	12.04	-5.68	650800	687871	GEI (2016)			1.76	1.28	2.13	-	-	2.01	2.03	1.72	1.43	1.43	1.28	2.13	2.01	--	--	NM	
GPEC	GPEC-MW-7D	6.9	-81.66	650778	688126	GEI (2016)			2.19	0.88	3.91	-	-	3.91	2.42	1.90	0.88	--	--	2.15	1.85	--	--	NM	
GPEC	GPEC-MW-8	8.09	-49.29	650559	688452	GEI (2016)			1.59	-0.92	2.46	-	-	2.46	2.41	2.14	1.40	1.67	1.24	2.28	-0.92	--	--	1.65	
GPEC	GPEC-MW-9	15.96	-1.08	650269	688506	GEI (2016)			2.08	1.57	2.63	-	-	2.54	2.63	2.20	2.14	1.60	1.60	2.21	2.19	--	--	1.57	
GPEC	GPEC-MW-10	13.16	-36.55	650394	687735	GEI (2016)			1.74	1.23	2.12	-	-	2.12	2.12	1.71	--	1.50	1.23	--	--	--	--	NM	
GPEC	GPEC-MW-11	13.14	-29.39	650054	687966	GEI (2016)			2.01	1.49	2.38	-	-	2.35	2.38	1.92	1.86	1.49	1.92	2.32	2.27	--	--	1.62	
GPEC	GPEC-MW-11D	13.08	-71.53	650054	687966	GEI (2016)			1.91	1.63	2.29	-	-	--	--	--	--	1.63	1.68	2.18	2.29	--	--	1.75	
GPEC	GPEC-MW-12	16.34	-1.37	649520	687767	GEI (2016)			6.00	5.28	6.97	-	-	6.38	6.23	5.45	6.13	5.28	5.31	6.14	6.15	--	--	6.97	
GPEC	GPEC-MW-101WT	12.18	-0.46	650829	687716	GEI (2016)			1.50	0.97	2.24	-	-	--	--	--	--	1.14	0.97	2.24	1.79	--	--	1.35	
GPEC	GPEC-MW-101I	12.02	-57.63	650829	687716	GEI (2016)			1.48	0.59	2.25	-	-	-	-	-	-	1.40	0.59	2.25	1.75	--	--	1.41	
GPEC	GPEC-MW-101D	12.14	-91.88	650829	687716	GEI (2016)			1.90	0.58	3.70	-	-	-	-	-	-	1.49	0.58	2.06	1.69	--	--	3.70	
GPEC	GPEC-MW-102D	9.15	-80.51	651026	687528	GEI (2016)			1.32	-0.06	2.32	-	-	-	-	-	-	1.65	-0.06	2.32	1.35	--	--	1.35	
GPEC	GPEC-MW-103	7.07	-47.67	651252	687797	GEI (2016)			1.39	0.12	2.40	-	-	-	-	-	-	0.12	1.77	2.40	1.21	--	--	1.43	-
GPEC	GPEC-MW202	9.14	-4.72	651061	687656	GEI (2016)			1.82	1.43	2.18	-	-	-	-	-	-	1.43	1.49	2.18	2.15	--	--	1.87	-
GPEC	GPEC-SB/MW205	7.86	-60.70	651230	687861	GEI (2016)			1.79	1.56	2.01	-	-	-	-	-	-	2.01	-	-	-	--	--	1.56	-
GPEC	GPEC-MW217I	21.21	-13.30	650066	688826	GEI (2016)			1.75	1.48	2.15	-	-	-	-	-	-	1.49	1.48	2.14	2.15	--	--	1.51	-
GPEC	GPEC-MW217D	21.33	-48.17	650066	688826	GEI (2016)			1.77	1.47	2.16	-	-	-	-	-	-	1.52	1.47	2.16	2.16	--	--	1.53	-
GPEC	GPEC-MW218I	53.23	-29.10	649215	688778	GEI (2016)			1.69	1.46	2.04	-	-	-	-	-	-	1.47	1.46	2.01	2.04	--	--	1.47	-
GPEC	GPEC-MW218D	53.58	-48.92	649215	688778	GEI (2016)			1.68	1.45	2.02	-	-	-	-	-	-	1.45	1.45	2.01	2.02	--	--	1.45	-
GPEC	GPEC-MW219S	41.86	1.00	648863	688280	GEI (2016)			1.72	1.71	1.72	-	-	-	-	-	-	1.72	1.71	--	--	--	--	--	-
GPEC	GPEC-MW219I	42.11	-25.54	648863	688280	GEI (2016)			1.71	1.70	1.71	-	-	-	-	-	-	1.71	1.70	--	--	--	--	--	-
GPEC	GPEC-MW219D	42.18	-55.50	648863	688280	GEI (2016)			1.73	1.71	1.75	-	-	-	-	-	-	1.75	1.71	--	--	--	--	--	-
GPEC	GPEC-MW220S	21.56	2.03	648650	687490	GEI (2016)			2.17	1.93	2.42	-	-	-	-	-	-	2.05	2.04	2.40	2.42	--	--	1.93	-
GPEC	GPEC-MW220I	21.64	-23.02	648650	687490	GEI (2016)			2.16	1.94	2.42	-	-	-	-	-	-	2.02	2.02	2.40	2.42	--	--	1.94	-
GPEC	GPEC-MW220D	21.58	-53.13	648650	687490	GEI (2016)			2.17	1.94	2.44	-	-	-	-	-	-	2.02	2.04	2.43	2.44	--	--	1.94	-
GPEC	GPEC-MW221S	14.28	1.79	649594	687637	GEI (2016)			6.28	6.03	6.64	-	-	-	-	-	-	6.03	6.03	6.36	6.36	--	--	6.64	-
GPEC	GPEC-MW221I	14.32	-35.28	649594	687637	GEI (2016)			1.89	1.53	2.28	-	-	-	-	-	-	1.74	1.53	2.28	2.22	--	--	1.70	-
GPEC	GPEC-MW221D	14.06	-70.34	649594	687637	GEI (2016)			1.94	1.59	2.32	-	-	-	-	-	-	1.79	1.59	2.32	2.25	--	--	1.75	-
GPEC	GPEC-MW222S	13.56	6.89	649231	686982	GEI (2016)			9.27	8.35	12.65	-	-	-	-	-	-	8.35	8.37	8.44	8.53	--	--	12.65	-
GPEC	GPEC-MW222D	13.35	-6																						

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
GPEC	GPEC-GT-1	10.72	-23.90	649683	687043	GEI (2016)			1.44	0.71	3.45	-	-	-	-	3.45	0.75	0.77	0.71	1.68	1.77	--	--	0.97	-
GPEC	GPEC-GT01S	11.43	1.46	649683	687043	GEI (2016)			6.45	6.45	6.45	-	-	-	-	-	-	-	-	--	--	--	--	6.45	-
GPEC	GPEC-GT-3	14.35	0.70	650008	687153	GEI (2016)			8.37	7.47	9.64	-	-	-	-	7.47	9.09	7.53	-	8.2	8.26	--	--	9.64	-
GPEC	GPEC-GT-4S	11.75	-0.84	650302	687258	GEI (2016)			4.58	4.13	4.88	-	-	-	-	4.57	4.88	4.13	4.23	4.81	4.87	--	--	NM	-
GPEC	GPEC-GT-4D	11.79	-51.88	650302	687258	GEI (2016)			1.18	-0.07	2.03	-	-	-	-	1.57	-0.07	1.63	0.75	2.03	1.83	--	-	0.50	-
GPEC	GPEC-GT-5	11.75	-0.46	650386	687283	GEI (2016)			2.79	0.96	4.26	-	-	-	-	3.78	2.86	1.06	0.96	4.26	4.2	--	-	3.58	1.59
GPEC	GPEC-GT5I	11.94	-22.74	650386	687283	GEI (2016)			1.24	1.17	1.31	-	-	-	-	-	-	-	-	--	--	1.17	-	1.31	-
GPEC	GPEC-GT-7	12.08	-27.56	650765	687412	GEI (2016)			1.48	0.91	2.15	-	-	-	-	1.68	0.91	1.59	0.94	2.15	1.82	--	-	1.30	-
GPEC	GPEC-GT-10S	9.16	-5.42	651251	687626	GEI (2016)			1.46	1.21	1.73	-	-	-	-	1.45	1.73	1.21	-	--	--	--	-	-	-
GPEC	GPEC-GT-10	7.70	-44.95	651251	687626	GEI (2016)			-0.04	-2.62	1.42	-	-	-	-	1.42	-0.92	-0.50	-	-2.62	1.03	--	-	1.32	-
GPEC	GPEC-SIS-2	13.61	0.97	650729	687839	GEI (2016)			1.66	0.84	2.48	-	-	-	-	1.70	1.48	1.34	0.84	2.13	2.48	--	-	-	-
GPEC	GPEC-SIS-6	10.61	1.10	649915	687221	GEI (2016)			6.71	5.89	7.73	-	-	-	-	7.37	7.73	5.92	5.89	--	--	--	-	6.65	-
GPEC	GPEC-SIS-7	11.37	4.70	649940	687151	GEI (2016)			8.64	8.23	9.05	-	-	-	-	8.23	9.05	-	-	--	--	--	-	-	-
GPEC	GPEC-SIS-8	11.45	5.77	649956	687112	GEI (2016)			9.38	8.47	10.28	-	-	-	-	8.47	10.28	-	-	--	--	--	-	-	-
GPEC	GPEC-SIS101S	11.28	3.01	649869.7	687064.9	GEI (2016)			4.70	4.10	5.00	-	-	-	-	-	-	-	-	--	--	4.7	-	-	-
GPEC	GPEC-SIS102S	11.73	3.45	649876.5	687054.8	GEI (2016)			4.30	3.70	4.60	-	-	-	-	-	-	-	-	--	--	4.3	-	-	-
GPEC	GPEC-SIS102I	11.75	-4.51	649876.5	687054.8	GEI (2016)			4.16	3.60	4.50	-	-	-	-	-	-	-	-	--	--	4.16	-	-	-
GPEC	GPEC-SIS103S	11.34	0.14	650430.7	687257.8	GEI (2016)			2.70	1.70	3.00	-	-	-	-	-	-	-	-	--	--	2.7	-	-	-
GPEC	GPEC-SIS104S	11.58	0.36	650430.4	687247.9	GEI (2016)			1.51	0.00	1.70	-	-	-	-	-	-	-	-	--	--	1.51	-	-	-
GPEC	GPEC-SIS104I	11.56	-6.14	650430.4	687247.9	GEI (2016)			1.50	0.10	1.80	-	-	-	-	-	-	-	-	--	--	1.5	-	-	-
GPEC	GPE-MW-1S	24.27	3.58	650044	689231	GEI (2016)			1.86	1.36	2.58	-	1.82	NM	2.58	2.15	2.01	1.40	1.38	2.02	2.02	-	-	1.36	-
GPEC	GPE-MW-1D	24.33	-26.02	650044	689231	GEI (2016)			1.92	1.40	2.59	-	1.95	NM	2.59	2.13	1.76	1.40	1.88	2.03	2.03	-	-	1.47	-
GPEC	GPE-MW-2S	6.97	0.74	650599	689369	GEI (2016)			3.48	2.69	4.70	-	2.69	4.70	3.98	3.04	4.16	2.78	2.90	3.48	3.57	-	-	3.44	3.55
GPEC	GPE-MW-2D	7.01	-31.40	650599	689369	GEI (2016)			3.44	2.75	4.33	-	2.75	4.33	4.19	3.20	4.24	2.87	2.91	3.40	3.35	-	-	3.13	-
GPEC	GPE-MW-3S	6.67	0.34	650633	689305	GEI (2016)			3.22	2.49	4.39	-	2.49	4.39	3.57	2.86	4.04	2.69	2.65	3.13	3.13	-	-	-	-
GPEC	GPE-MW-3D	6.79	-29.70	650633	689305	GEI (2016)			2.22	1.86	2.69	-	1.86	2.69	2.52	2.53	1.92	1.95	2.10	2.37	2.02	-	-	-	-
GPEC	GPE-MW-4S	6.95	0.25	650666	689240	GEI (2016)			3.17	2.48	4.36	-	2.48	4.36	3.55	2.84	4.01	2.67	2.61	3.12	3.12	-	-	2.93	-
GPEC	GPE-MW-4D	7.01	-27.00	650666	689240	GEI (2016)			2.93	2.15	3.87	-	2.15	3.87	3.26	2.77	3.61	2.72	2.47	2.94	2.82	-	-	2.66	-
Varick Street	MW-2	59.28	5.78	648815	688815	GEI (2016)			1.95	1.37	2.73	-	2.08	2.43	2.73	2.25	1.94	1.39	1.39	1.92	2.02	-	-	1.37	1.94
Varick Street	PZ-1	55.08	2.58	649064	688844	GEI (2016)			1.92	1.43	2.77	-	2.09	NM	2.77	2.28	1.92	1.43	1.44	1.95	1.96	-	-	1.43	-
Varick Street	PZ-2	8.40	-10.14	650801	689057	GEI (2016)			0.86	0.53	1.19	-	-	-	-	-	0.53	1.19	--	--	-	-	-	-	-
Ditmas	W-1	11.51	-0.41	650603	687377	GEI (2016)			1.24	0.37	2.04	-	0.91	1.49	1.47	1.27	0.74	0.87	0.37	2.04	2.00	-	-	1.26	-
Ditmas	W-2	12.29	0.29	650641	687389	GEI (2016)			1.58	1.15	2.06	-	1.34	1.89	1.91	1.63	1.19	1.27	1.15	2.06	2.02	-	-	1.29	-
Ditmas	DMW-10/W-3	10.81	2.09	650490	687237	GEI (2016)			1.38	1.00	1.65	-	1.00	NM	1.65	1.40	-	1.39	1.44	--	--	-	-	-	-
Ditmas	DMW-8/W-4	11.27	1.55	650564	687264	GEI (2016)			2.30	1.94	2.54	-	1.94	2.45	2.54	2.25	-	-	-	--	--	-	-	-	-
Ditmas	DMW-2	11.71	-0.09	650764	687217	CEUS (2012)			4.11	2.77	4.94	4.11	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-5	7.70	1.88	651101	687027	CEUS (2012)			0.81	-0.06	3.54	0.81	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-6	11.48	5.18	650813	687063	CEUS (2012)			5.35	3.41	7.48	5.35	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-7A	11.34	8.50	650584	687112	CEUS (2012)			6.79	5.36	9.61	6.79	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-20	11.24	1.30	650543	687307	CEUS (2012)			1.79	0.91	5.00	1.79	-	-	-	-	-	-	-	-	-	-	-	-	-
Ditmas	DMW-21	11.02	1.34	650763	687383	CEUS (2012)			1.74	0.10	4.61</														

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
Equity	MW-4A	12.25	4.75	649389	686652	AECOM (2017)			5.40	5.40	5.58	5.40	-	-	-	-	5.40	-	-	-	-	-	-	-	-
Equity	MW-4B	12.47	-22.50	649389	686652	AECOM (2017)			0.02	-0.66	0.66	0.02	-	-	-	-	0.37	-0.31	0.00	-	-	-	-	-	-
Equity	MW-4C	12.03	-68.00	649389	686652	AECOM (2017)			0.85	-0.02	2.08	0.85	-	-	-	-	1.63	0.94	-0.02	-	-	-	-	-	-
Equity	MW-5A	14.14	4.14	649165	686581	AECOM (2017)			5.65	5.65	5.83	5.65	-	-	-	-	5.65	-	-	-	-	-	-	-	-
Equity	MW-5B	14.19	-16.30	649165	686581	AECOM (2017)			0.64	0.64	0.87	0.64	-	-	-	-	0.64	-	-	-	-	-	-	-	-
Equity	MW-6A	12.85	2.85	648864	686667	AECOM (2017)			5.56	5.02	6.06	5.56	-	-	-	-	5.65	5.37	5.43	-	-	-	-	5.79	-
Equity	MW-6B	12.50	-22.50	648864	686667	AECOM (2017)			1.07	0.65	1.39	1.07	-	-	-	-	0.65	1.32	1.06	-	-	-	-	1.24	-
Equity	MW-11B	10.66	-26.20	649556	686593	AECOM (2017)			0.17	-0.46	0.91	0.17	-	-	-	-	-	0.15	0.19	-	-	-	-	-	-
Equity	MW-11C	10.48	-84.52	649556	686593	AECOM (2017)			1.28	0.63	2.13	1.28	-	-	-	-	-	1.95	0.6	-	-	-	-	-	-
Equity	MW-16A	11.36	-1.14	649848	686638	AECOM (2017)			1.60	1.08	2.13	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-16B	11.09	-31.18	649848	686638	AECOM (2017)			0.71	0.07	1.05	0.71	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-16C	11.10	-91.18	649848	686638	AECOM (2017)			1.86	1.20	2.39	1.86	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-19A	9.65	-8.04	649502	686299	AECOM (2017)			4.91	4.75	5.07	4.91	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-19B	9.39	-23.10	649502	686299	AECOM (2017)			0.87	0.58	1.16	0.87	-	-	-	-	-	-	-	-	-	-	-	-	-
Equity	MW-19C	9.43	-73.10	649502	686299	AECOM (2017)			1.97	1.67	2.26	1.97	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EB025GW	5.70	-27.10	651770	685623	AQ(2016) Table F3-4			2.40	0.97	3.50	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EB025GW	5.70	-11.00	651770	685623	AQ(2016) Table F3-4			0.51	-2.40	3.10	0.51	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EK098GWA	5.80	-27.30	649582	684650	AQ(2016) Table F3-4			-0.30	-3.80	3.10	-0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	EK098GWB	5.50	-10.00	649582	684650	AQ(2016) Table F3-4			-0.20	-3.60	2.90	-0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MC031GWA	6.50	-27.20	652544	689039	AQ(2016) Table F3-4			0.15	-3.10	3.40	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MC031GWB	4.10	-5.00	652544	689039	AQ(2016) Table F3-4			0.02	-2.90	3.20	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC056GWA	5.30	-28.10	648916	690983	AQ(2016) Table F3-4			-0.69	-1.90	0.38	-0.69	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC056GWB	5.40	-21.10	648916	690983	AQ(2016) Table F3-4			-0.33	-2.90	3.40	-0.33	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC069GWA	6.40	-38.60	650915	688968	AQ(2016) Table F3-4			2.00	2.00	0.92	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	NC069GWB	6.60	-25.00	650915	688968	AQ(2016) Table F3-4			-0.16	0.92	2.80	-0.16	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW003SC	10.80	-16.50	651829	685358	AQ(2016) Table F3-4			1.70	0.71	2.60	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW004SC	12.40	-17.90	651831	685041	AQ(2016) Table F3-4			2.60	0.58	3.50	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW005SC	14.50	-17.40	652765	688840	AQ(2016) Table F3-4			4.40	4.00	4.80	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Newtown Creek	MW006SC	16.90	-13.70	653176	688659	AQ(2016) Table F3-4			5.20	4.80	5.50	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Frito Lay)	MW-5	13.80	1.80	649526	684673	AQ(2016) Table F3-4			2.00	-0.09	3.70	2	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Frito Lay)	MW-6	15.70	3.00	649352	684606	AQ(2016) Table F3-4			4.90	3.80	5.70	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Waste Mgmt)	MW-18	23.60	-5.60	649009	691253	AQ(2016) Table F3-4			2.60	2.00	4.30	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
NC (Waste Mgmt)	MW-19	24.90	-1.90	649093	691426	AQ(2016) Table F3-4			3.10	2.90	3.30	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	K 889. 1	-	-53	648557	684189	NYSDEC (1937-1947)			3.40	2.2	5.0	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	Q 3809. 1	-	-4.5	652732	693324	NYSDEC (1937-1947)			10.80	8.5	13.0	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	K 3260.2	-	-11.3	646601	689034	NYSDEC (1937-1947)			9.40	8.2	12.6	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-
USGS	Q 1391.1	-	-85	656010	686768	NYSDEC (1937-1947)			13.40	13.0	15.8	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon	CMW-29D	-	-50	648923	690466	AQ(2016) Table F-E-2			-2.10	-2.60	-1.20	-2.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon	CMW-34D	-	-50	648417	690716	AQ(2016) Table F-E-2			-2.90	-3.30	-2.00	-2.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Paragon	CMW-41D	-	-50	648080	691030	AQ(2016) Table F-E-2			-0.90	-2.30	0.20	-0.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Meeker	DEC-006D	-	-50	648591	688629	AQ(2016) Table F-E-2			2.40	2.4	2.4	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Meeker	DEC-031	-	-10	648348	687862	AQ(2016) Table F-E-2			2.60	2.6	2.6	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Meeker	DEC-042	-	-10	648183	688606	AQ(2016) Table F-E-2			2.50	2.5	2.5	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	OW2R-07	-	-19.6	651883	690055	AQ(2016) Table F-E-2			7.40	6.3	7.7	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	OW11R-07	-	-10.7	650968	691234	AQ(2016) Table F-E-2			7.10	6.8	7.7	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	PDW-18	-	-10	651035	689898	AQ(2016) Table F-E-2			2.10	1.4	3.0	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-
PDRC	PMW-1A	-	-10	650648	690423	AQ(2016) Table F-E-2			0.																

Table L4 - Calibration Data Set
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

Site Area	Well ID	Riser Elev.	Screen Elev. For Modflow	Easting(a)	Northing(a)	Source	Computed Head	Calibration Residual	Calibration Value GW Elev.	Groundwater Elevation Measurements															
										Minimum	Maximum	Non Date-Specific(b)	3/18/09	6/6/09	7/14/09	9/21/09	12/11/09	12/12/12 (AM)	12/12/12 (PM)	10/9/15 HT	10/9/15 LT	2/22-3/4/17	3/8/17	3/29/17	5/10/17
EMGPRP	MW-124I	-	-10	647353	690701	Roux (2013-2016)			-3.60	-7.00	-2.60	-3.6	-	-	-	-	-	-	-	-	-	-	-	-	-
EMGPRP	MW-130	-	-10	646064	690391	Roux (2013-2016)			4.70	3.00	5.30	4.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Gardiner's/Raritan Clay																									
GPEC	GPEC-MW5D2	10.01	-153.19	650750	688982				-0.34			-	-	-	-	-	-	-	-	-	-	-	-	-0.37	-0.30
GPEC	GPEC-GT5D	11.81	-154.78	650386	687283				-1.70			-	-	-	-	-	-	-	-	-	-1.66	-	-1.92	-1.52	
GPEC(LNG)	GPE-MW2D2	6.97	-102.48	651144	688036				1.27			-	-	-	-	-	-	-	-	-	-	-	0.98	1.56	
Varick Street	MW-2D	59.6	-82.98	648815	688815				0.87			-	-	-	-	-	-	-	-	-	0.56	-	0.71	1.34	
Not Representative																									
GPEC	GPEC-MW217S	21.11	12.44	650066	688826				9.18			-	-	-	-	-	-	9.17	9.19	-	-	-	-	-	-

- Notes:**
1. Elevations are in feet relative to North American Vertical Datum of 1988.
2. Easting and northing coordinates in feet relative to North American Datum of 1983, New York State East.

- Footnotes:**
a. For model purposes, identical coordinates used for wells in same cluster.
b. Calibration values based on averaged values from tidal monitoring (Anchor 2016); long-term USGS reporting; and averaged quarterly readings 2013-2015 at ExxonMobil (Roux 2015, 2015, and 2016).
 Tidal monitoring (Anchor 2016)
 Long-term USGS reporting
 Quarterly gauging 2013-2015 (Roux 2014, 2015, 2016)
 Equity MGP (7/31/13 and 7/16/15 for MW-19 cluster and 7/31/13, 7/16/15, and 12/4/15 for MW-16 cluster)
 Ditmas (2005-2012 quarterly); BCF Oil (various events 2007-2009).
 GPEC (Well not gauged on synoptic dates; measurements during interim gauging and sampling used).
c. Italicized elevations shown for Equity site taken on same day as measurements at GPEC. Average for those wells used for calibration includes other dates not shown per note above.

