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Feasibility Study Report

Goshen Former Manufactured Gas Plant Site

West Main Street, Goshen New York

Site No. 3-36-046

January 2011

Certification Statement

I, Jason D. Brien, P.E. certify that I am currently a NYS registered professional engineer and that this *Feasibility Study Report* was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER *Technical Guidance for Site Investigation and Remediation* (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

_____ Date _____

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Site No. 3-36-046

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Introduction

This *Feasibility Study Report* (FS Report) presents an evaluation of remedial alternatives to address environmental impacts identified at the NYSEG former manufactured gas plant (MGP) site (the site) located in Goshen, New York (New York State Department of Environmental Conservation [NYSDEC] Site No. 3-36-046). This FS Report has been prepared by ARCADIS of New York, Inc. (ARCADIS) on behalf of NYSEG in accordance with an Order on Consent (Index Number D0-0002-9309) between NYSEG and the NYSDEC.

The purpose of this FS Report is to identify and evaluate remedial alternatives that are:

- Appropriate for site-specific conditions
- Protective of public health and the environment
- Consistent with relevant sections of NYSDEC guidance

The overall objective of this FS Report is to recommend a reliable, cost-effective remedy that achieves the remedial action objectives (RAOs) established for the site.

Background

The approximately ¾-acre site is located on West Main Street in the Village of Goshen, in Orange County, New York. Figure 1 shows the site location. The site is owned by NYSEG and presently serves as a natural gas service center. The site is bounded by Rio Grande Creek at the northwest corner, Village of Goshen property to the north and northeast, private commercial properties to the east and west, and West Main Street to the south (see Figure 2). The site is zoned as commercial shopping (i.e., commercial) and properties around the site are zoned as industrial, central shopping, and one and two family residential. The site is also located within the Village of Goshen Architectural Design District.

The MGP operated for approximately 60 years (ca. 1885 to 1945), producing gas using the carbureted water gas and coal carbonization processes. The known extent of the former MGP is shown on Figure 2. The site was converted to a natural gas operations center between 1945 and 1947. While operational, the MGP consisted of a gas house (composed of a meter house, purifying/purifier houses, oil tanks, a boiler, a

generator, a washer, and a superheater), three gas holders, a shed, furnace area, coal storage area, retorts, and a lime kiln.

Nature and Extent of Impacts

Coal tar DNAPL in subsurface soil is responsible for the majority of the environmental impacts on site. NAPL-containing soil was observed at 13 of the 88 subsurface investigation locations completed during the various site investigations. The distribution of DNAPL observed at the site is due a combination of the northwesterly hydraulic gradient, gravitational forces, and heterogeneity of the overburden materials. DNAPL has been observed generally within the boundary of the eastern half of the site within the alluvial unit in the vicinity of former MGP structures (tar drip, former Gas Holders #1 and #2). The vast majority of the NAPL was encountered in relatively thin, sporadic seams at depths below the water table generally between 12 to 25 feet below grade. NAPL appears to have migrated only a short distance from the assumed NAPL sources (i.e., holders, tar drip). The deepest interval where NAPL (blebs only) was observed was approximately 33.5 feet below grade, where DNAPL appears to have penetrated the till unit at soil boring SB08-30, located west of the former holders. Recoverable amounts of NAPL have historically accumulated in NAPL monitoring well NMW08-02. Approximately one foot of NAPL was measured in the well during two NAPL monitoring events conducted in December 2008 and March 2009.

Subsurface soil sampling locations where elevated concentrations of MGP-related COCs were detected generally coincide with locations where DNAPL was observed; specifically north of the former tar drip and in the vicinity of the former holders. At least one subsurface soil sample collected from nine soil borings (57 total soil borings completed at the site) contained elevated concentrations of BTEX and PAHs (i.e., greater than 10 and 500 mg/kg, respectively). The greatest concentrations of MGP-related COCs were detected in subsurface soil samples collected from soil borings SB08-2(22.5'-23'), SB08-18(19'-19.5'), SB08-29(18.5'-19'), and piezometer PZ08-2(11'-11.5'). Visual observations of oil-like material (OLM) were noted at each of these sampling locations/intervals.

A total of 13 subsurface soil samples collected from soil borings, test borings, and test pits contained individual BTEX compounds and PAHs at concentrations greater than commercial SCOs. Additionally, 24 subsurface soil samples contained individual BTEX compounds and PAHs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs.