We could conservatively assume that this is the lateral flow above the mudline that would be equal to Anchor's estimate of 33% lateral discharge. But more likely, most of this discharge is through the mudline due to the permeable nature of the shoreline (i.e., not a VPS).

Table L5 - Flow Model Mass Balance
Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

	Water Balance			Pct. Of Subtotal
	MGD	GPM	FT ³ /D	
I. Full Model				
a. Sources				
Constant Head Cells Into Model	1.3	919.6	177,023	55.8%
Recharge Into Model	1.05	727	140,025	44.2%
Total Into Model	2.37	1647	317,048	100.0%
b. Sinks				
Constant Head Cells Out of Model	1.31	908	174,838	55.1%
Drains Out of Model	0.006	4.5	866	0.3%
Wells Out of Model	1.06	734	141,345	44.6%
Total Out of Model	2.37	1647	317,049	100.0%
c. % Error (sources - sinks) (b)			-0.00032%	
d. Creek Budget				
Induced Infiltration from Creek (from pumping)	0.76	530	102,070	NA
Net Discharge to Creek	1.27	885	170,390	NA
II. Flow Specific to Greenpoint Energy Center (d)				
a. Entering GPEC				
Recharge	0.07	49.0	9,423	72.6%
UGA flow entering site from west of GPEC	0.02	15.8	3,035	23.4%
Flow entering or returning to GPEC from eastern end of Maspeth Ave.	0.004	2.7	521	4.0%
Total Into GPEC	0.10	67.4	12,979	100.0%
b. Leaving GPEC				
Southern - Offsite flow along Maspeth Ave.	0.023	15.9	3,068	23.7%
Eastern - Offsite flow along Newtown Creek shoreline (Shallow)	0.010	6.7	1,290	10.0%
Eastern - Offsite flow along Newtown Creek shoreline (Intermediate/Deep)	0.031	21.8	4,188	32.3%
Northern - Offsite flow along northern property line	0.033	22.9	4,413	34.1%
Total Out of GPEC	0.097	67	12,959	100.0%
c. Maspeth Ave. utility infiltration	0.0065	4.50	866	NA

Notes:

- Flow calculated by Modflow using Mass Balance and Zone Budget.
- Percent Error shown for difference between model-calculated total flow in and total flow out, for check of numeric mass balance calculation.
- Values shown for comparative purposes; they do not need to balance.
- Total flow on and off-site differ slightly due to computed occurrence of localized areas of parallel or reverse flow across zones, and does not indicate model error.

MGD Million gallons per day

GPM Gallons per minute

FT³/D Cubic feet per day

Figures

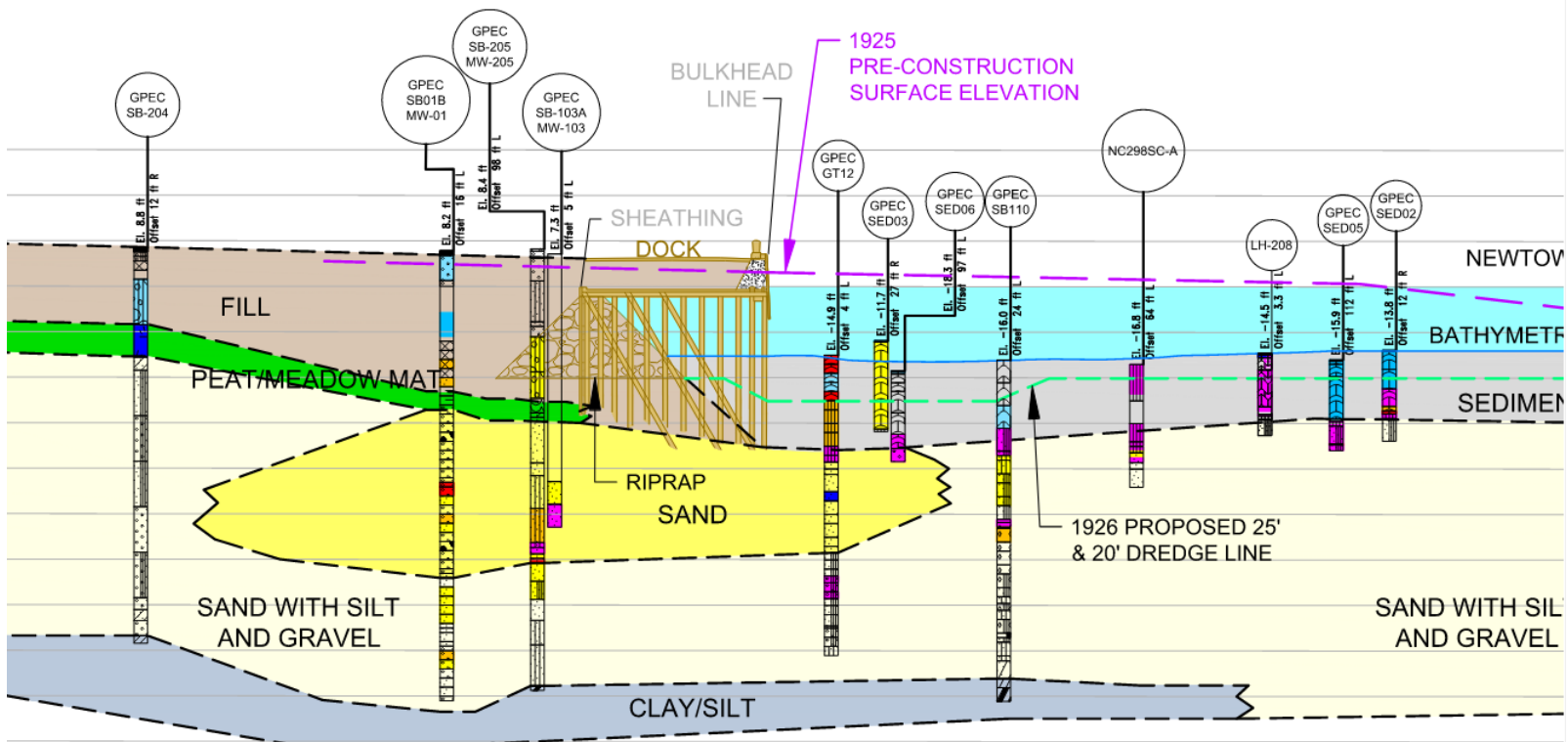
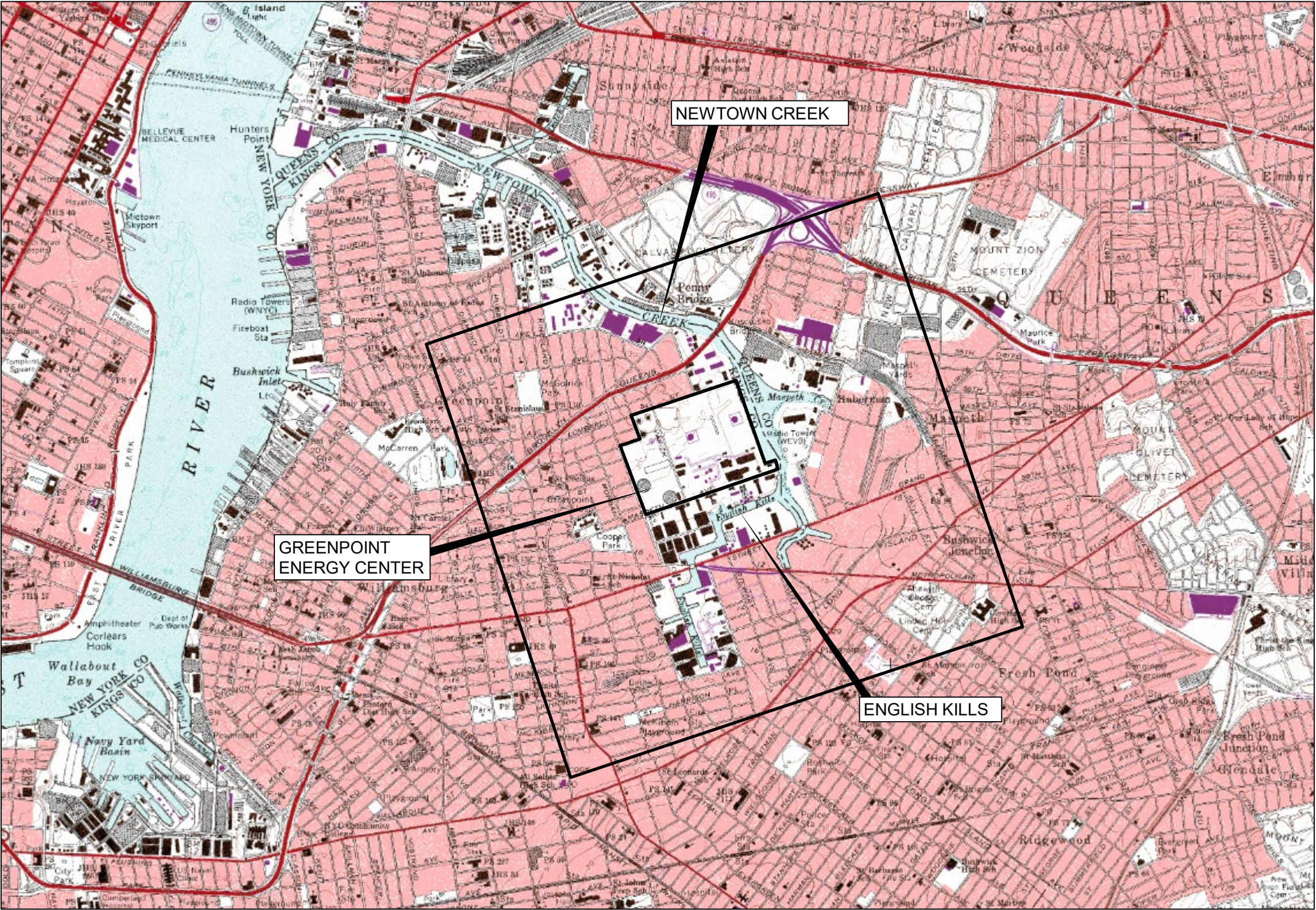


Figure 17: Subsurface Profile C from
Greenpoint RI Report



DRAFT



LEGEND



GROUNDWATER
MODEL LIMIT



SCALE, MILES

SOURCE:

UNITED STATES GEOLOGICAL SURVEY, BROOKLYN, N.Y. QUADRANGLE,
1967, PHOTOREVISED 1979.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



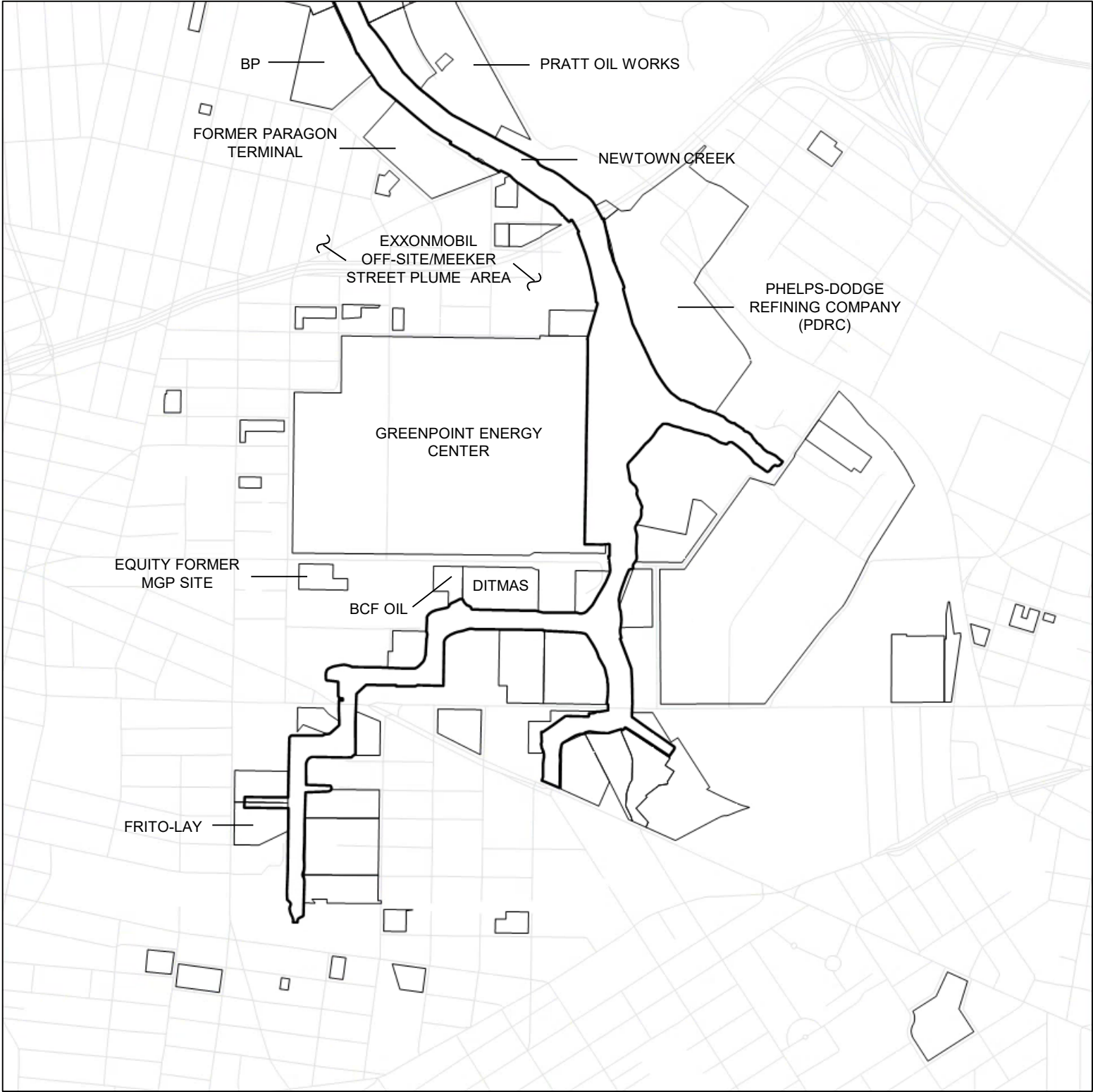
Project 125180

SITE LOCATION

September 2019

Figure L1-1

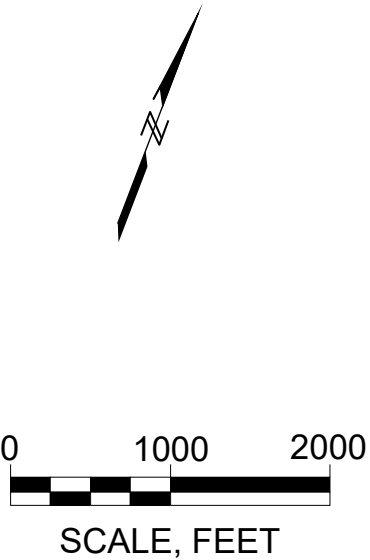
DRAFT



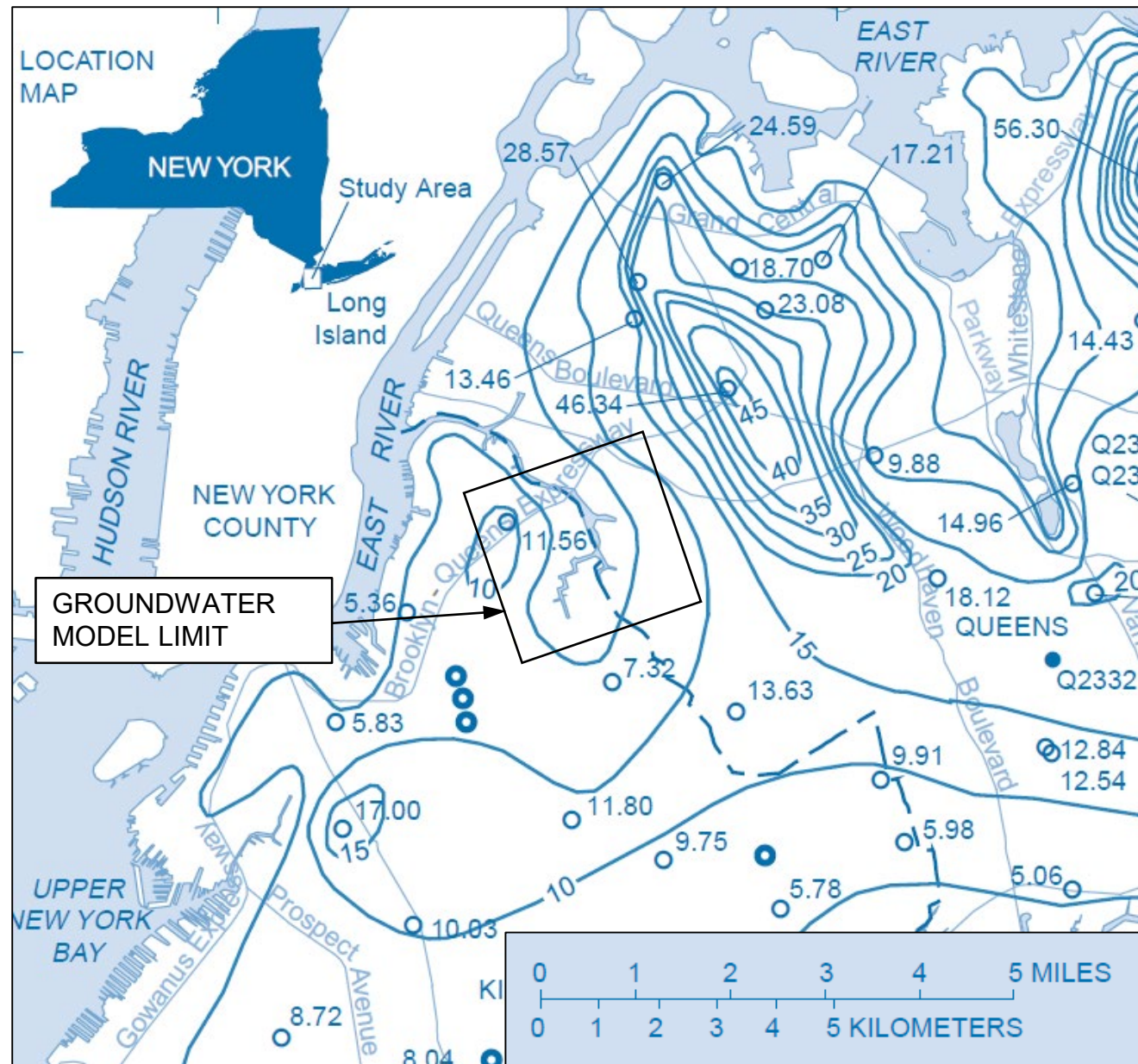
LEGEND



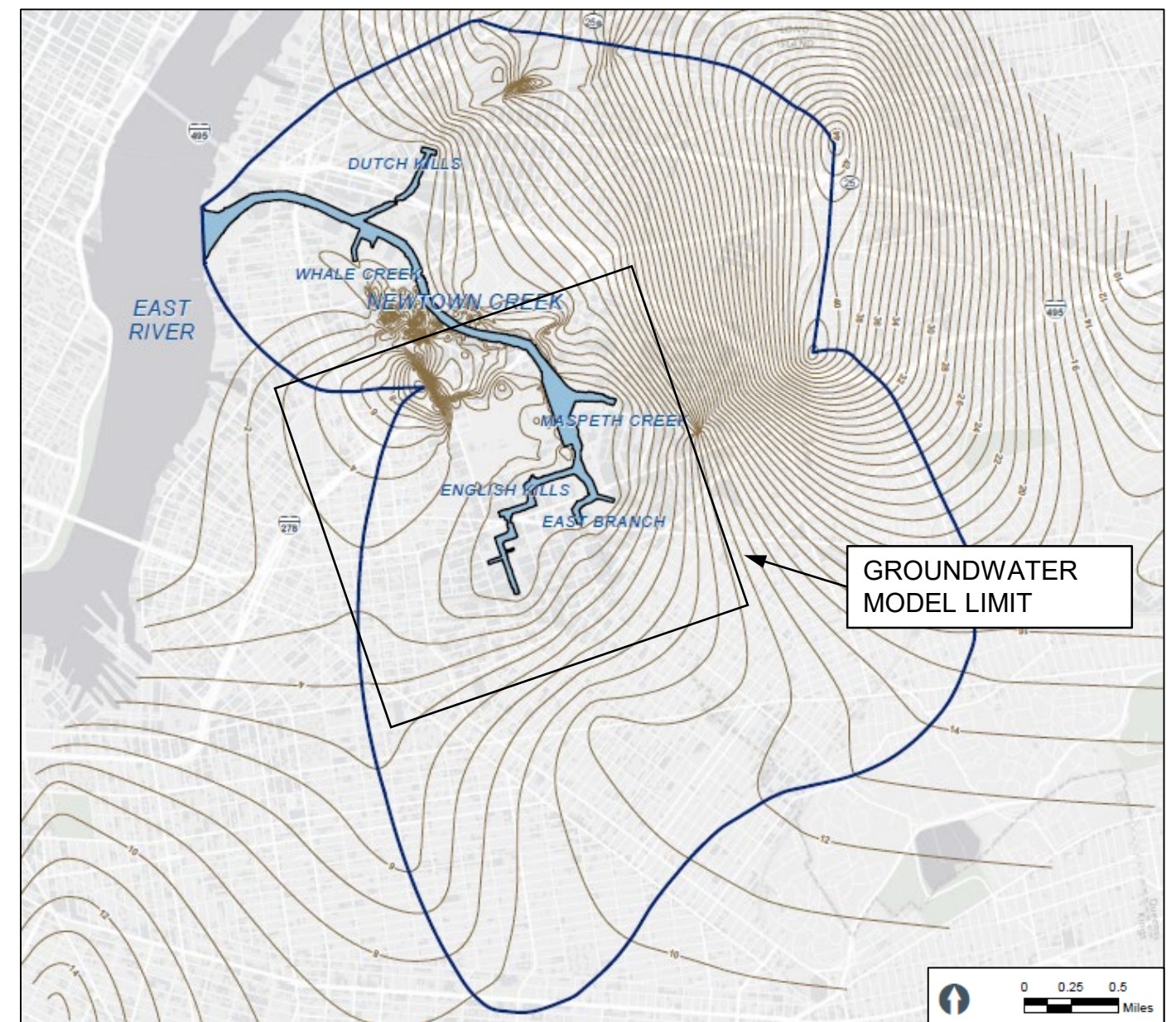
INVESTIGATED SITE (SITES WITH AVAILABLE SUBSURFACE DATA USED FOR MODEL ARE LABELED)



Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SITE REFERENCE LOCATIONS	
		Project 125180	September 2019 Figure L2-1



MEASURED 1997 WATER TABLE OF UPPER GLACIAL AQUIFER [USGS, 1997].



1-FOOT ARITHMETIC AVERAGE GROUNDWATER ELEVATION CONTOURS IN UPPER GLACIAL AQUIFER (FT. NAVD 88) [AQ, 2016]

NOTE: CONTOURS SHOWN REPRESENT THE OUTWASH/MORaine PORTION OF THE UPPER GLACIAL AQUIFER. LOCALIZED WATER TABLE MOUNDING IN FILL ABOVE LOW-PERMEABILITY MARSH DEPOSITS ARE NOT REFLECTED IN THESE CONTOURS.

SOURCES:

USGS, 1997. WATER-TABLE ALTITUDE IN KINGS AND QUEENS COUNTIES, NEW YORK, IN MARCH 1997, FACT SHEET FS 134-97, USGS, NOVEMBER 1997.

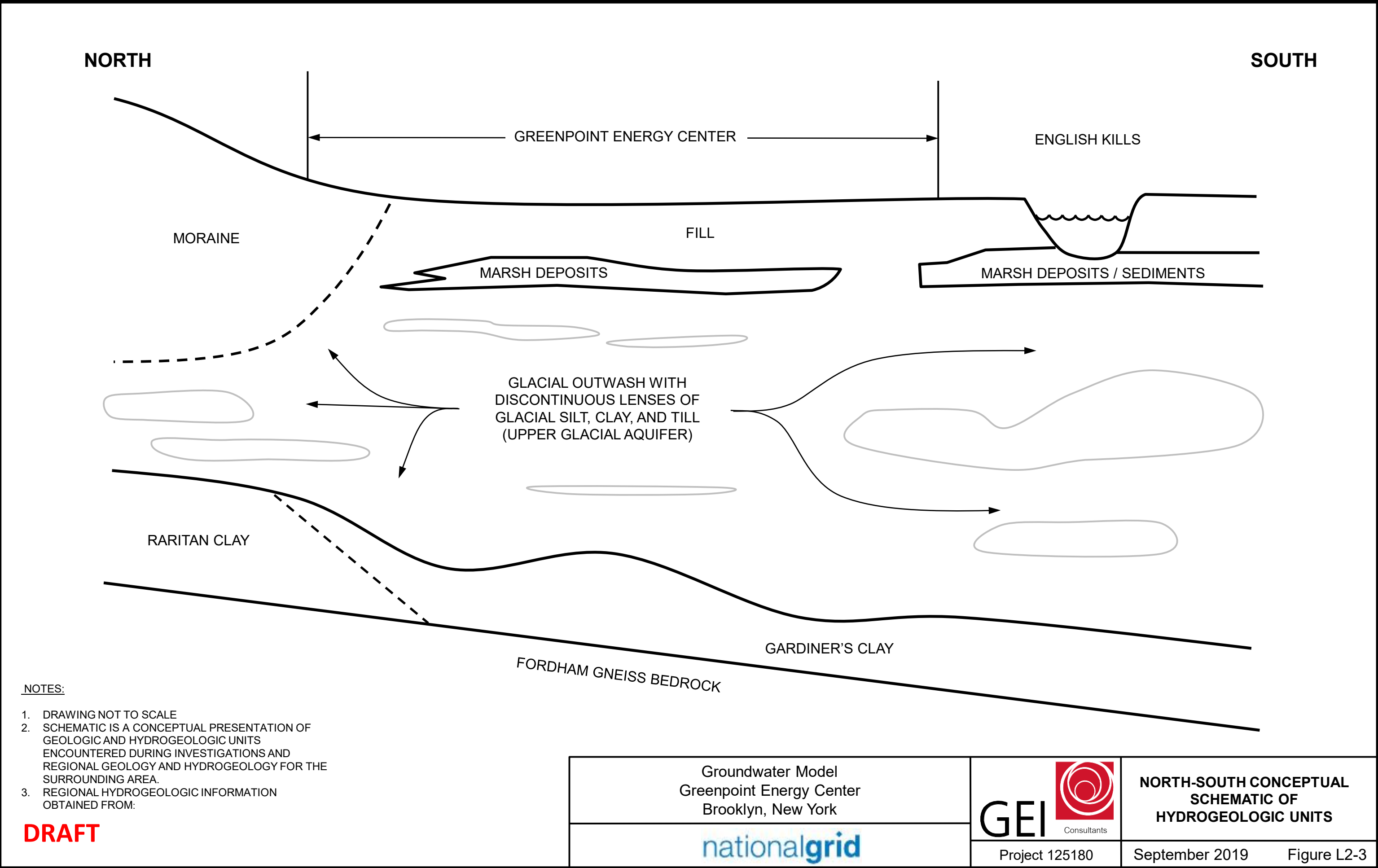
AQ, 2016. DRAFT REMEDIAL INVESTIGATION REPORT, REMEDIAL INVESTIGATION/FEASIBILITY STUDY, NEWTOWN CREEK. ANCHOR QEA LLC, NOVEMBER 2016.

LEGEND



GROUNDWATER MODEL LIMIT

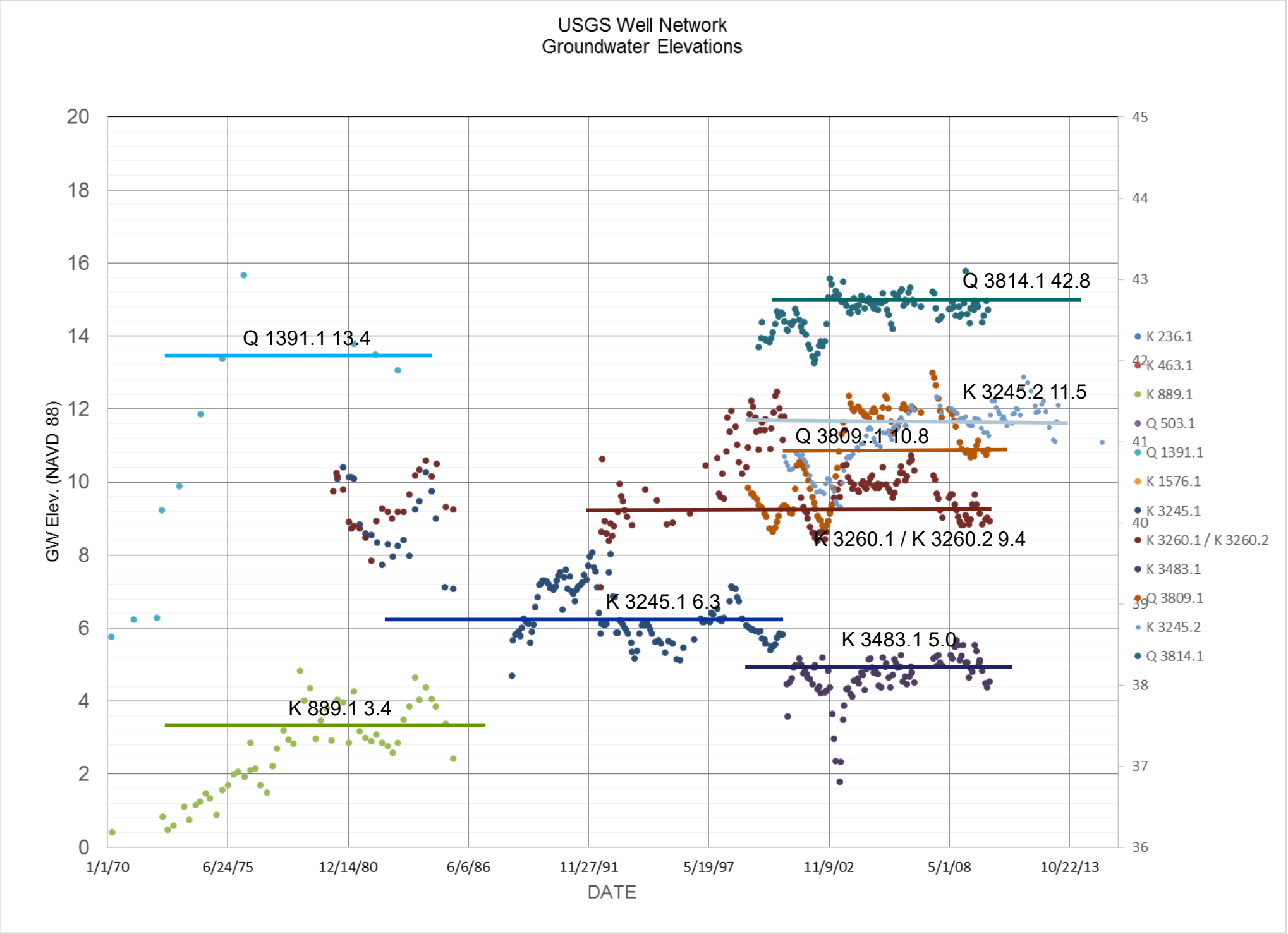
Groundwater Model Greenpoint Energy Center Brooklyn, New York	GEI Consultants	REGIONAL GROUNDWATER CONTOURS	
nationalgrid	Project 125180	September 2019	Figure L2-2



- NOTES:
- 1. DRAWING NOT TO SCALE
 - 2. SCHEMATIC IS A CONCEPTUAL PRESENTATION OF GEOLOGIC AND HYDROGEOLOGIC UNITS ENCOUNTERED DURING INVESTIGATIONS AND REGIONAL GEOLOGY AND HYDROGEOLOGY FOR THE SURROUNDING AREA.
 - 3. REGIONAL HYDROGEOLOGIC INFORMATION OBTAINED FROM:

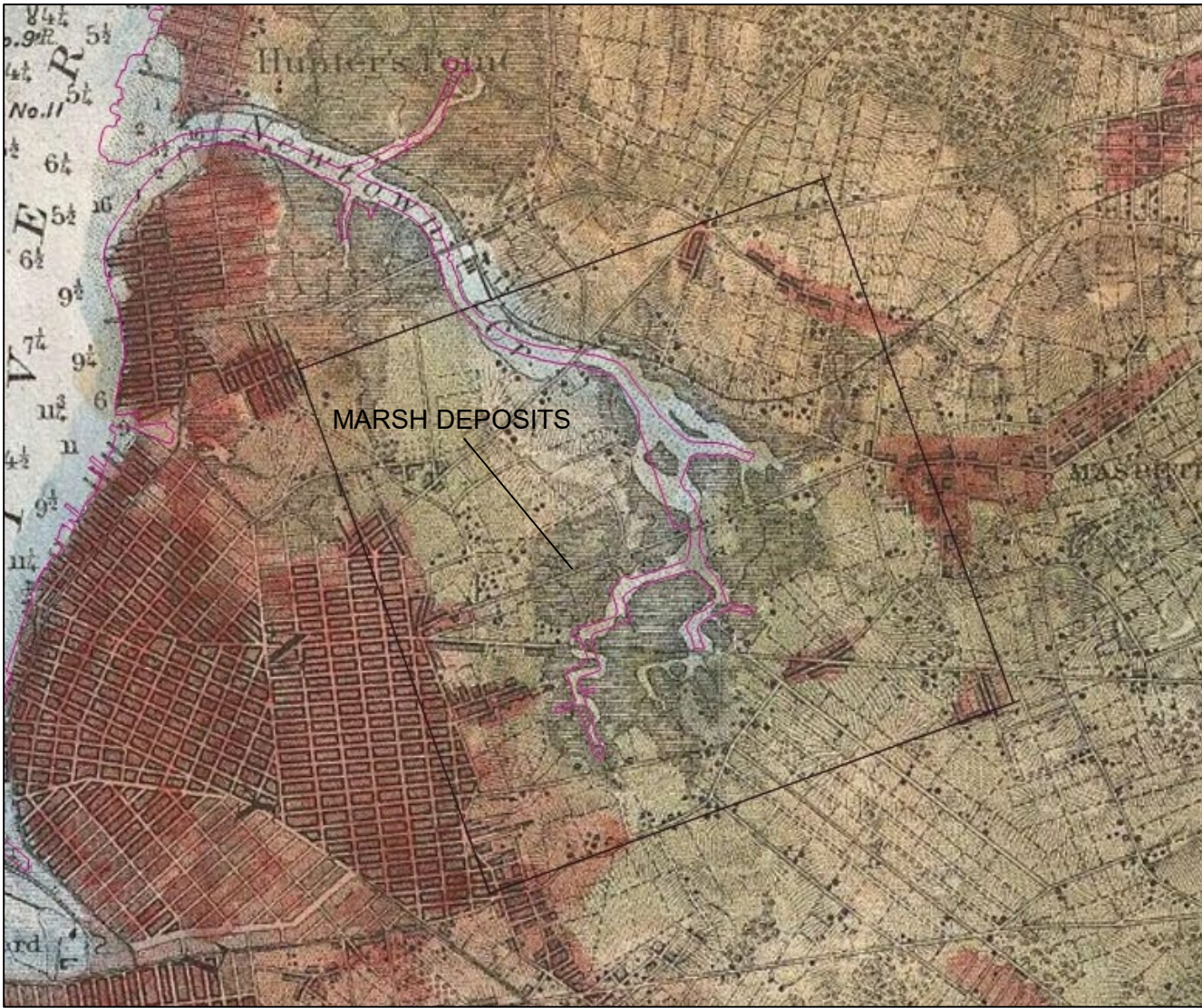
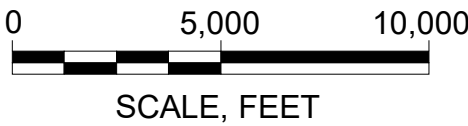
DRAFT

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	GEI Consultants	NORTH-SOUTH CONCEPTUAL SCHEMATIC OF HYDROGEOLOGIC UNITS	
		Project 125180	September 2019 Figure L2-3

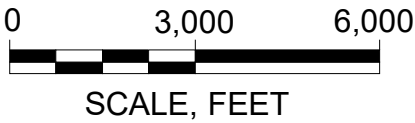




1781



1866



LEGEND



GROUNDWATER MODEL LIMIT

SOURCES:

1781: G. TAYLOR, A. SKINNER, MAP OF NEW YORK AND PART OF LONG ISLAND, SURVEYED BY ORDER OF HIS EXCELLENCY THE COMMANDER IN CHIEF OF HIS MAJESTY'S FORCES.

1866: COAST SURVEY OFFICE, COAST CHART NO. 20, NEW YORKBAY AND HARBOR, SURVEY OF THE COAST OF THE UNITED STATES.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



Project 125180

HISTORIC MAPS

September 2019

Figure L2-5

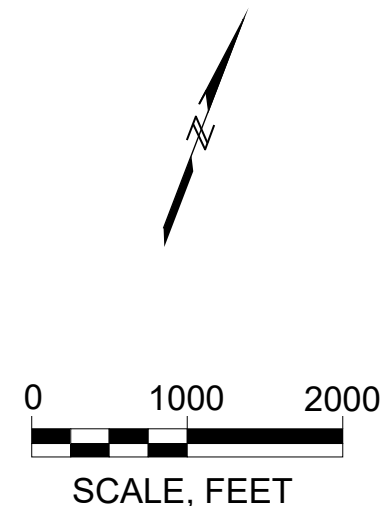
DRAFT



LEGEND

42

REPORTED TYPICAL PUMPING RATE
(GPM) (a)



NOTES:

- (a) PUMP RATE FOR BROOKLYN TRUCK WASH NOT REPORTED OR AVAILABLE. RATE APPLIED IN MODEL CONSIDERED TO BE CONSERVATIVE FOR INDUSTRY.
- (b) SOURCE FOR EXXONMOBIL PUMP RATES: SITE FREE-PRODUCT RECOVERY SYSTEMS, EXXONMOBIL GREENPOINT REMEDIATION PROJECT, ROUX ASSOCIATES, November 18, 2011.
- (c) SOURCE FOR PHELPS-DODGE PUMP RATES: ANNUAL OM&M REPORT (CRA 2008 AND 2012).
- (d) NO INFORMATION AVAILABLE AS TO WHETHER WITHDRAWALS OR DEWATERING AT THESE LOCATIONS ARE ONGOING WITHIN MODEL AREA.

GROUNDWATER EXTRACTION / WITHDRAWAL LOCATIONS IN MODEL

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

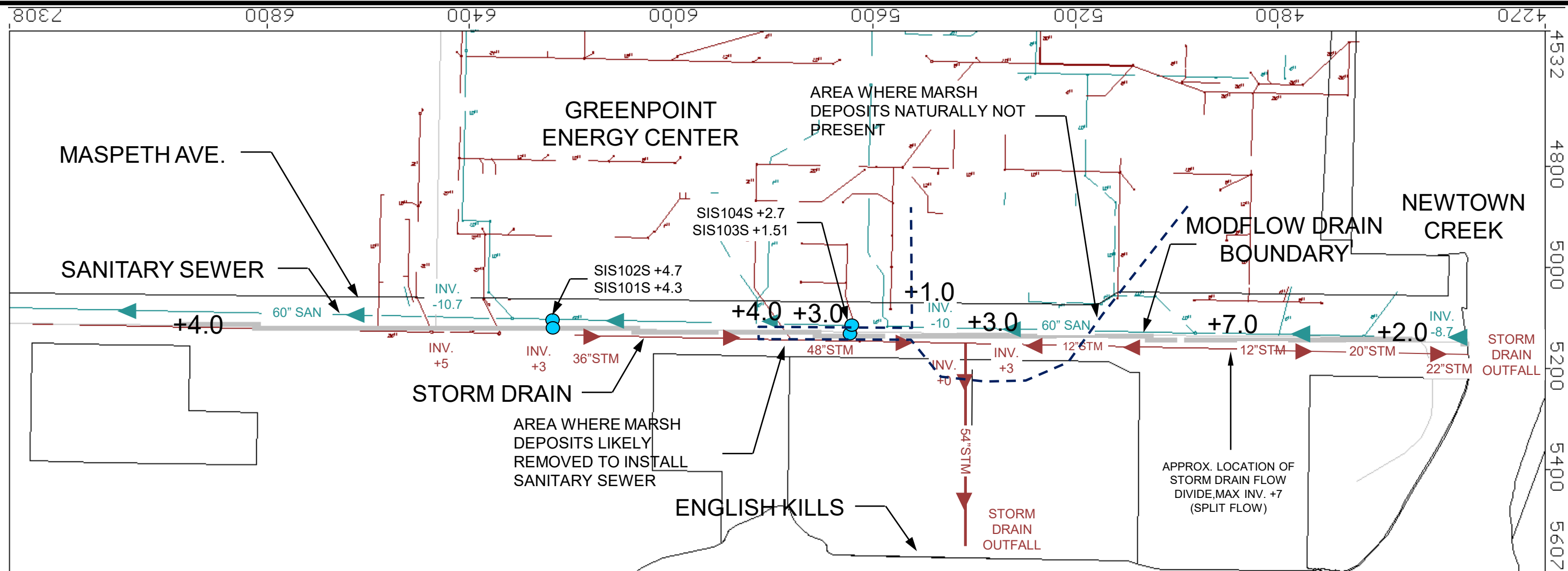


Project 125180

GROUNDWATER EXTRACTION LOCATIONS

September 2019

Figure L2-6



LEGEND

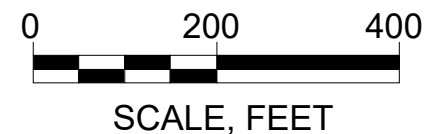
MODEL DRAIN BOUNDARY
+4.0 MODEL DRAIN CELL ELEVATION (b)

SEWER INFILTRATION SERIES MONITORING WELLS IN STREET:
● SIS102S +4.7 WELL CLOSEST TO SIDEWALK / GPEC
● SIS101S +4.3 WELL CLOSEST TO STREET CENTERLINE / UTILITIES
NOS. REPRESENT OBS. GROUNDWATER ELEVATIONS (c)
--- AREA WHERE MARSH DEPOSITS ASSUMED NOT PRESENT

48" STM
INV. +3
60" SAN
INV. -10
STORM DRAIN / DIAMETER
DRAIN INVERT ELEV. (FT. NAVD)
SANITARY SEWER / DIAMETER
SEWER INVERT ELEV. (FT. NAVD)

NOTES:

- DRAIN CELLS REPRESENT INFILTRATION TO MASPETH UTILITIES, EITHER THE STORM DRAIN OR SANITARY SEWER BEDDING. WATER ENTERING DRAIN NODES LEAVES THE SYSTEM IN MODEL. DRAINS MAINTAIN GROUNDWATER ELEVATIONS AT ASSIGNED ELEVATIONS. DRAIN ELEVATIONS ASSIGNED IN MODEL BASED ON OBSERVED AQUIFER RESPONSE AND NOT INVERTS, AS MANY FACTORS BESIDES INVERT GOVERN INFILTRATION RATE.
- DRAIN CELLS BETWEEN NOTATIONS ASSIGNED ELEVATIONS THAT VARY LINEARLY BETWEEN THE NOTED ELEVATIONS.
- GROUNDWATER ELEVATION: APPROX. AVERAGE OF OBS. GROUNDWATER ELEVATIONS MEASURED BY CONTINUOUS LOGGING 2/22/17 – 3/14/17.



DRAFT

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



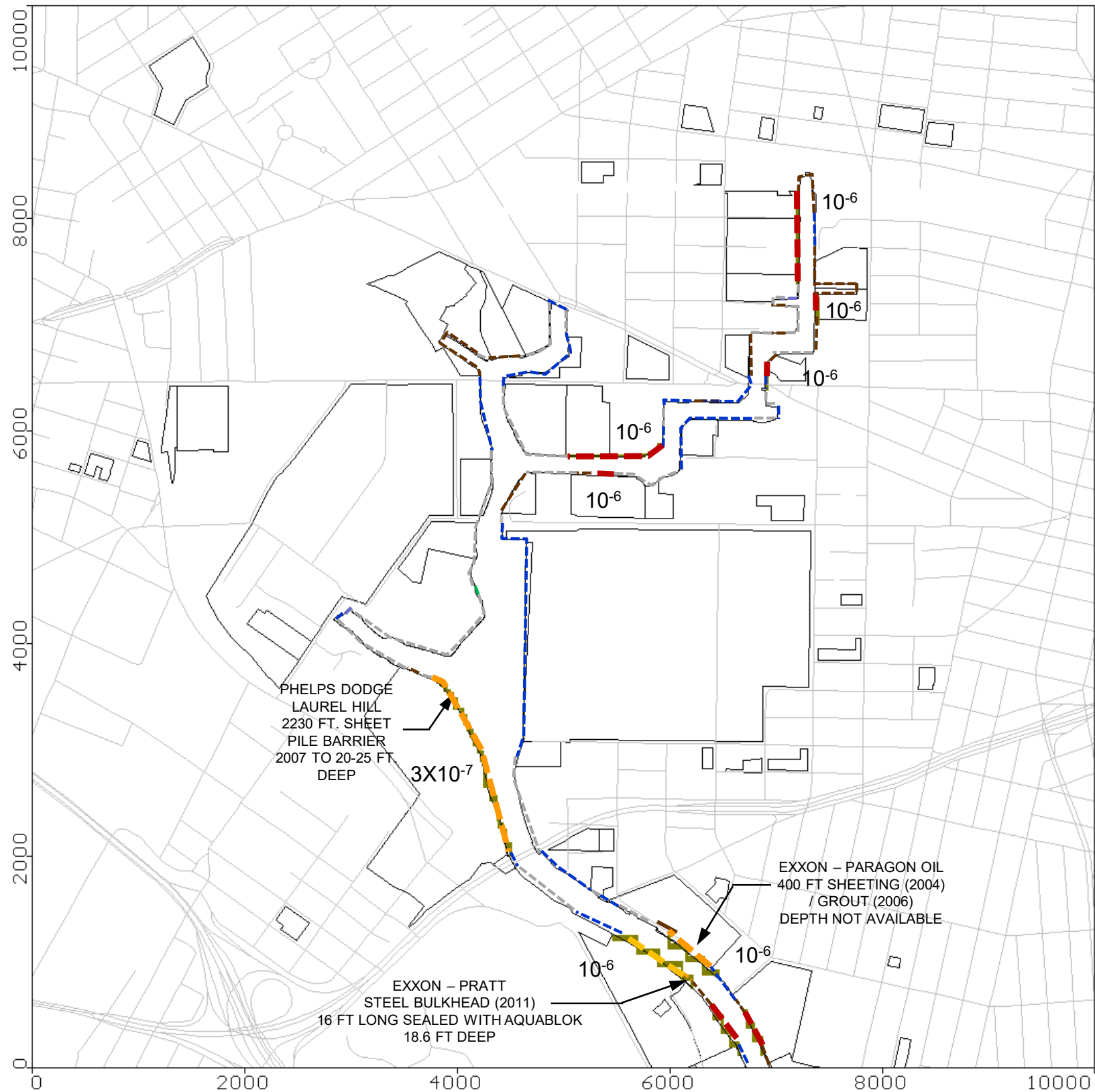
Project 125180

MASPETH AVE. UTILITIES

September 2019

Figure L2-7

DRAFT



LEGEND

SHORELINE TYPE (ANCHOR, 2016)

MODELED AS WALL BOUNDARY

- REMEDIAL BARRIER WALL / CUTOFF
- 10⁻⁶ STEEL SHEETPILE WITH HYDRAULIC CONDUCTIVITY USED IN MODEL (cm/s)