Potentially MGP-related dissolved phase compounds (i.e. BTEX and PAHs) were detected at concentrations greater than NYSDEC Class GA Standards or Guidance Values in groundwater samples collected from several shallow monitoring wells (screened within the fill and alluvial units). Elevated concentrations were generally detected on the northern half of the site, downgradient from areas where DNAPL was observed. Groundwater samples collected from monitoring well MW-08-05S contained the greatest concentrations of BTEX and PAHs. Monitoring wells MW-08-05D and MW-08-07D were the only deep monitoring wells to contain BTEX compounds and/or PAHs at concentrations greater than NYSDEC Class GA Standards and Guidance Values.

Remedial Action Objectives

RAOs are media-specific goals that, if met, would be comprehensive in protecting human health and the environment from the MGP-related impacts identified at the site. Potential site-wide remedial alternatives will be evaluated based on their ability to meet the RAOs and be protective of human health and the environment.

RAOs have not been developed for surface soil or Rio Grande Creek sediment based on the results of the Remedial Investigation and Human Health Exposure Assessment (HHEA) that indicated potentially MGP-related COCs detected site surface soil and sediment either are not conclusively present or do not pose a significant risk to human health or the environment. Proposed site-specific RAOs for subsurface soil and groundwater are presented in the following table.

Table ES.1 Remedial Action Objectives

RAOs for Subsurface Soil
RAOs for Public Health Protection
1. Prevent to the extent practicable ingestion/direct contact with MGP-related COCs/NAPL.
2. Prevent, to the extent practicable, inhalation of or exposure to MGP-related COCs from impacted soil.
RAOs for Environmental Protection
3. Address, to the extent practicable, MGP-related COCs/NAPL in soil that could result in impacts to groundwater or surface water.

RAOs for Groundwater
RAOs for Public Health Protection
1. Prevent, to the extent practicable, ingestion of groundwater containing MGP-related dissolved phase COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values.
2. Prevent, to the extent practicable, contact with or inhalation of VOCs from groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values.
RAOs for Environmental Protection
3. Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable.
4. Address the source of groundwater impacts to the extent practicable.
5. Mitigate, to the extent practicable, the discharge of groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values to surface water.

Remedial Technology Screening and Development of Remedial Alternatives

The objective of the technology screening is to identify general response actions (GRAs), associated remedial technology types and technology process options, and then narrow the universe of process options to those that have had documented success at achieving similar RAOs at former MGP sites to identify options that are implementable and potentially effective at addressing impacts identified for the project site. Based on this screening, remedial technology types and technology process options were eliminated or retained and subsequently combined into potential site-wide remedial alternatives for further, more detailed evaluation. This approach is consistent with the screening and selection process provided in DER-10.

Based on the results of the technology screening, the following potential site-wide remedial alternatives were developed.

- Alternative 1 – No Action
- Alternative 2 – NAPL Recovery, Groundwater Monitoring, and Institutional Controls
- Alternative 3 – MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

- Alternative 4 – MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

- Alternative 5 – Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring

Detailed Evaluation of Alternatives

Following the development of the remedial alternatives, a detailed description of each alternative was prepared and each alternative was evaluated with respect to the following criteria presented in DER-10:

- Short-Term Impacts and Effectiveness
- Long-Term Effectiveness and Permanence
- Land Use
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Implementability
- Compliance with SCGs
- Overall Protection of Public Health and the Environment
- Cost Effectiveness

These evaluation criteria encompass statutory requirements and include other gauges such as overall feasibility. Descriptions of the evaluation criteria are presented in the following sections. Additional criteria, including community acceptance, will be addressed following submittal of this FS Report.

Comparative Analysis of Alternatives

Following the detailed evaluation of each alternative, a comparative analysis of the alternatives was completed using the eight evaluation criteria. The comparative analysis indentified the advantages and disadvantages of each alternative relative to each other and with respect to the evaluation criteria. The results of the comparative analysis were used as a basis for recommending the preferred remedy for achieving the RAOs established for the site.

Preferred Remedial Alternative

Based on the comparative analysis of the remedial alternatives, Alternative 3 is the preferred remedial alternative for the site. This alternative would cost-effectively

achieve the best balance of the NYSDEC evaluation criteria. The preferred remedial alternative reduces the potential for future exposure to subsurface soil and groundwater containing MGP-related impacts.

The primary components of the preferred remedial alternative consist of the following:

- Pre-ISS excavation of approximately 760 cy of soil to account for material building during ISS treatment; verify the location of and remove subsurface obstructions (i.e., former MGP foundations and structures) that would prohibit ISS treatment to the target depths; and locate, protect, and facilitate relocation of subsurface utilities, as appropriate.