ASSUMED PERVIOUS WITH NO IMPEDENCE TO HORIZONTAL DISCHARGE, NOT MODELED

- BARE GROUND
- CONCRETE
- RIPRAP
- WOOD

MODELED WALL BOUNDARY

- SHEETPILE CUTOFF MODELED AS UNIT THICKNESS (1 FT.), HYD. COND = 0.001 FT./D (3E-7 cm/s)

NOTE: MODELED BULKHEAD THICKNESS = 0.4 FT.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



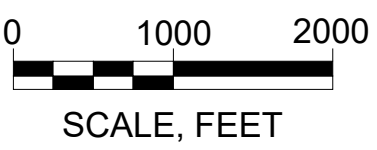
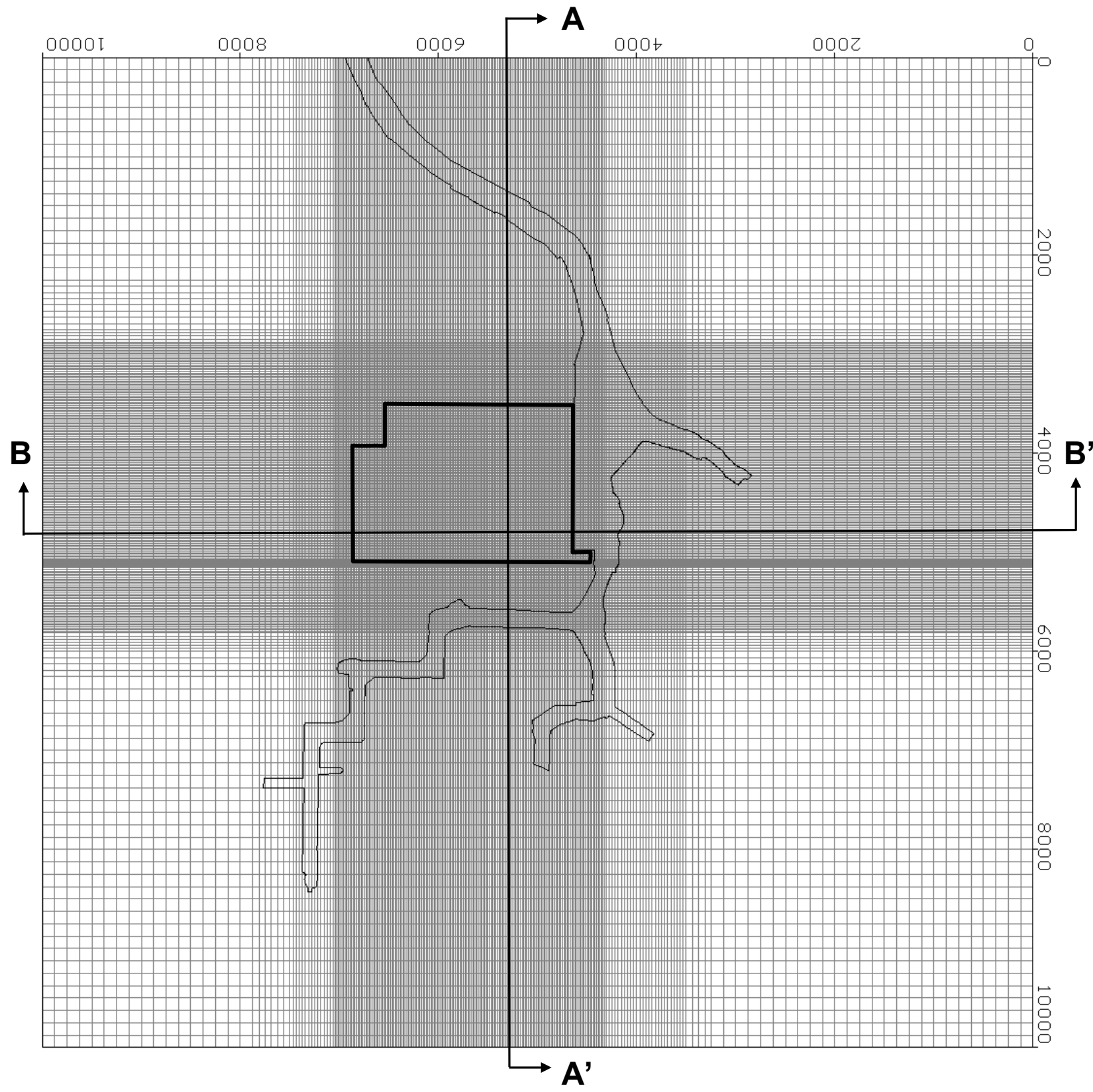
SHORELINE TYPE

Project 125180

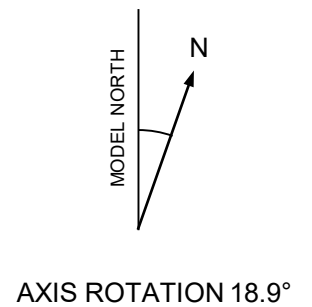
September 2019

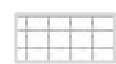
Figure L2-8

DRAFT



HORIZONTAL GRID SPACING:
15 FT. ONSITE
8 FT NORTH-SOUTH ALONG
MASPETH AVE.
124 FT. AT MODEL CORNERS



- LEGEND
-  GRID LINES
 -  LOCATION OF CROSS-SECTIONS (Figure L4)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



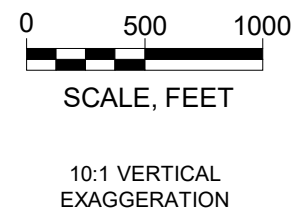
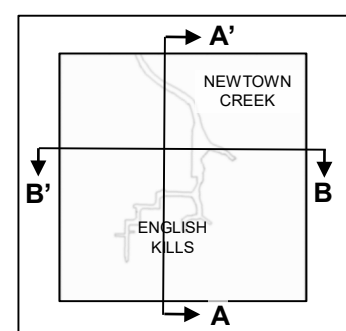
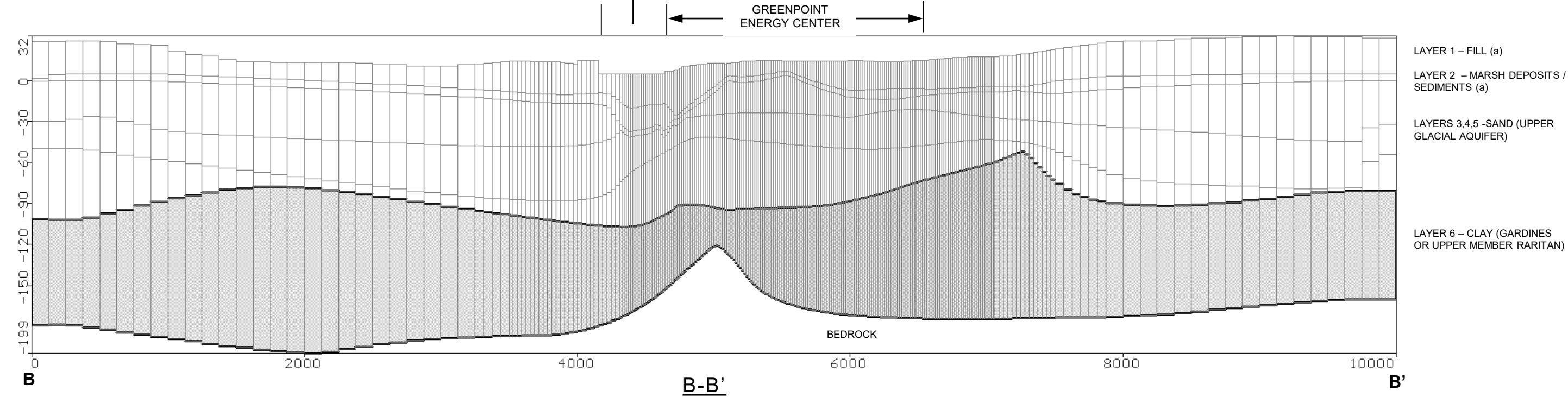
Project 125180

MODEL GRID

September 2019

Figure L3-1

DRAFT



- LEGEND
- MODEL GRID LINES
 - INACTIVE (NO-FLOW) CELLS

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



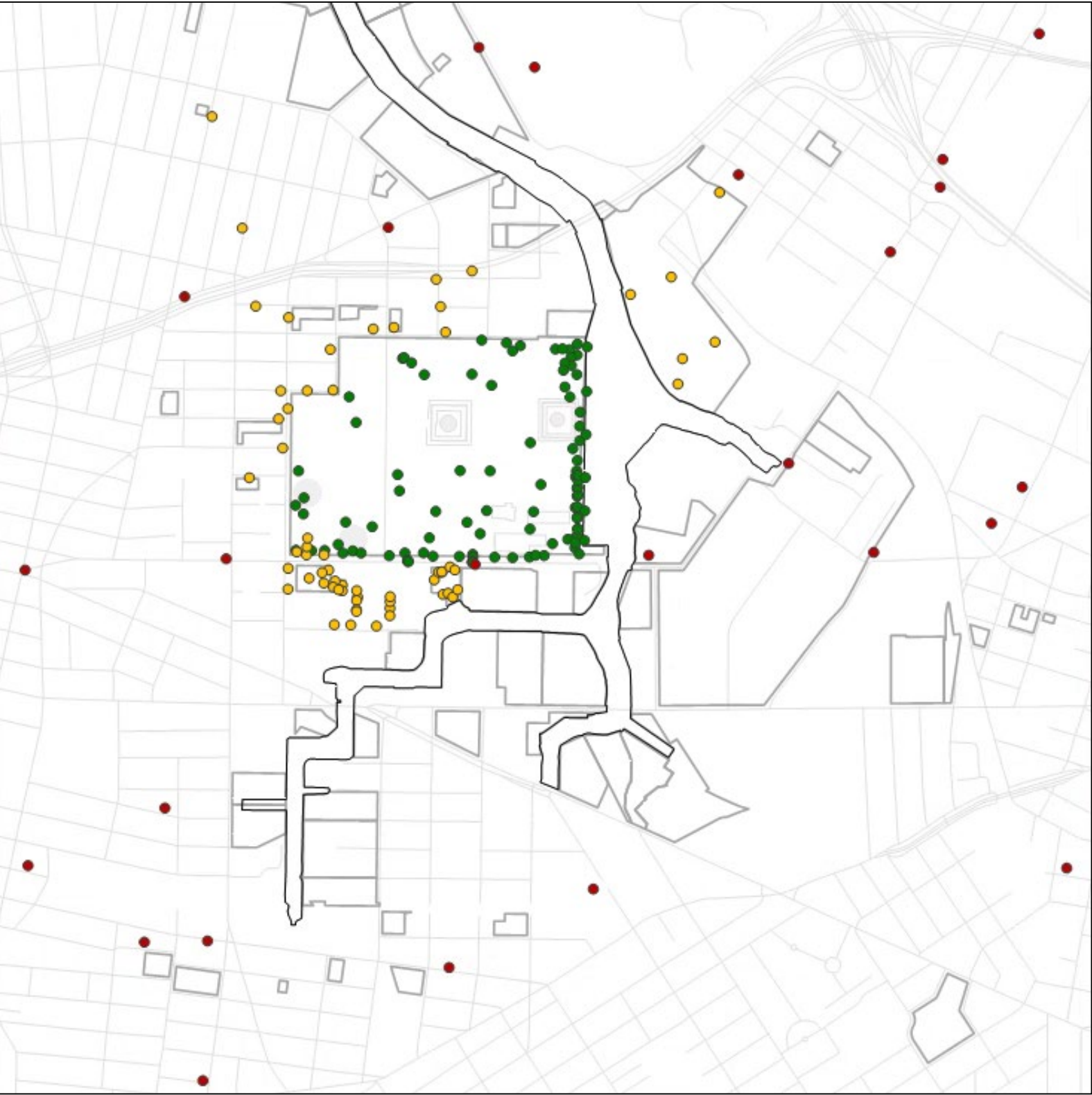
**MODEL GRID
CROSS-SECTIONS**

Project 125180

September 2019

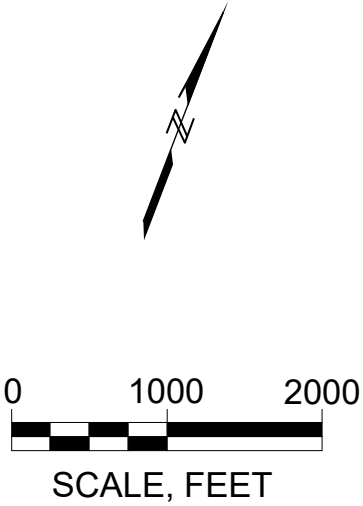
Figure L3-2

DRAFT



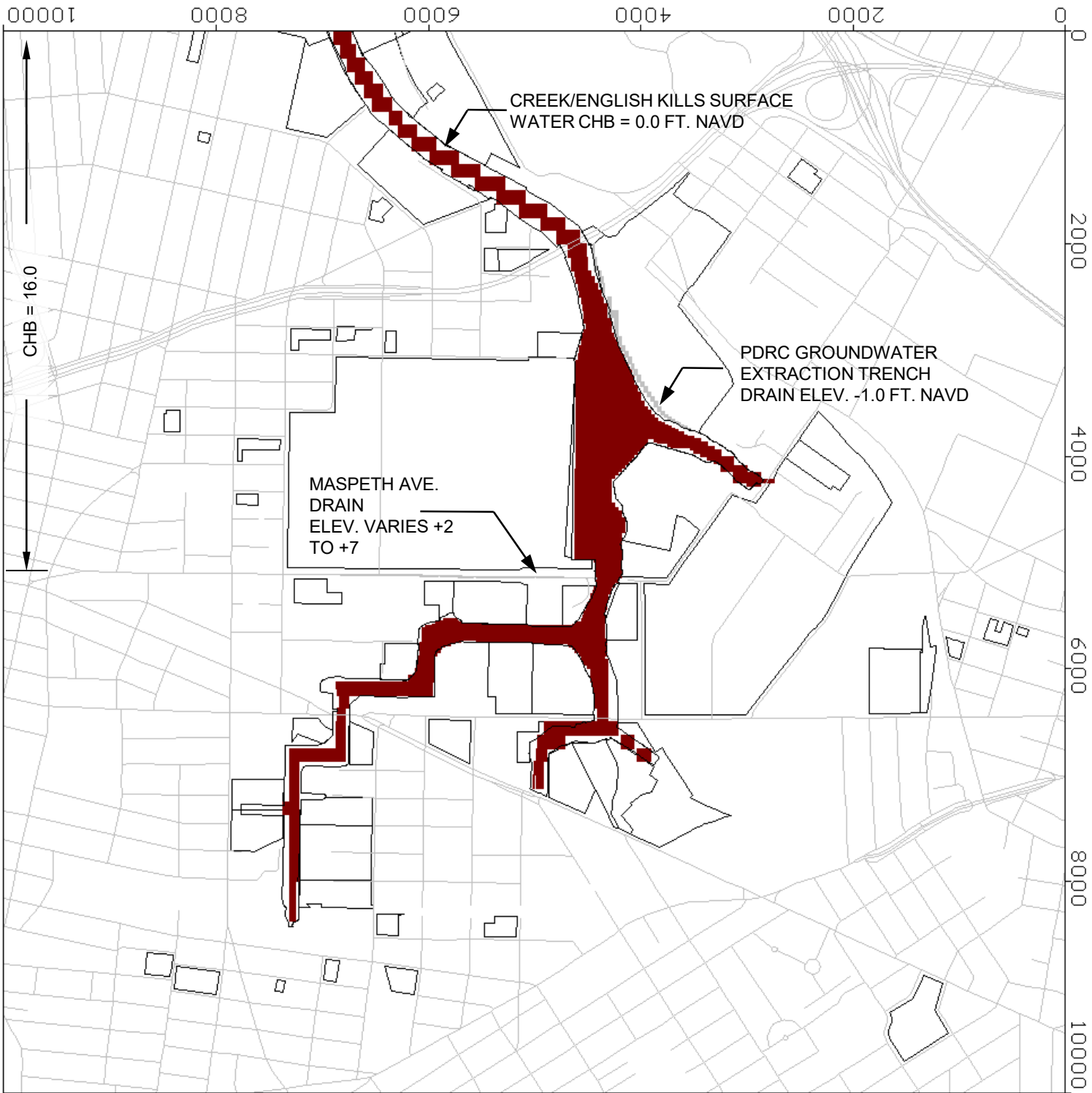
CALIBRATION DATA SOURCE

- GREENPOINT
- OTHER DAR SITES
- NEWTOWN CREEK
- USGS



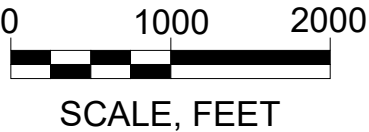
Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	STRATIGRAPHIC INPUT SOIL BORING LOCATIONS	
		Project 125180	September 2019 Figure L3-3

DRAFT



LEGEND

- CONSTANT HEAD
- DRAIN (MASPETH AVE. UTILITIES)



MODEL LAYER 1

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



SHALLOW HEAD BOUNDARIES

Project 125180

September 2019

Figure L3-4

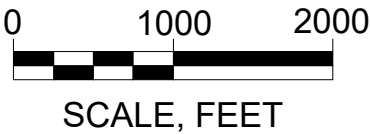
DRAFT



MODEL LAYER 5

LEGEND

CONSTANT HEAD
BOUNDARY



NOTE:
(a) HEAD BOUNDARY ASSIGNED HERE TO SIMULATE
EFFECTS OF GROUNDWATER EXTRACTION IN AREA
TO NORTH OUTSIDE MODEL LIMITS.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York



UPPER GLACIAL AQUIFER
CONSTANT HEAD BOUNDARIES

Project 125180

September 2019

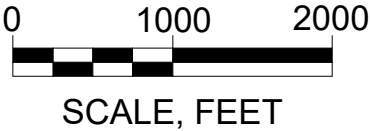
Figure L3-5

DRAFT



AREAL RECHARGE RATES

- COMMERCIAL/INDUSTRIAL 5 IN./YR(a)
- UNPAVED 9 IN./YR
- UNDEVELOPED / VEGETATED 16 IN./YR
- URBAN RESIDENTIAL 8 IN./YR
- DISCRETIZED IMPERVIOUS SURFACE / BUILDINGS 0.5 IN./YR



FOOTNOTE:

- (a) COMMERCIAL/INDUSTRIAL RECHARGE USED AS DEFAULT OVER SURFACE WATER. APPLIED RECHARGE OVER SURFACE WATER DOES NOT AFFECT MODEL.

MODEL LAYER 1

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

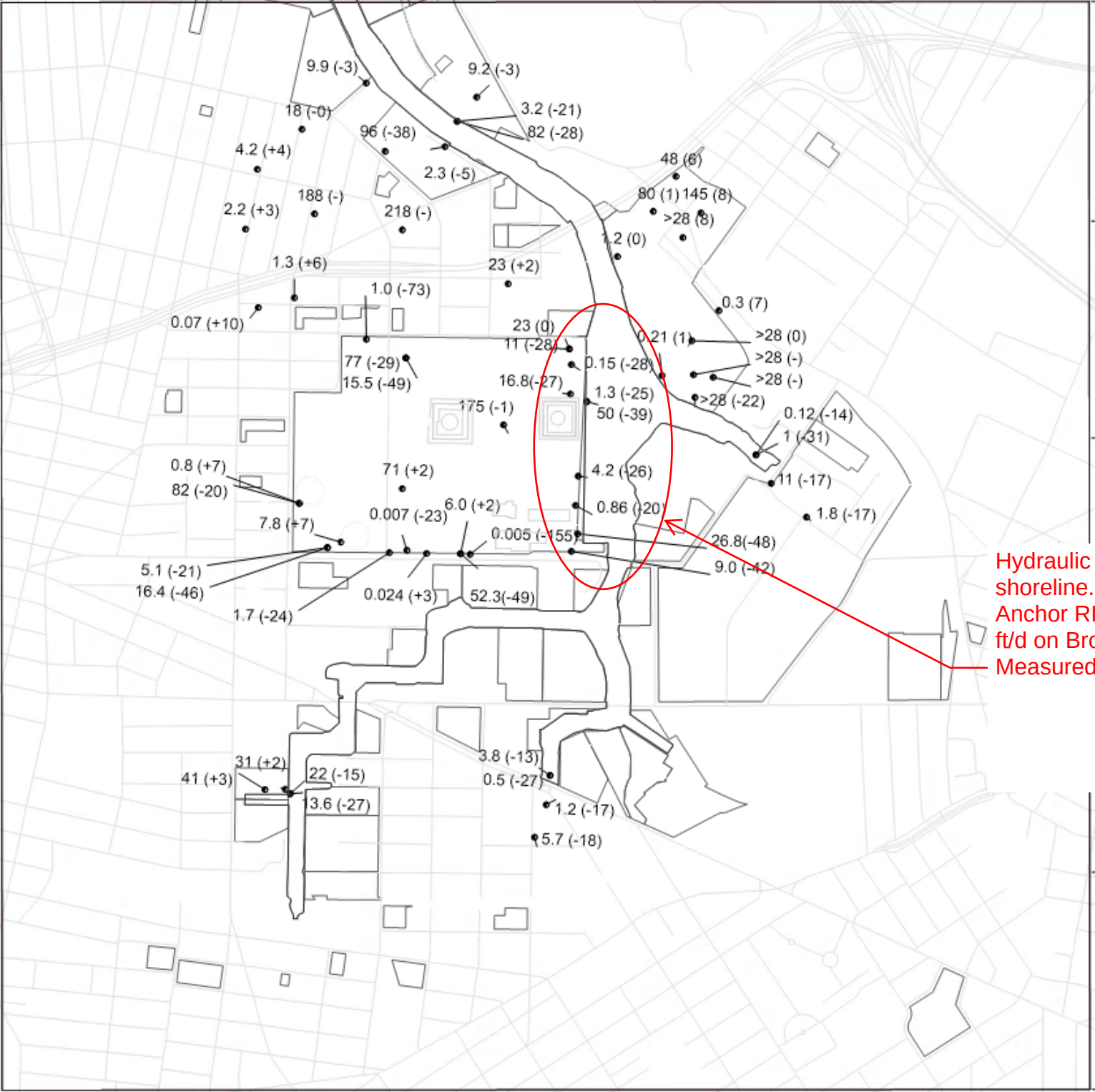


RECHARGE BOUNDARIES

Project 125180

September 2019

Figure L3-6

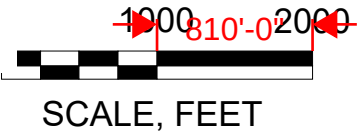


LEGEND

15 (-12) REPORTED HYDRAULIC CONDUCTIVITY
IN FT./DAY (ELEVATION APPROX. MID-
POINT WELL SCREEN)

(-) WELL SCREEN ELEVATION NOT
AVAILABLE

Hydraulic conductivity varies along the
shoreline.
Anchor RI Model 2 assumed fill unit K of 3.4
ft/d on Brooklyn side
Measured geomean at SL22 is 1 ft/day.



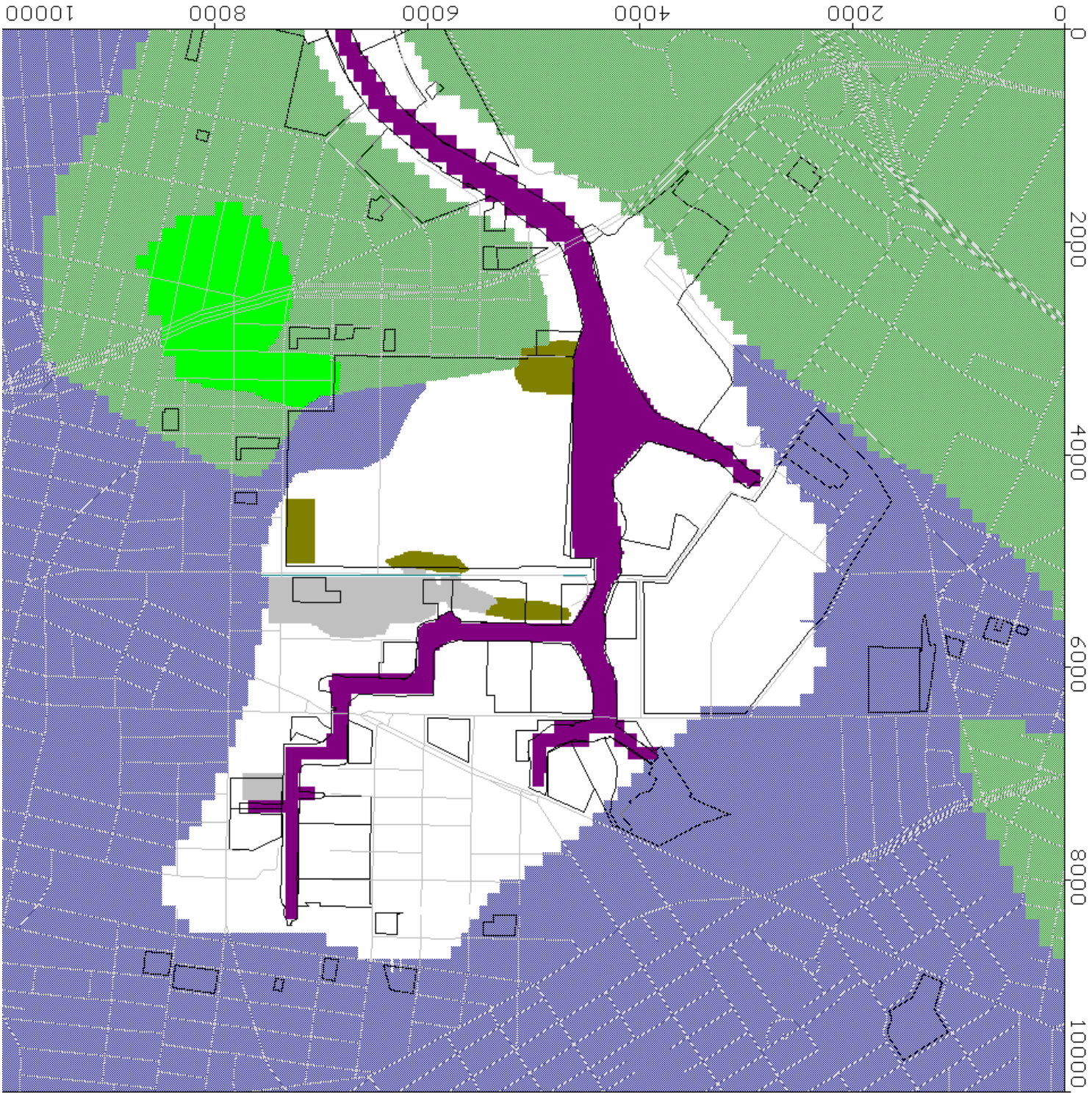
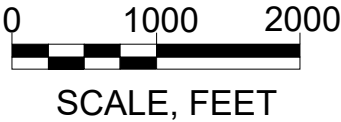
Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	HYDRAULIC CONDUCTIVITY MEASUREMENTS
	Project 125180	September 2019 Figure L3-7

DRAFT

We had assumed
horizontal K of 2
ft/day in the fill

HYDRAULIC CONDUCTIVITY ZONES

- FILL ($K_H = 2, K_V = 0.2$)
- OPEN WATER ($K_H = K_V = 500$)
- FILL 1 – ASSUMED DENSE MATERIAL SOUTH OF MASPETH ($K_H = 0.1, K_V = 0.05$)
- FILL, MISCELLANEOUS POCKETS ($K_H = 0.5, K_V = 0.1$)
- MASPETH AVE. UTILITY CORRIDOR ($K_H = 50, K_V = 50$)
- UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
- MORAINE ZONE 1 ($K_H = 10, K_V = 0.5$)
- MORAINE ZONE 2 ($K_H = K_V = 0.012$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

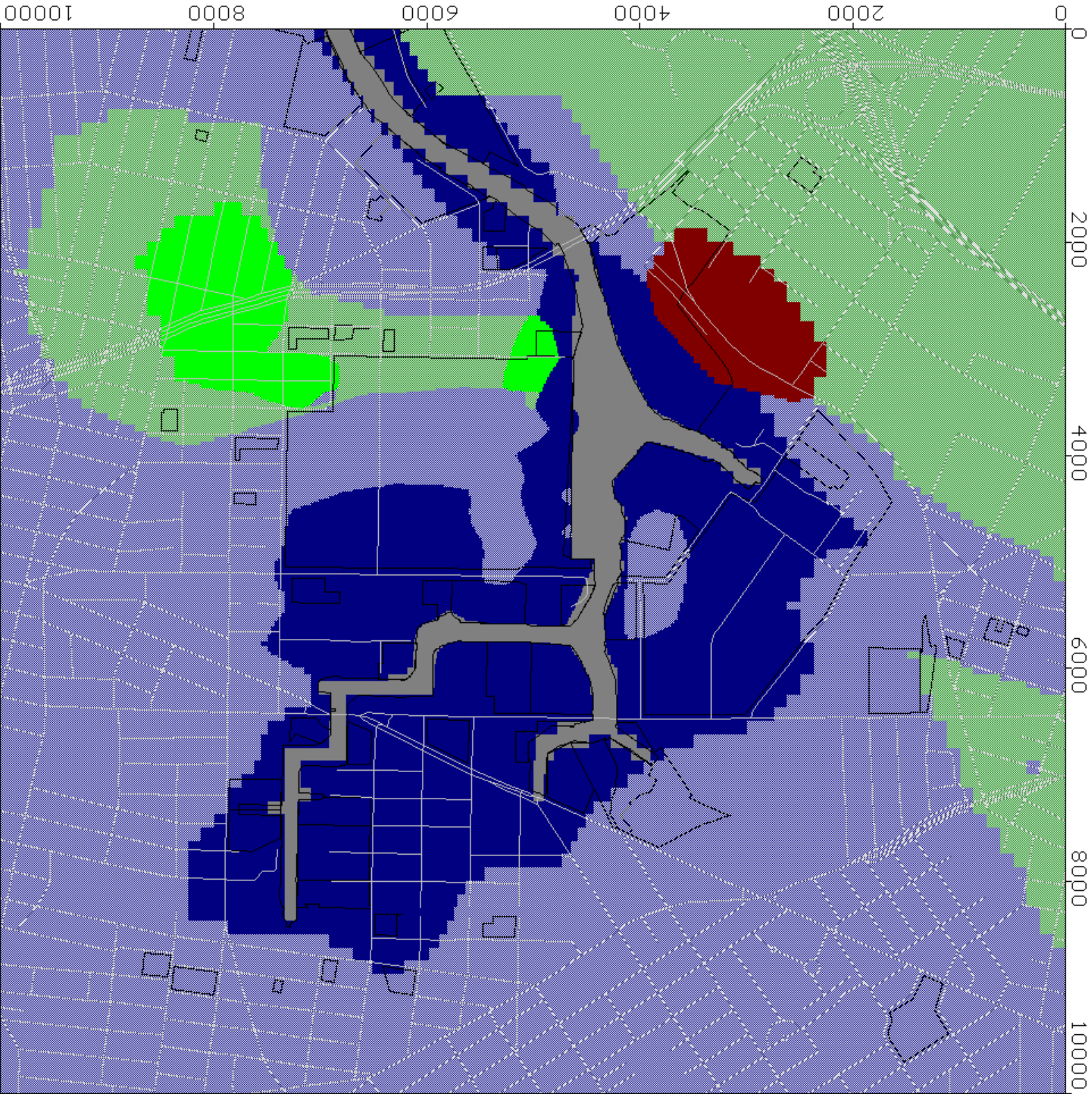


Project 125180

HYDRAULIC CONDUCTIVITY
LAYER 1

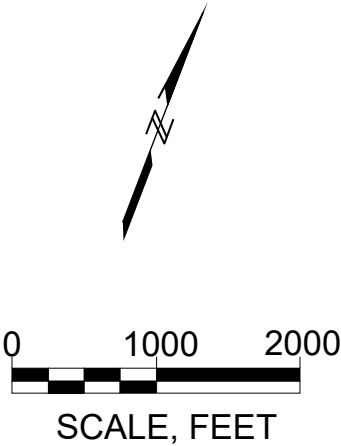
September 2019 Figure L3-8a

DRAFT



HYDRAULIC CONDUCTIVITY ZONES

- MARSH DEPOSITS ($K_H = 0.1$, $K_V = 0.001$)
- SEDIMENTS ($K_H = 3$, $K_V = 0.3$)
- UPPER GLACIAL AQUIFER ($K_H = 80$, $K_V = 30$)
- MORAINE ZONE 1 ($K_H = 10$, $K_V = 0.5$)
- MORAINE ZONE 2 ($K_H = K_V = 0.012$)
- MORAINE ZONE 3 ($K_H = 0.4$, $K_V = 0.08$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY
 K_V = VERTICAL HYDRAULIC CONDUCTIVITY
HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



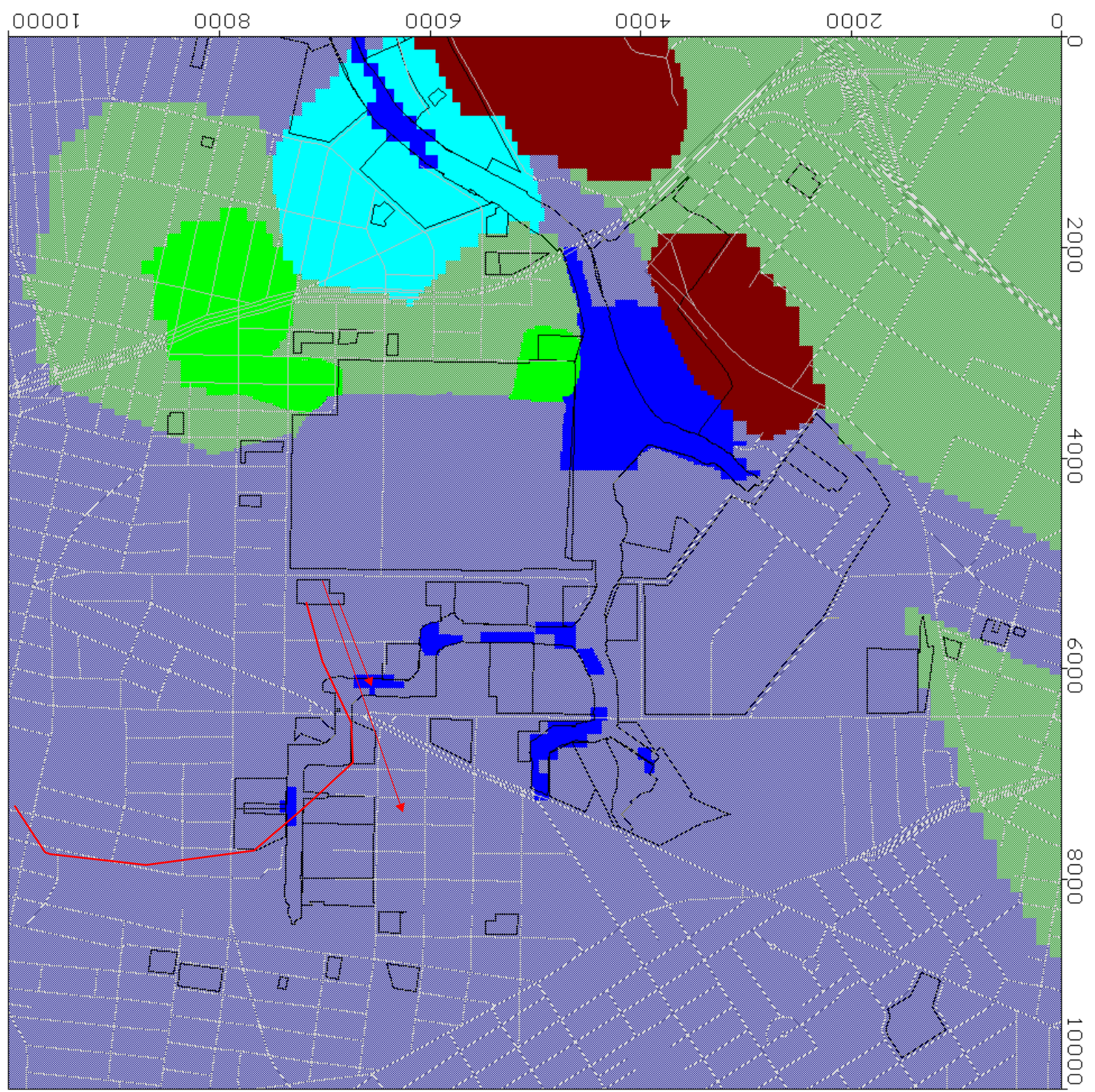
Project 125180

HYDRAULIC CONDUCTIVITY
LAYER 2

September 2019

Figure L3-8b

DRAFT



- HYDRAULIC CONDUCTIVITY ZONES
- UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
 - MORAINE ZONE 1 ($K_H = 10, K_V = 0.5$)
 - MORAINE ZONE 2 ($K_H = K_V = 0.012$)
 - MORAINE ZONE 3 ($K_H = 0.4, K_V = 0.08$)
 - FINE-GRAINED NATIVE MATERIAL ($K_H = 30, K_V = 3$)
 - COARSE DEPOSITS ($K_H = 250, K_V = 25$)

NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

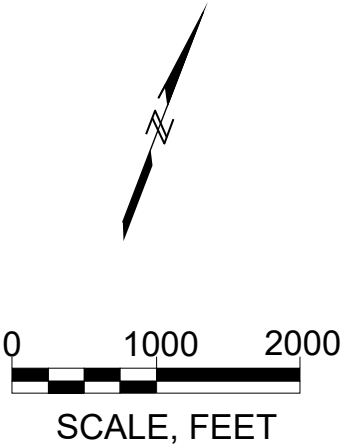
K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	HYDRAULIC CONDUCTIVITY LAYER 3	
		Project 125180	September 2019 Figure L3-8c

DRAFT

- HYDRAULIC CONDUCTIVITY ZONES
- UPPER GLACIAL AQUIFER ($K_H = 80, K_V = 30$)
 - MORAINE ZONE 1 ($K_H = 10, K_V = 0.5$)
 - MORAINE ZONE 2 ($K_H = K_V = 0.012$)
 - MORAINE ZONE 3 ($K_H = 0.4, K_V = 0.08$)
 - COARSE DEPOSITS ($K_H = 250, K_V = 25$)
 - CLAY INTERBEDS ($K_H = 250, K_V = 25$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY
 K_V = VERTICAL HYDRAULIC CONDUCTIVITY
HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



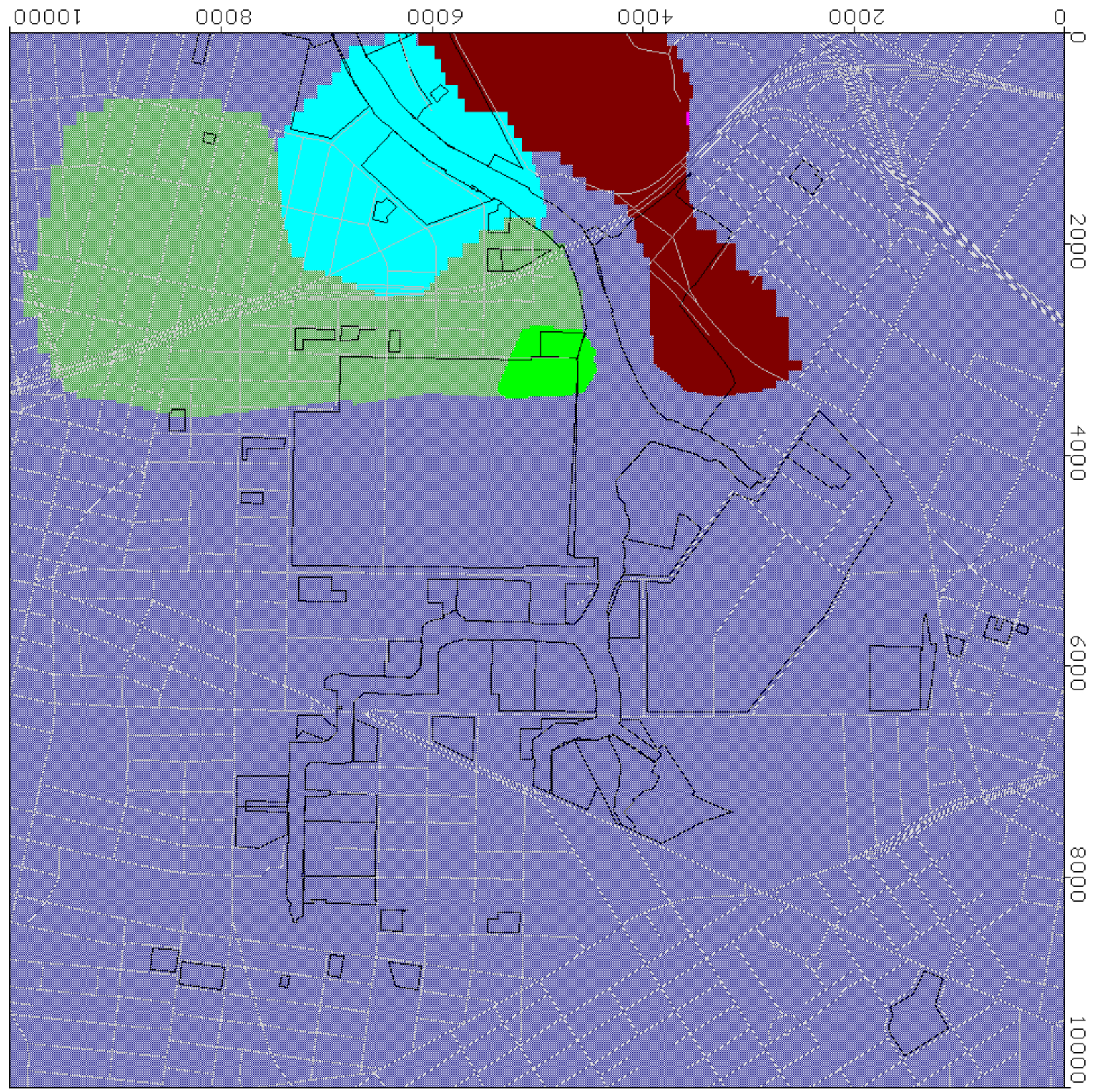
Project 125180

HYDRAULIC CONDUCTIVITY
LAYER 4

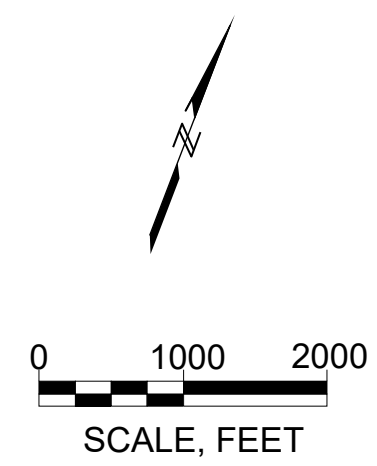
September 2019

Figure L3-8d

DRAFT



- HYDRAULIC CONDUCTIVITY ZONES
- UPPER GLACIAL AQUIFER ($K_H = 80$, $K_V = 30$)
 - MORAINE ZONE 1 ($K_H = 10$, $K_V = 0.5$)
 - MORAINE ZONE 2 ($K_H = K_V = 0.012$)
 - MORAINE ZONE 3 ($K_H = 0.4$, $K_V = 0.08$)
 - COARSE DEPOSITS ($K_H = 250$, $K_V = 25$)



NOTES:

K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY

K_V = VERTICAL HYDRAULIC CONDUCTIVITY

HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)



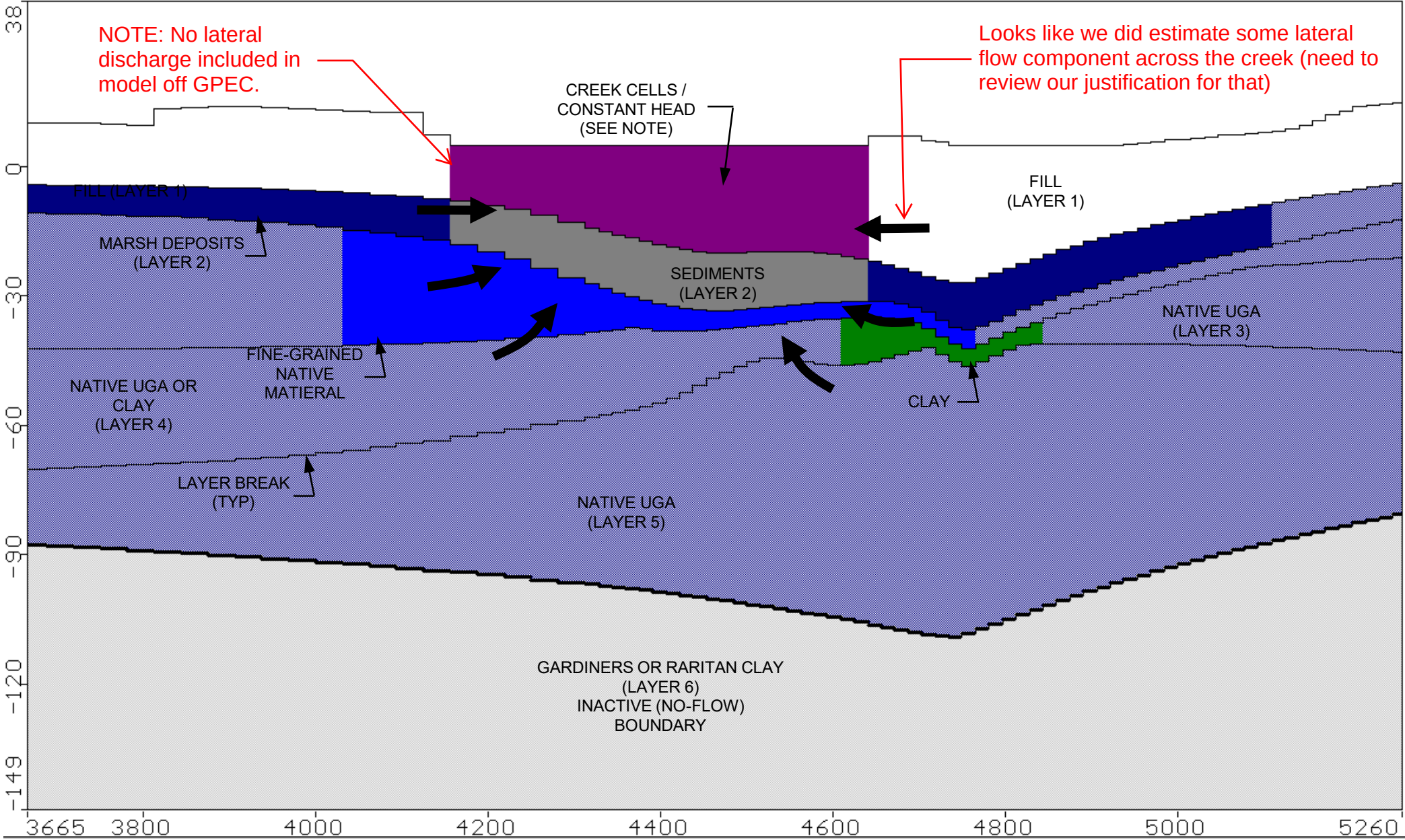
HYDRAULIC CONDUCTIVITY
LAYER 5

Project 125180

September 2019

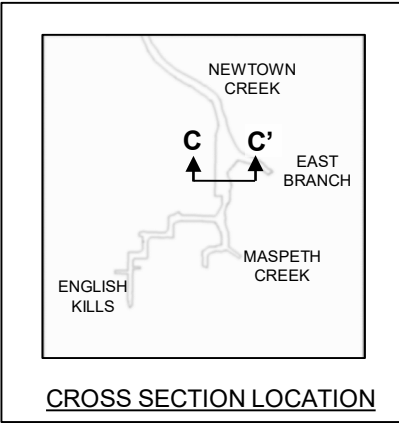
Figure L3-8e

DRAFT



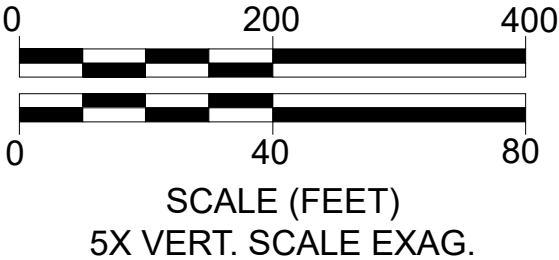
- HYDRAULIC CONDUCTIVITY ZONES
- FILL ($K_H = 2$, $K_V = 0.2$)
 - SEDIMENTS ($K_H = 3$, $K_V = 0.3$)
 - MARSH DEPOSITS ($K_H = 0.1$, $K_V = 0.001$)
 - FINE-GRAINED NATIVE MATERIAL ($K_H = 30$, $K_V = 3$)
 - CLAY INTERBEDS ($K_H = 250$, $K_V = 25$)
 - UPPER GLACIAL AQUIFER ($K_H = 80$, $K_V = 30$)
 - OPEN WATER ($K_H = K_V = 500$)
 - GARDINERS OR RARITAN CLAY (INACTIVE)
- CONCEPTUAL GROUNDWATER DISCHARGE PATTERN

NOTE: HIGH HYDRAULIC CONDUCTIVITY IN CREEK CELLS (500 FT./DAY) CONTAIN CONSTANT HEAD BOUNDARY(CHB) CELLS. WHERE CHB CELLS NOT PRESENT, HIGH-CONDUCTIVITY CELLS ALLOW UNINHIBITED FLOW TO CHB. GROUNDWATER ENTERING CHB CELLS EXITS THE MODEL.



CROSS SECTION C-C'
(MODEL ROW 138)

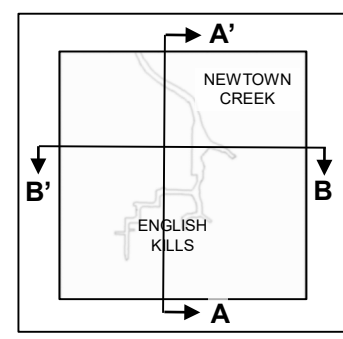
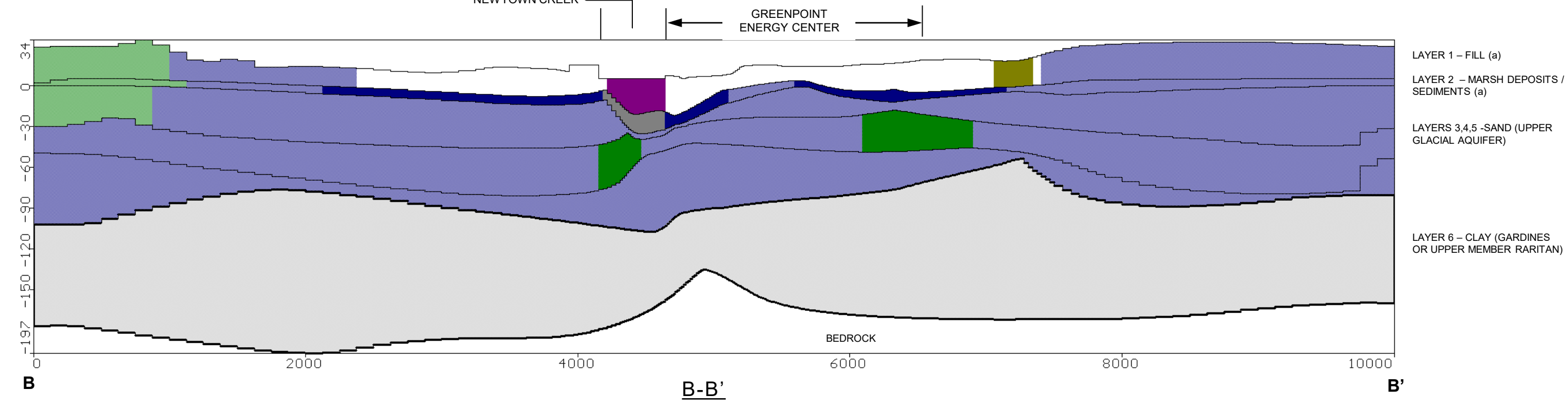
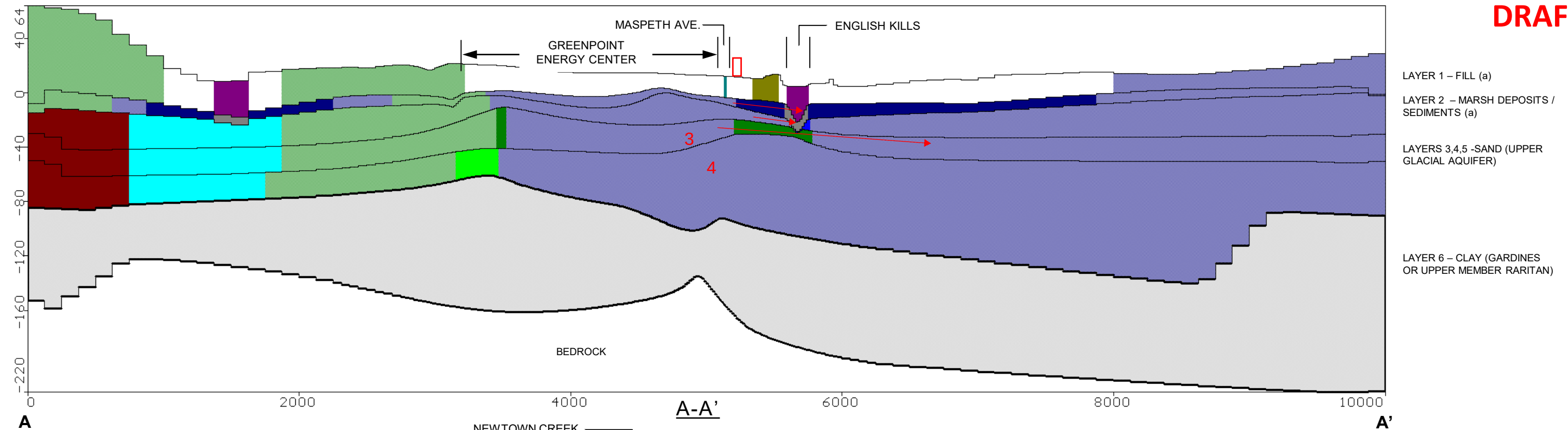
HORIZ.
VERT.



NOTES:
 K_H = HORIZONTAL HYDRAULIC CONDUCTIVITY
 K_V = VERTICAL HYDRAULIC CONDUCTIVITY
HYDRAULIC CONDUCTIVITY VALUES ARE IN FEET PER DAY (FT./DAY)

Groundwater Model Greenpoint Energy Center Brooklyn, New York	GEI Consultants	SHOREFRONT DETAILS
nationalgrid	Project 125180	September 2019 Figure L3-9

DRAFT



0 500 1000
SCALE, FEET

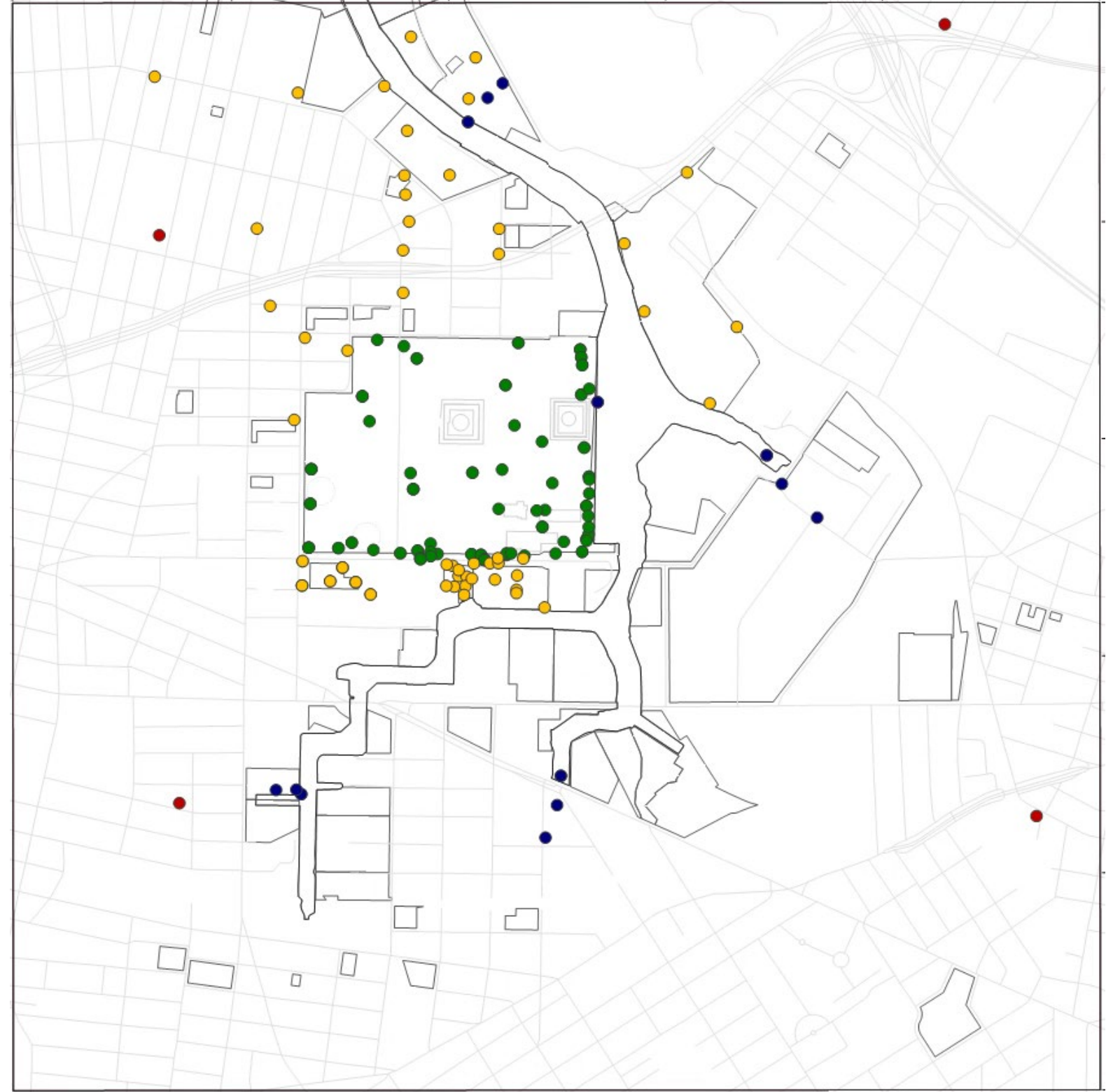
10:1 VERTICAL EXAGGERATION

LEGEND

- MODEL GRID LINES
- INACTIVE (NO-FLOW) CELLS

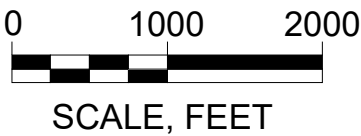
Groundwater Model Greenpoint Energy Center Brooklyn, New York		HYDRAULIC CONDUCTIVITY CROSS-SECTIONS	
		Project 125180	September 2019 Figure L3-10

DRAFT



CALIBRATION DATA SOURCE

- GREENPOINT
- OTHER DAR SITES
- NEWTOWN CREEK
- USGS



Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

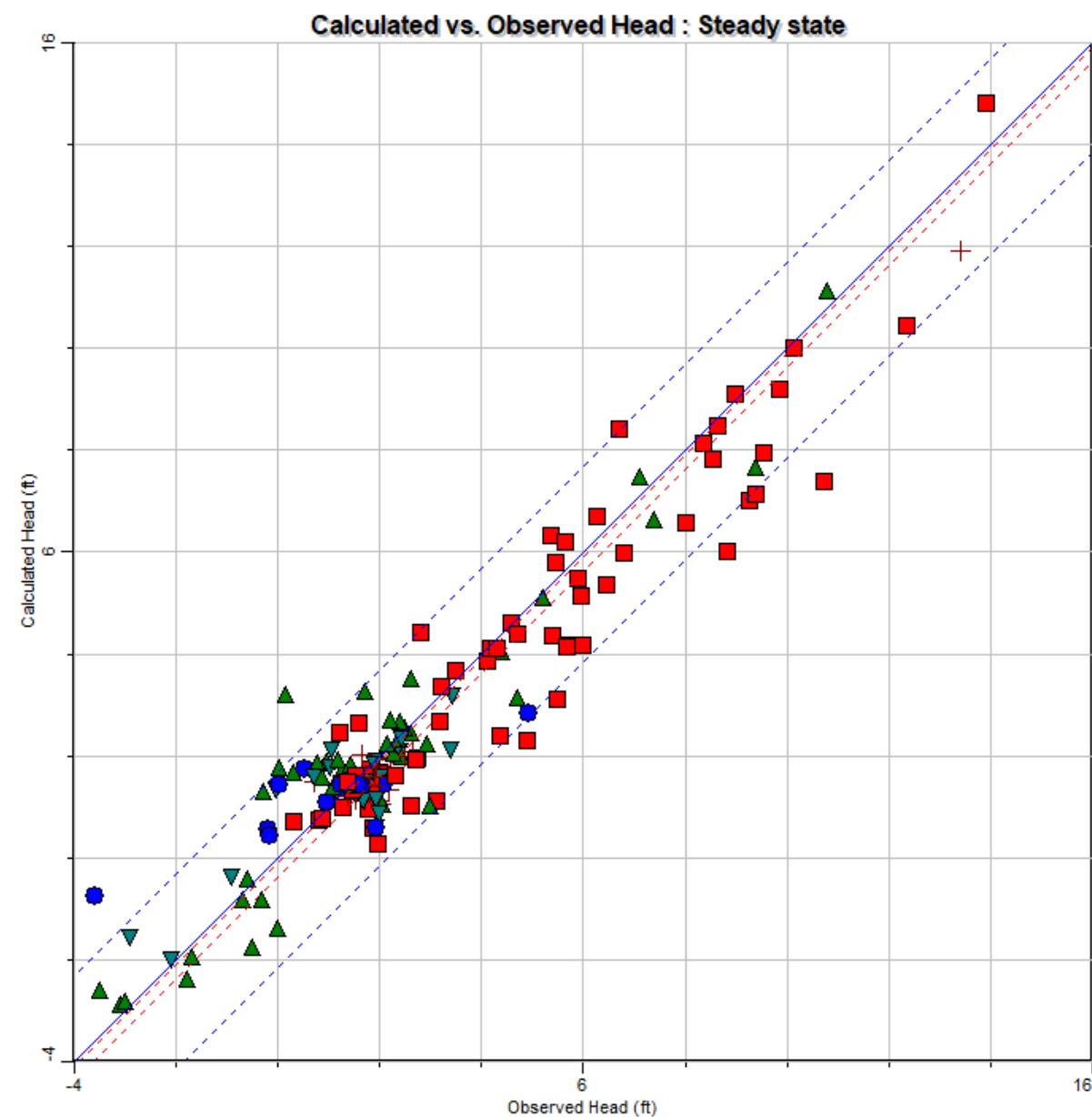


Project 125180

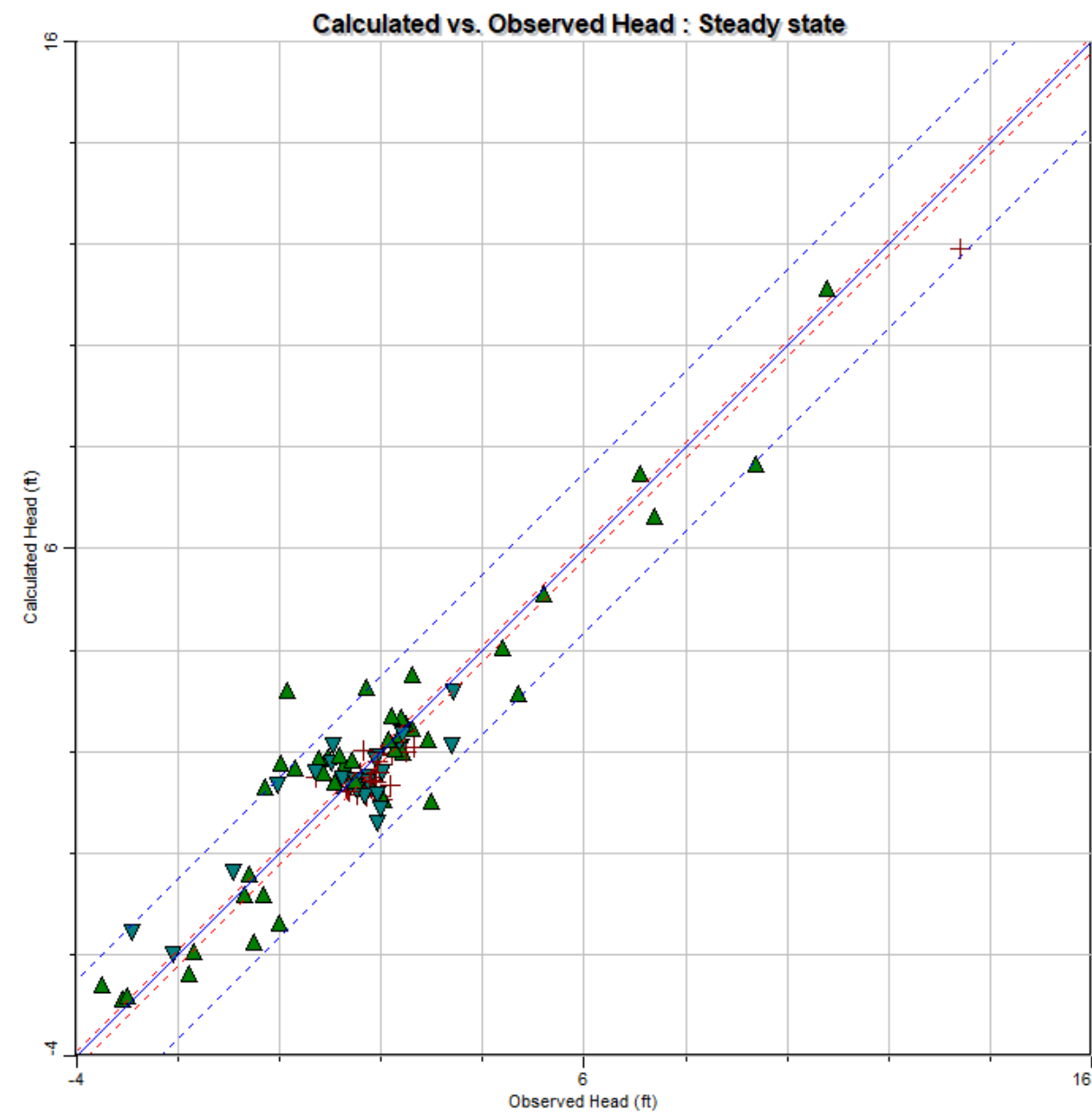
**CALIBRATION DATA
POINTS**

September 2019

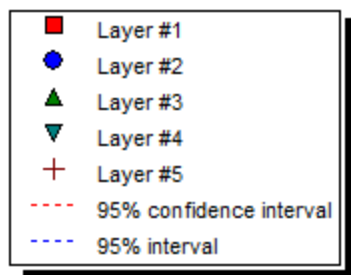
Figure L4-1



ALL MODEL LAYERS



UPPER GLACIAL AQUIFER LAYERS



95% Confidence Interval: Confidence that a calculated head for any given observed head would fall within the range shown.

95% Interval: Range in which 95% of data points are expected to fall, for example with an expanded calibration data set.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



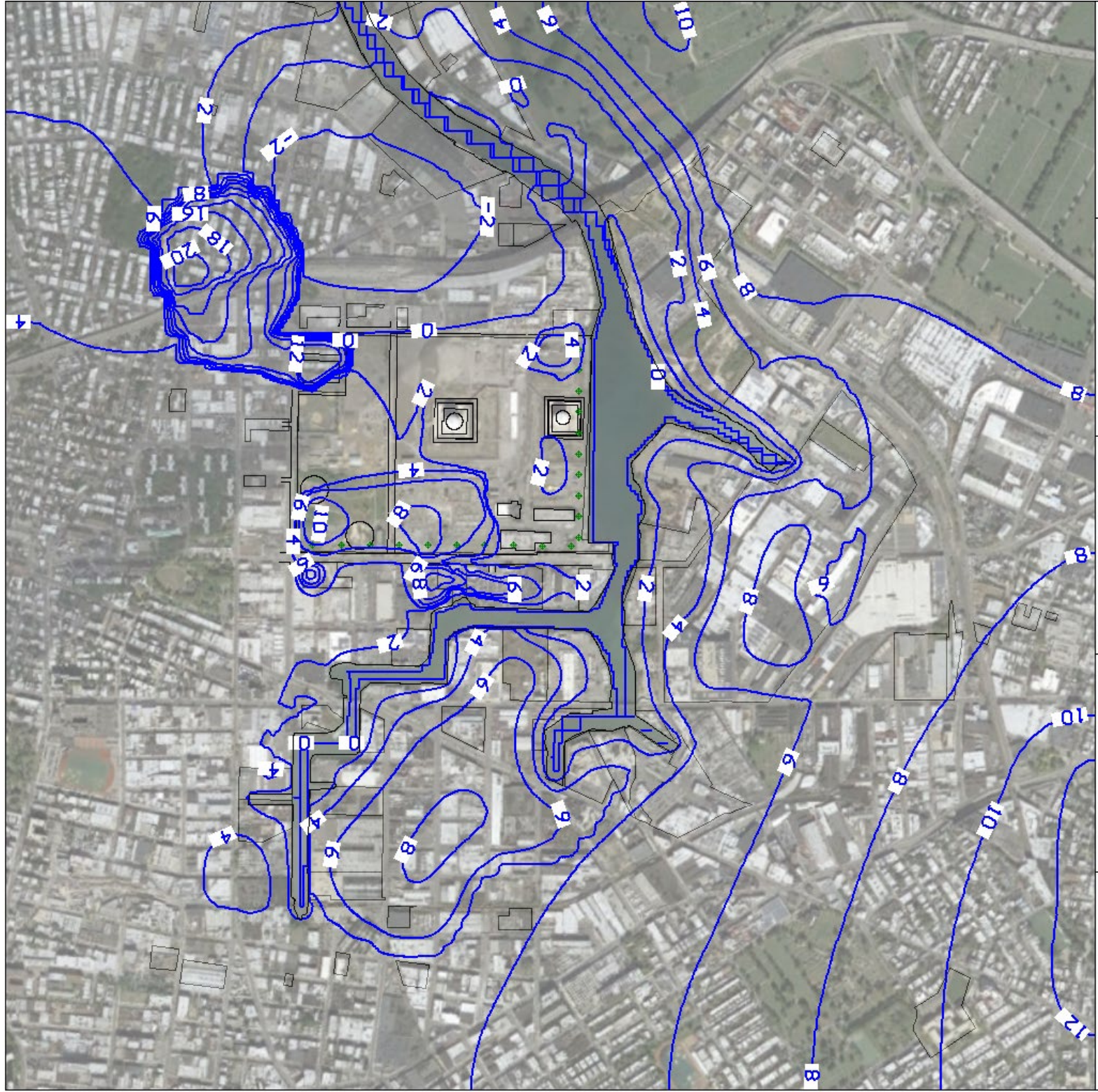
Project 125180

**CALIBRATION
RESIDUALS PLOTS**

September 2019

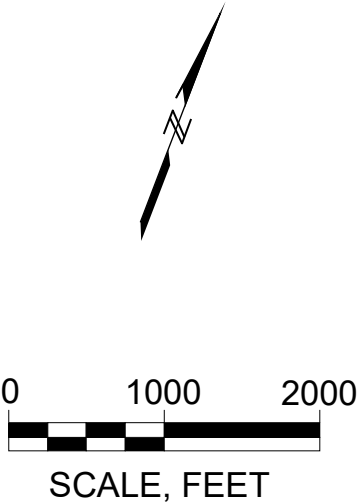
Figure L4-2

DRAFT



LEGEND

1.0 MODEL-CALCULATED GROUNDWATER ELEVATION CONTOUR, FT. NAVD

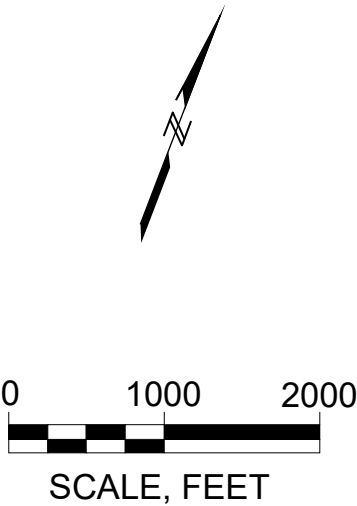


Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	QUALITATIVE CALIBRATION – WATER TABLE	
		Project 125180	September 2019 Figure L4-3

DRAFT

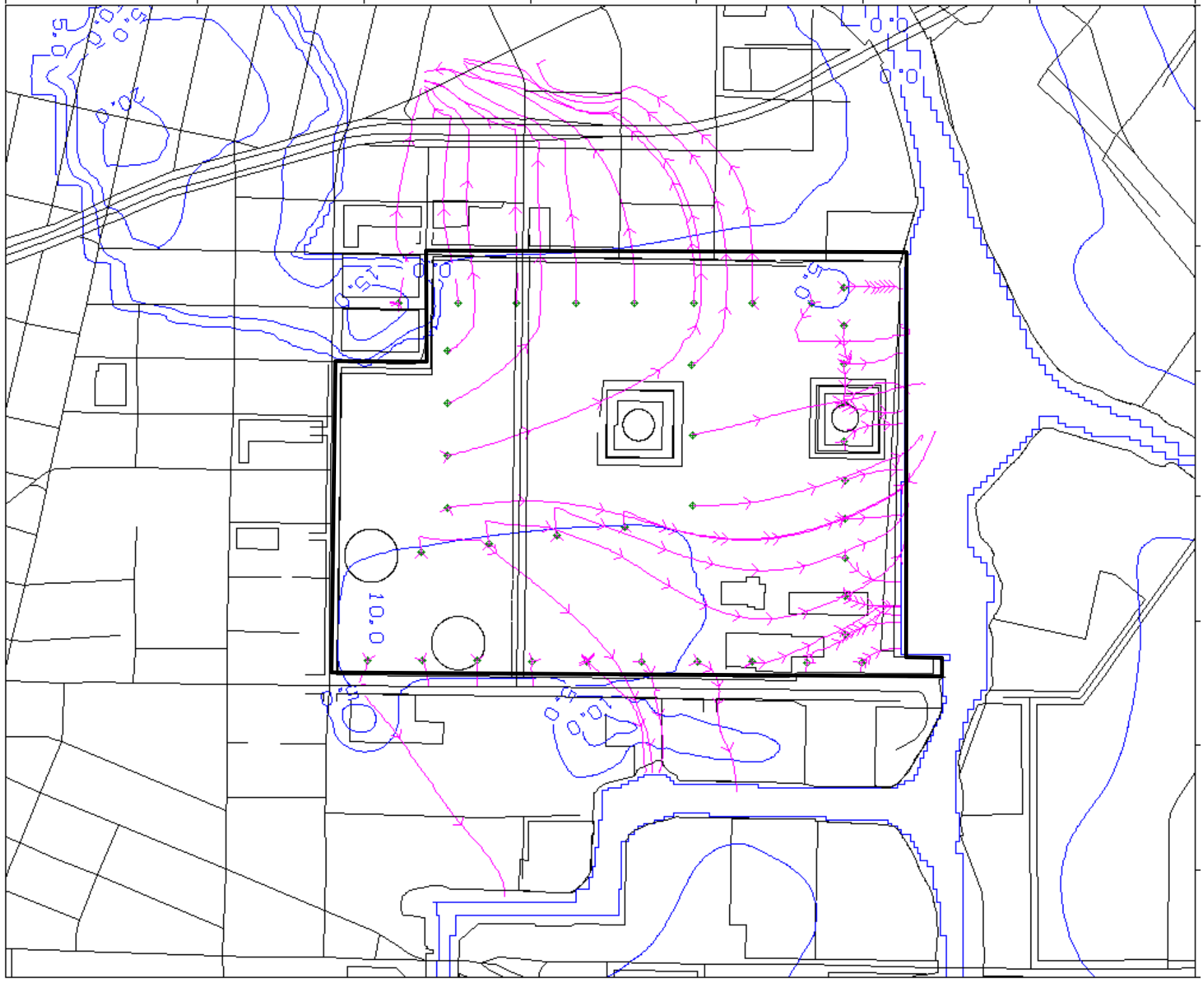
LEGEND

— 1.0 — MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD



Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	QUALITATIVE CALIBRATION – UPPER GLACIAL AQUIFER	
		Project 125180	September 2019 Figure L4-4

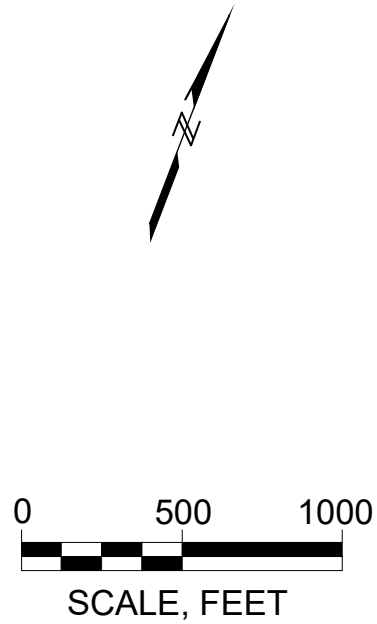
DRAFT



LEGEND

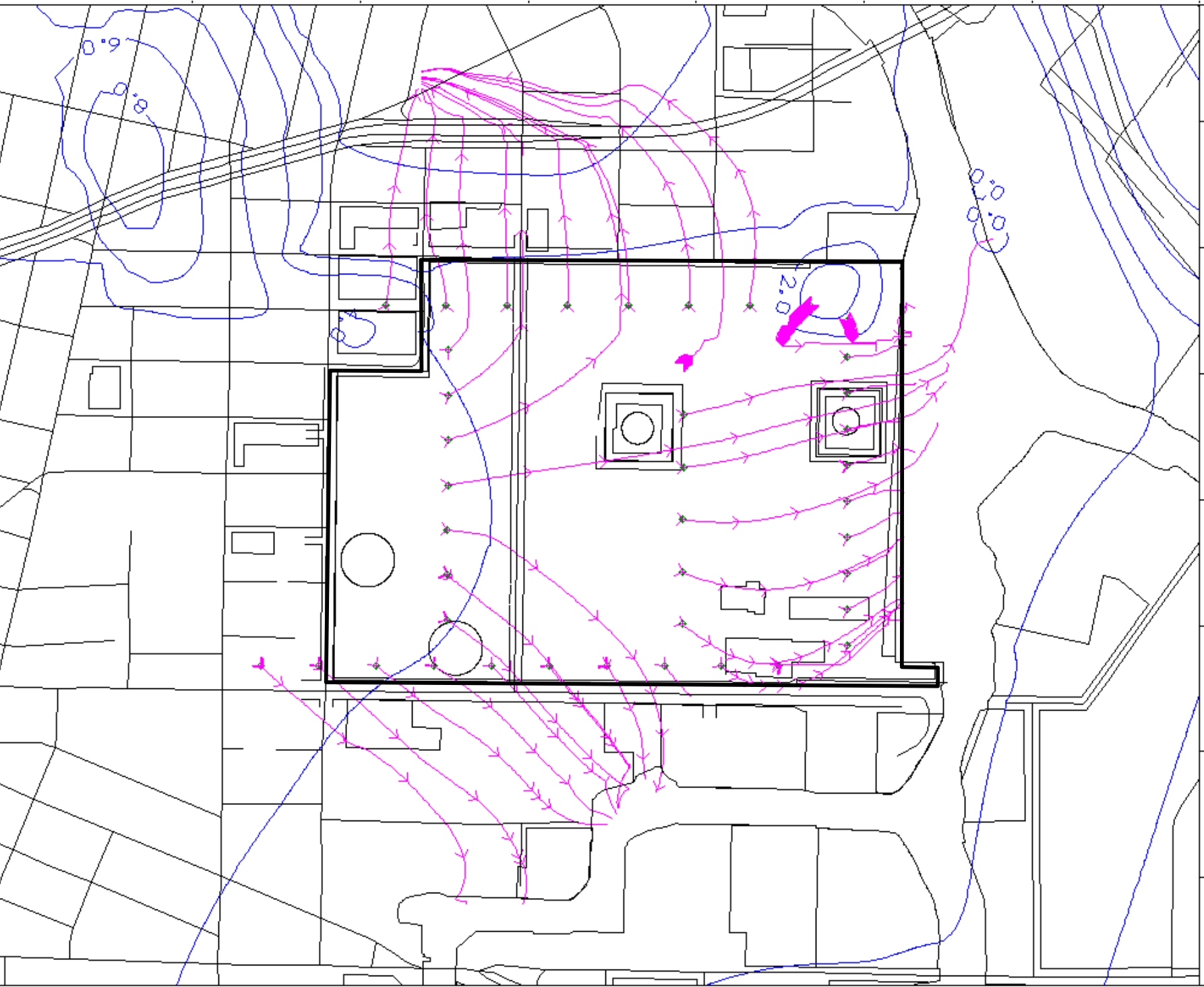
— 2 — MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD

➔ PARTICLE FLOW PATH (5 YR
TICK SPACING)



Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	COMPUTED GROUNDWATER FLOW – WATER TABLE	
nationalgrid	Project 125180	September 2019	Figure L5-1

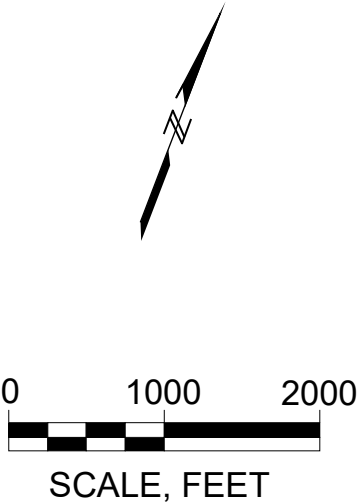
DRAFT



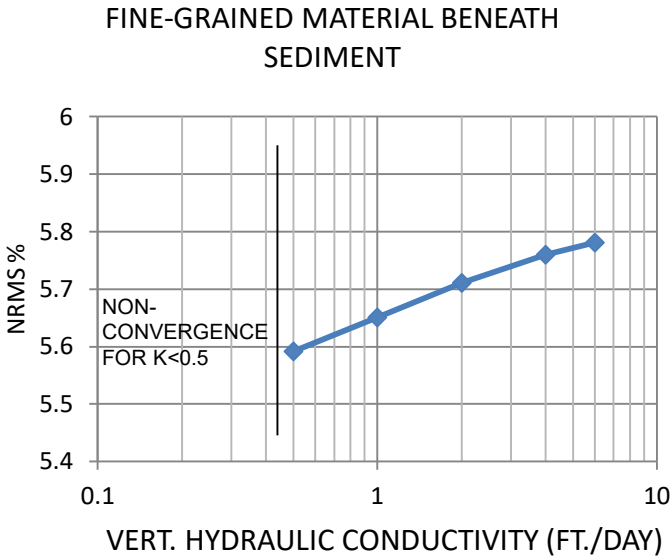
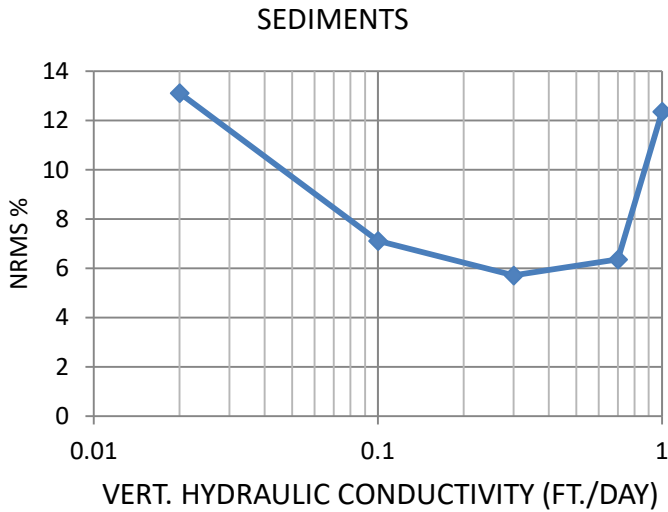
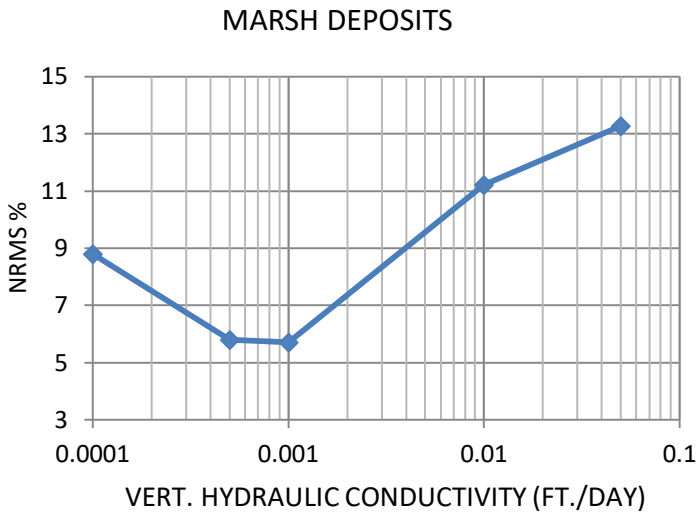
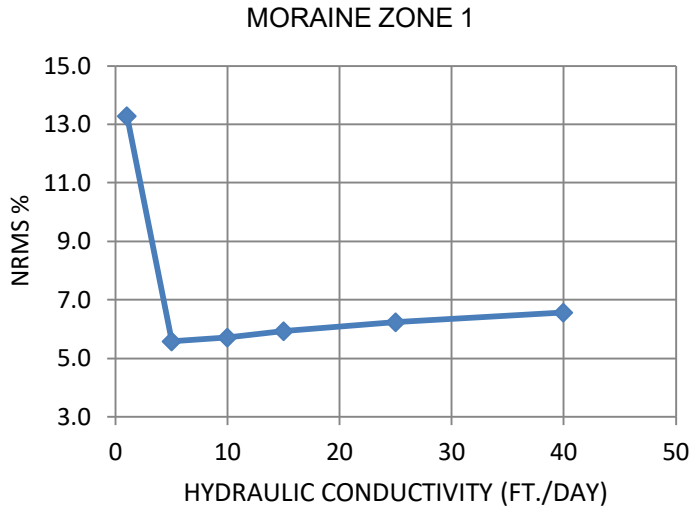
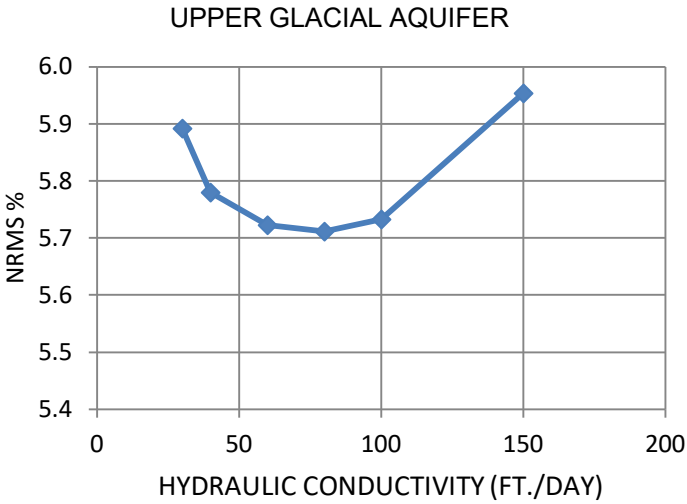
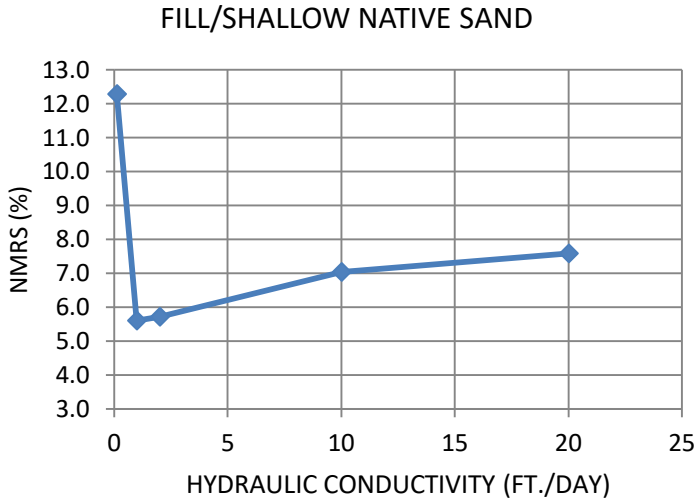
LEGEND

— 2 —

MODEL-CALCULATED
GROUNDWATER ELEVATION
CONTOUR, FT. NAVD



Groundwater Model Greenpoint Energy Center Brooklyn, New York	 GEI Consultants	COMPUTED GROUNDWATER FLOW – UPPER GLACIAL AQUIFER	
		Project 125180	September 2019 Figure L5-2



(a) EVERY 2nd CONTOUR REPORTED BY ANCHOR SHOWN FOR CLARITY.

Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid

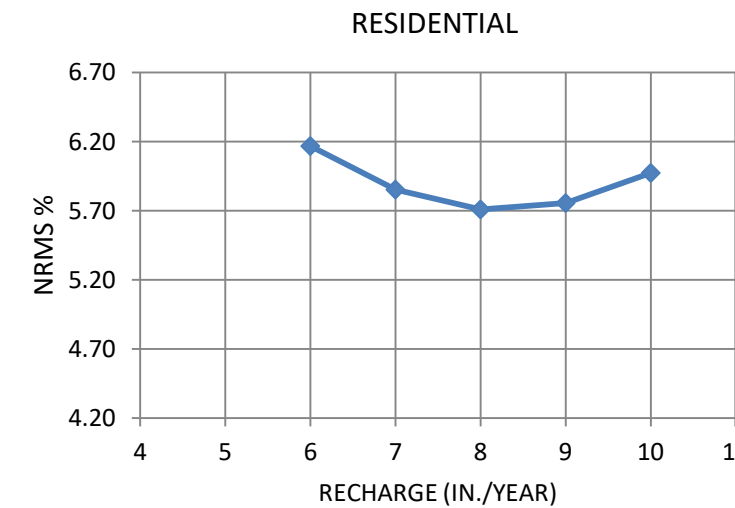
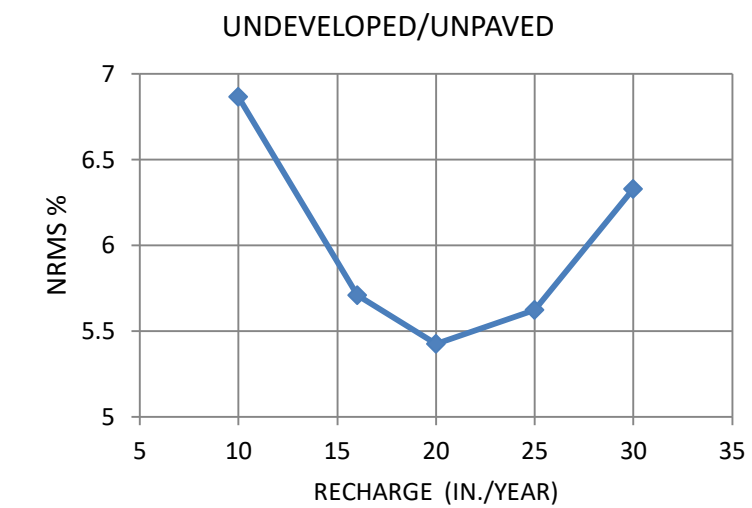
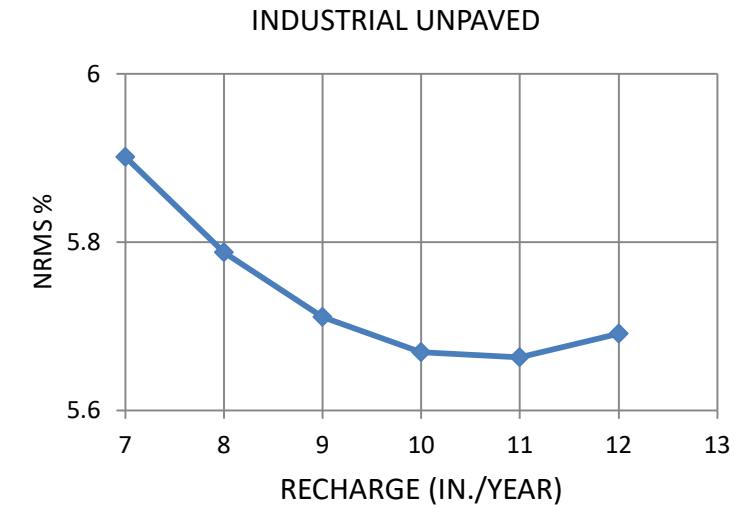
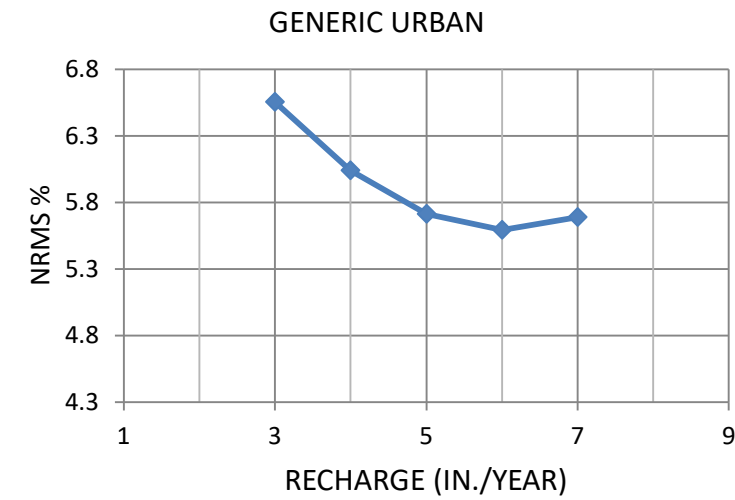


Project 125180

**SENSITIVY ANALYSIS
SOIL TYPE**

September 2019

Figure L5-3



(a) EVERY 2nd CONTOUR REPORTED BY ANCHOR SHOWN FOR CLARITY.

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	SENSITIVY ANALYSIS RECHARGE	
		Project 125180	September 2019 Figure L5-4

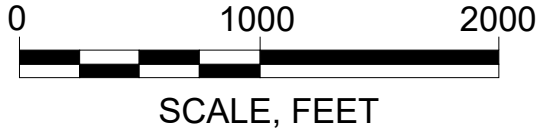


LEGEND

— 2 — MODEL-CALCULATED GROUNDWATER ELEVATION CONTOUR, FT. NAVD

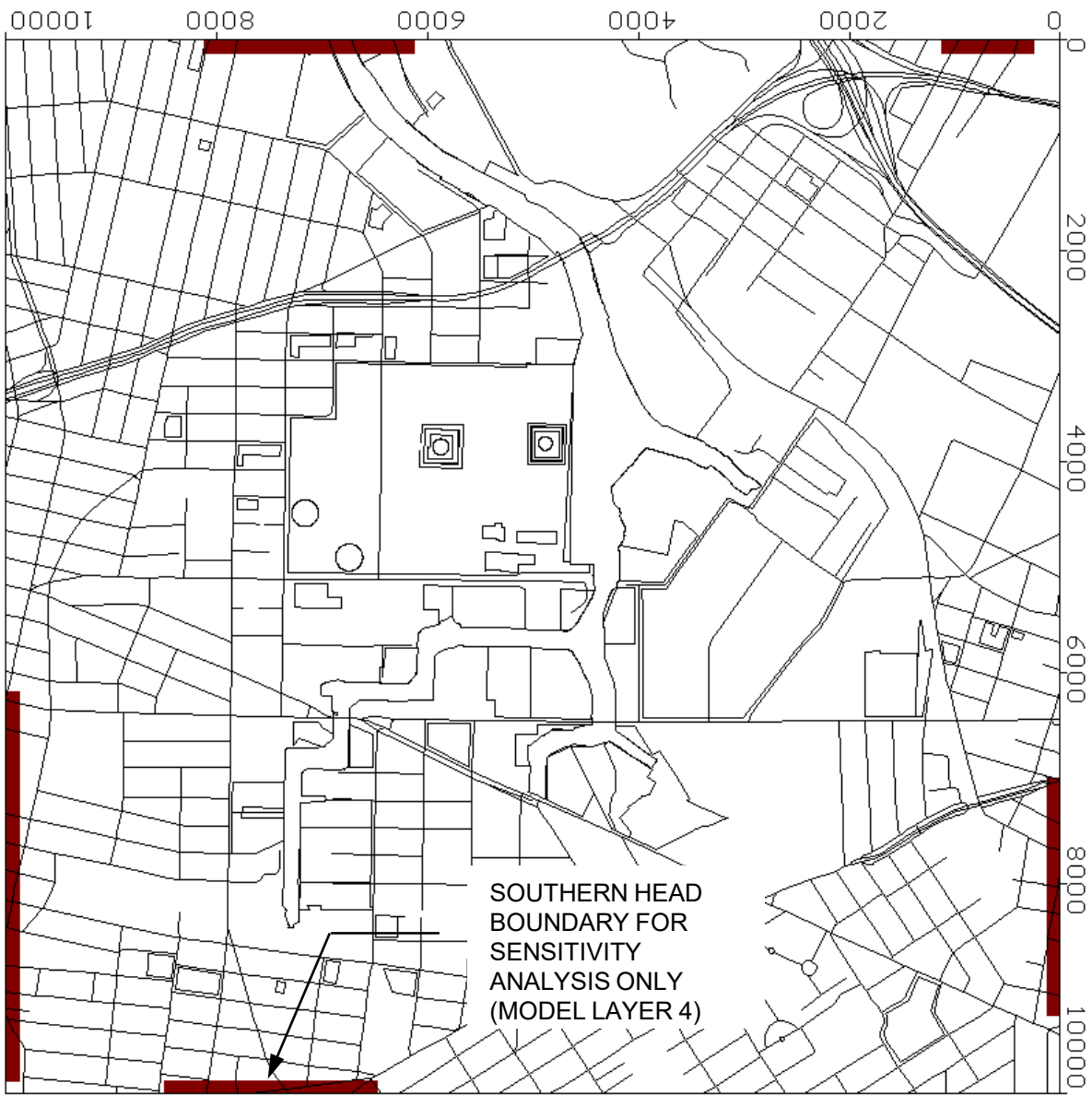
→ PARTICLE FLOW PATH

CAPTURE ZONE AS FUNCTION OF PUMPING RATE
SUPPLY WELL AT BROOKLYN TRUCK WASH

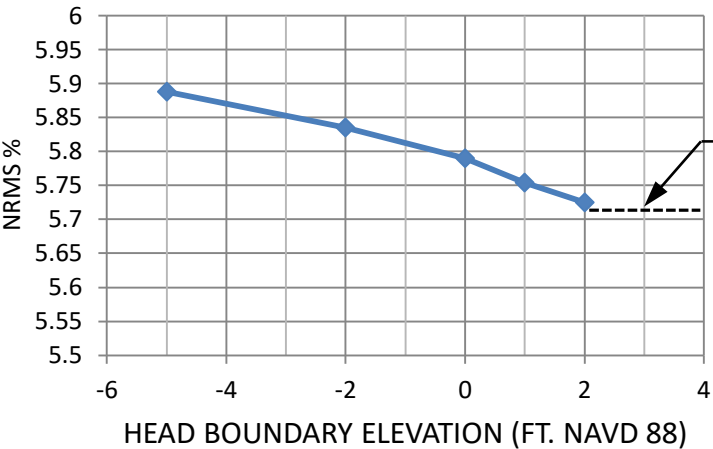


- NOTES:
- (a) PUMPING RATE AND EXACT WELL LOCATION NOT AVAILABLE. ASSUMED TO BE IN CENTER OF PROPERTY. PARTICLE PATH CAPTURE ZONE DELINEATION ANALYSIS PERFORMED TO ASSESS POTENTIAL INFLUENCE ON OFF-PROPERTY FLOW FROM GPEC.
 - (b) PUMP INTAKE SET IN MODEL LAYER 3, UPPER UGA. ABOVE GRAPHICS REPRESENT MODEL LAYER 3 EXCEPT THAT PARTICLE LINES TRAVEL DOWNWARD FROM RECHARGE SOURCES IN UPPER MODEL LAYERS.

Groundwater Model Greenpoint Energy Center Brooklyn, New York nationalgrid	GEI Consultants	SENSITIVY ANALYSIS SUPPLY PUMPING	
		Project 125180	September 2019 Figure L5-5



SOUTHERN HEAD BOUNDARY SENSITIVITY



MODEL-COMPUTED NMRS FOR CALIBRATED MODEL (WITH NO SOUTHERN CHB).

COMPUTED HEADS IN CALIBRATED MODEL WITH NO SENSITIVITY HEAD BOUNDARY ARE APPROXIMATELY 2 TO 4 FT. NAVD AT LOCATION OF SENSITIVITY BOUNDARY.

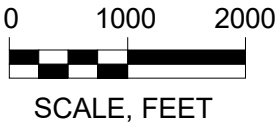
SENSITIVITY PLOT

NOTES:

- (a) HEAD BOUNDARY APPLIED AT LOCATION SHOWN TO ASSESS WHETHER PUMPING AT CORNELL BEVERAGES, OR TUNNEL DEWATERING AT MTA L-TRAIN SUBWAY MAY AFFECT MODEL. FOR SENSITIVITY ANALYSIS ONLY, EFFECTS OF PUMPING/DEWATERING MODELED AS HEAD BOUNDARY TO SIMULATE POTENTIAL NET EFFECTS ON CALIBRATION.
- (b) DUE TO LIMITED OR NO INFLUENCE OF HEADS AT SOUTHERN MODEL LIMIT IN RANGE EVALUATED, NO HEAD BOUNDARY IS USED OR CONSIDERED NECESSARY IN MODEL TO REPRESENT PUMPING WELL OR MTA SUBWAY TUNNEL.

LEGEND

CONSTANT HEAD BOUNDARY



Groundwater Model
Greenpoint Energy Center
Brooklyn, New York

nationalgrid



Project 125180

**SENSITIVITY ANALYSIS
POTENTIAL PUMPING /
DEWATERING LOCATIONS**

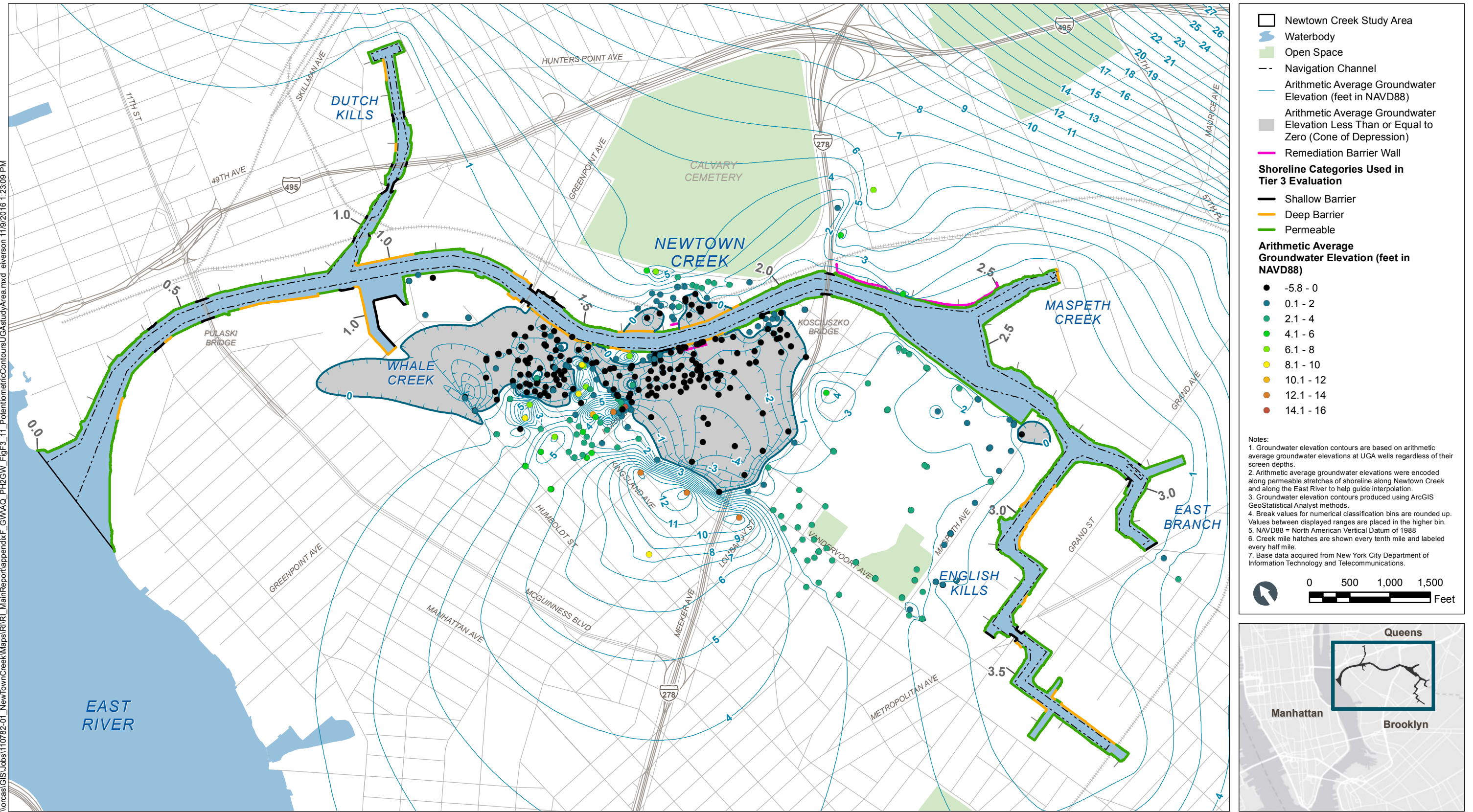
September 2019

Figure L5-6

Attachment A

Groundwater Contours

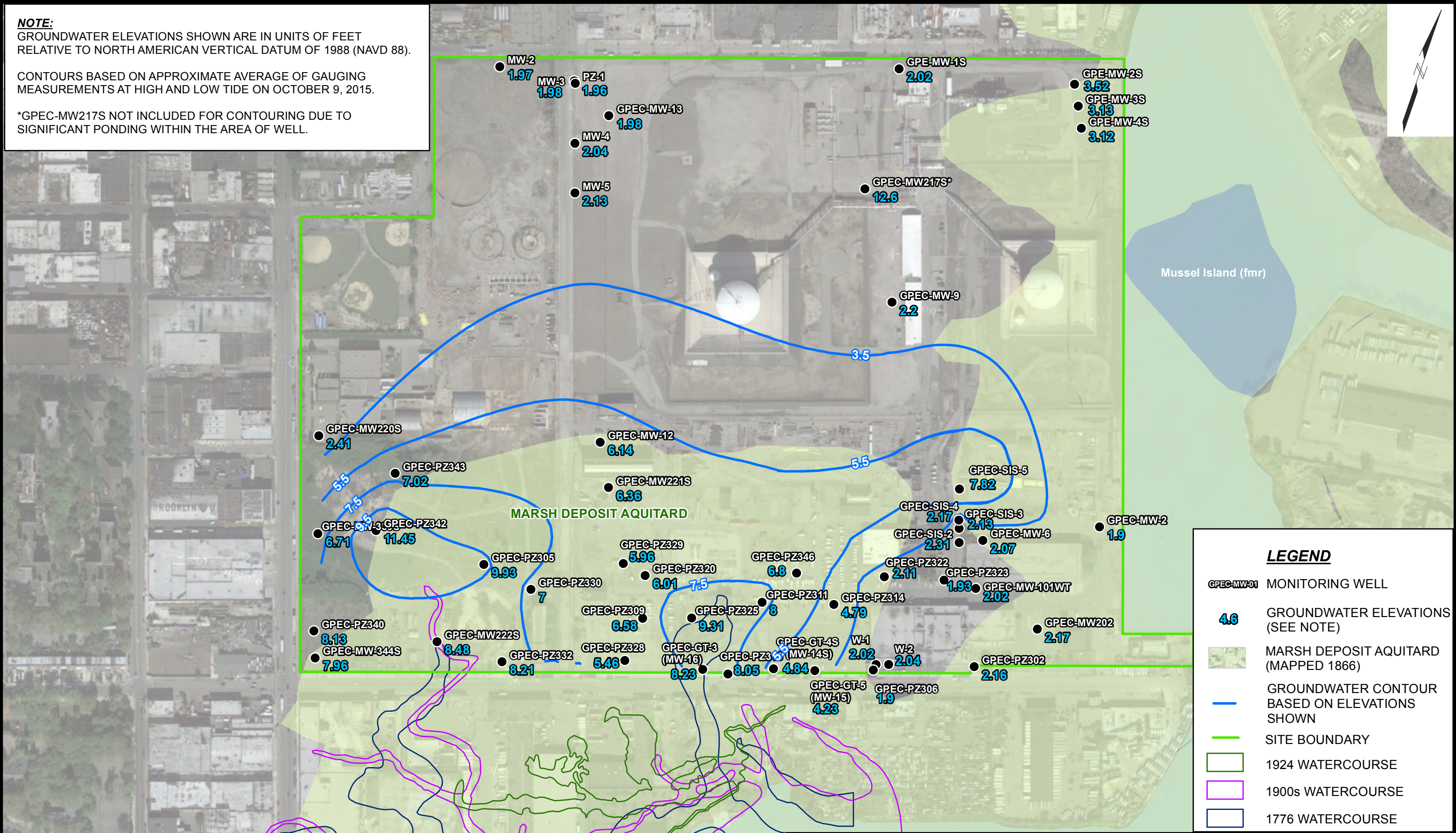
\\orca\GIS\Jobs\110782-01_NewtownCreek\Maps\RI\RI_MainReport\AppendixF_GWAQ_Ph2GW_FigF3_11_PotentiometricContoursUGAstudyArea.mxd everson 11/9/2016 1:23:09 PM



NOTE:
GROUNDWATER ELEVATIONS SHOWN ARE IN UNITS OF FEET
RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

CONTOURS BASED ON APPROXIMATE AVERAGE OF GAUGING
MEASUREMENTS AT HIGH AND LOW TIDE ON OCTOBER 9, 2015.

*GPEC-MW217S NOT INCLUDED FOR CONTOURING DUE TO
SIGNIFICANT PONDING WITHIN THE AREA OF WELL.



SOURCES:
1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO
(<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. 1900, and 1776 MAPPED WATERCOURSES FROM BROOKLYN UNION GAS DRAWING 7C57,
1924 MAPPED WATERCOURSE FROM 1924 HISTORIC AERIAL PHOTO PROVIDED BY AECOM.
3. KS. ENGINNERS SURVEY MAY, AUGUST AND SEPTEMBER 2015.



Interim Remedial Investigation Report
Greenpoint Energy Center
Brooklyn, New York

GROUNDWATER TABLE
ELEVATION CONTOURS
OCTOBER 2015

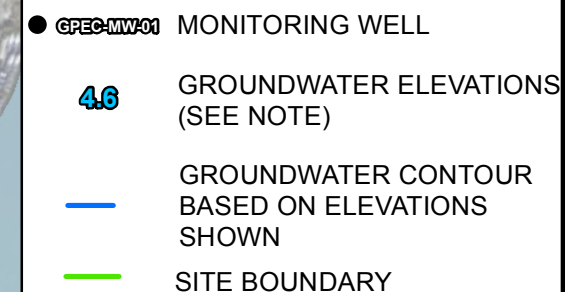
Project 125180

November 2016

Fig. 19

GROUNDWATER ELEVATIONS SHOWN ARE IN UNITS OF FEET
RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

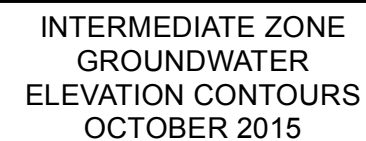
*GPEC-MW-8 NOT USED FOR CONTOUR PREPERATION DUE TO RAPID TIDAL RESPONSE IN WELL.



1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO (<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. KS. ENGINEERS SURVEY MAY, AUGUST AND SEPTEMBER OF 2015.



nationalgrid



Project 125180

November 2016

Fig. 20

NOTE:
GROUNDWATER ELEVATIONS SHOWN ARE IN UNITS OF FEET
RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

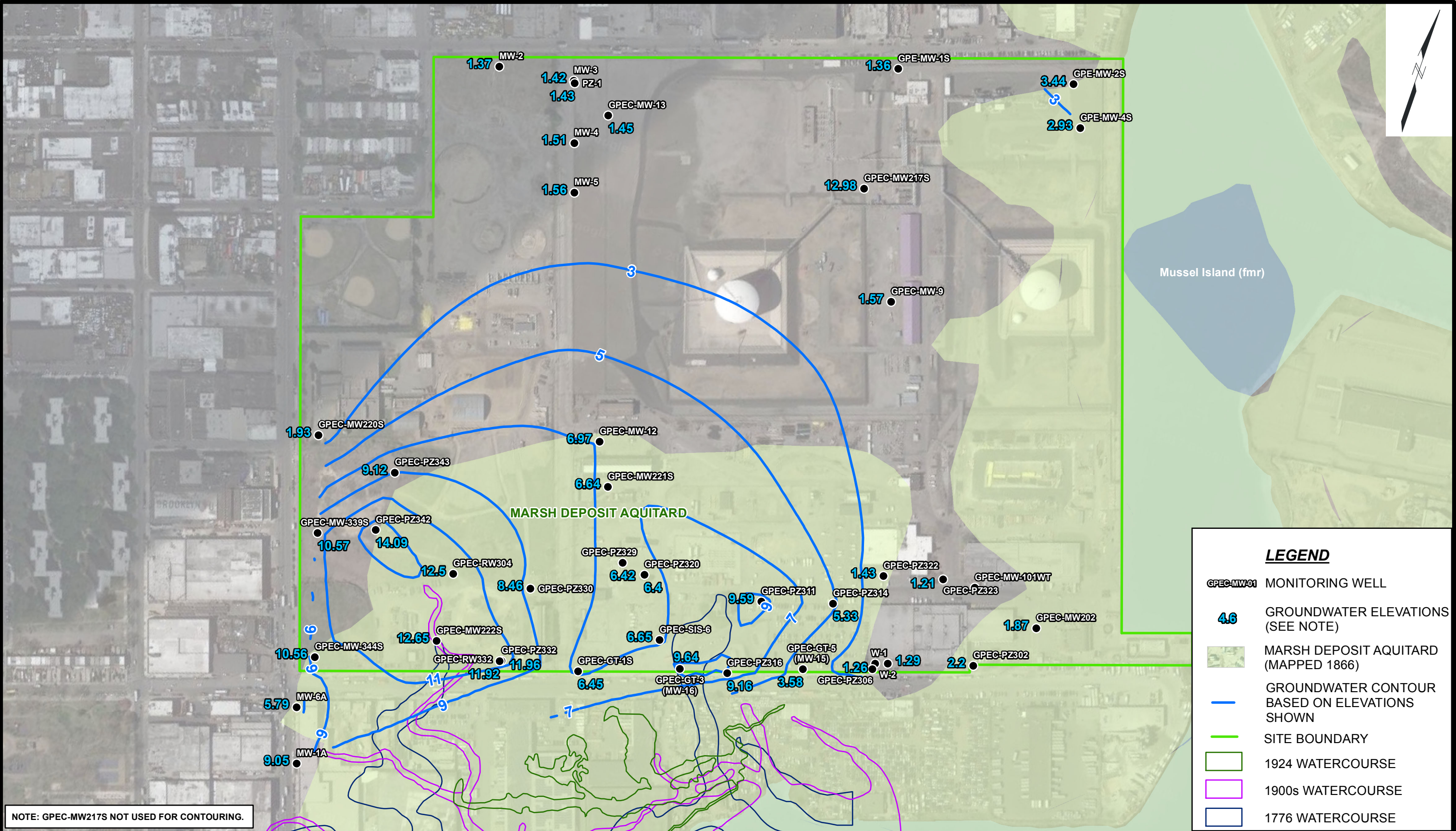
CONTOURS BASED ON APPROXIMATE AVERAGE OF GAUGING
MEASUREMENTS AT HIGH AND LOW TIDE ON OCTOBER 9, 2015.



SOURCES:
1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO
(<http://www.google.com/earth/>), IMAGERY DATE: 6/17/2010.
2. KS. ENGINEERS SURVEY MAY, AUGUST AND SEPTEMBER OF 2015.



Interim Remedial Investigation Report Greenpoint Energy Center Brooklyn, New York nationalgrid	 GEI Consultants	DEEP ZONE GROUNDWATER ELEVATION CONTOURS OCTOBER 2015	
		Project 125180	November 2016



SOURCES:

1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO (<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.

2. 1900, and 1776 MAPPED WATERCOURSES FROM BROOKLYN UNION GAS DRAWING 7C57, 1924 MAPPED WATERCOURSE FROM 1924 HISTORIC AERIAL PHOTO PROVIDED BY AECOM.

3. KS. ENINNERS SURVEY MAY, AUGUST AND SEPTEMBER 2015.

0 300 600

SCALE: 1" = 300'

Greenpoint Energy Center
Former Manufactured Gas Plant Site
Brooklyn, New York

SHALLOW ZONE
(0-25 FT BGS) ELEVATION
CONTOURS MARCH 2017

Project 125180 April 2017 Fig. 6



SOURCES:

1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO
(<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. 1900, and 1776 MAPPED WATERCOURSES FROM BROOKLYN UNION GAS DRAWING 7C57,
1924 MAPPED WATERCOURSE FROM 1924 HISTORIC AERIAL PHOTO PROVIDED BY AECOM.
3. KS. ENGINEERS SURVEY MAY, AUGUST AND SEPTEMBER 2015.



Greenpoint Energy Center
Former Manufactured Gas Plant Site
Brooklyn, New York

nationalgrid



Project 125180

LEGEND

- GPEC-MW-01 MONITORING WELL
- 4.6 GROUNDWATER ELEVATIONS
(SEE NOTE)
- GROUNDWATER CONTOUR
BASED ON ELEVATIONS
SHOWN
- SITE BOUNDARY

INTERMEDIATE ZONE
(25-60 FT BGS) ELEVATION
CONTOURS MARCH 2017

April 2017

Fig. 6



SOURCES:

1. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLETM EARTH PRO (<http://www.google.com/earth/>),IMAGERY DATE: 6/17/2010.
2. 1900, and 1776 MAPPED WATERCOURSES FROM BROOKLYN UNION GAS DRAWING 7C57, 1924 MAPPED WATERCOURSE FROM 1924 HISTORIC AERIAL PHOTO PROVIDED BY AECOM.
3. KS. ENINNERS SURVEY MAY, AUGUST AND SEPTEMBER 2015.

0 300 600

SCALE: 1" = 300'

Greenpoint Energy Center
Former Manufactured Gas Plant Site
Brooklyn, New York

nationalgrid

GEI Consultants

Project 125180

**DEEP ZONE
(< 60 FT BGS) ELEVATION
CONTOURS MARCH 2017**

April 2017

Fig. 6