- Removal of the UST located south of former Gas Holder #2.

- ISS treatment of approximately 2,600 cy of subsurface soil (including an estimated 850 cy of MGP source material) to depths ranging from 12 feet to the top of the till unit (i.e., 26 to 28 feet below grade).

- Transportation and off-site disposal of approximately 2,900 tons of surface material and ISS spoils as C&D debris and 330 tons of site soil as a non-hazardous solid waste.

- Reuse of an assumed 380 cy of site soil that is suitable for subsurface backfill (i.e., free of visual impacts, odors, rubble, and debris).

- Importation of approximately 300 cy of clean fill material and the restoration of site surfaces.

- Installation of five NAPL collection wells to facilitate passive NAPL recovery.

- Establishing institutional controls on the NYSEG property in the form of deed restrictions and environmental easements to control intrusive (i.e., subsurface) activities that could result in potential damage to solidified soil and exposure to residual groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of non-treated groundwater on the NYSEG property.

- Preparation of an SMP to document the following:
  - The institutional controls that have been established and will be maintained for the site.
  - Extent of solidified soil.
  - Known locations of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 commercial use SCOs.
  - Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially stabilized material encountered during these activities.
  - Protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring.
  - Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities.
- Conducting semi-annual NAPL monitoring/passive NAPL recovery (i.e., manual bailing or pumping).
- Conducting annual groundwater monitoring to confirm groundwater flow direction and verify the extent and concentrations of dissolved phase COCs.
- Preparing an annual report to summarize semi-annual NAPL and annual groundwater monitoring activities and results.

Acronyms and Abbreviations

amsl	above mean sea level
BFS	blast furnace slag
BTEX	benzene, toluene, ethylbenzene, and xlyene
CAMP	community air monitoring plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/s	centimeter per second
COC	constituent of concern
C&D	construction and demolition
cy	cubic-yard
DAR	Division of Air Resources
DER	Division of Environmental Remediation
DNAPL	dense non-aqueous phase liquid
DUS/HPO	dynamic underground stripping and hydrous pyrolysis/oxidation
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
gpm	gallons per minute
GRA	general response action
HASP	health and safety plan

HHEA	Human Health Exposure Assessment
ISCO	in-situ chemical oxidation
ISS	in-situ stabilization
LDR	land disposal regulation
LTTD	low-temperature thermal desorption
MGP	manufactured gas plant
mg/kg	milligram per kilogram
NAPL	non-aqueous phase liquid
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
POTW	publicly-owned treatment works
PPE	personal protective equipment
ppm	part per million
PRB	permeable reactive barrier
QA/QC	quality assurance/quality control
RAO	remedial action objective

RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RI/FS	Remedial Investigation/Feasibility Study
SCGs	standards, criteria, and guidelines
SCO	soil cleanup objective
SCSDT	Site Characterization Summary and Data Transmittal
SMP	site management plan
SPI	Site Prioritization Investigation
SVOC	semi-volatile organic compound
TAGM	Technical and Administrative Guidance Memorandum
TCLP	Toxicity Characteristic Leaching Procedure
USACE	United States Army Corp of Engineers
USAF	United States Air Force
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UTS	universal treatment standard
UV	ultraviolet
VOC	volatile organic compound

1. Introduction

This *Feasibility Study Report* (FS Report) presents an evaluation of remedial alternatives to address environmental impacts identified at the NYSEG former manufactured gas plant (MGP) site (the site) located in Goshen, New York (New York State Department of Environmental Conservation [NYSDEC] Site No. 3-36-046). This FS Report has been prepared by ARCADIS of New York, Inc. (ARCADIS) on behalf of NYSEG in accordance with an Order on Consent (Index Number D0-0002-9309) between NYSEG and the NYSDEC.

1.1 Regulatory Frame Work

This FS Report has been prepared to evaluate remedial alternatives to address environmental impacts at the site in a manner consistent with the Order and with NYSDEC *DER-10 Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC, 2010).

This FS Report has also been prepared in consideration of the following documents:

- Applicable provisions of the New York State Environmental Conservation Law (ECL) and associated regulations, including Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 375-6 (6 NYCRR Part 375-6).

- NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4025 titled, *Guidelines for Remedial Investigations/Feasibility Studies* (NYSDEC, 1989).

- NYSDEC TAGM 4030 titled, *Selection of Remedial Actions at Inactive Hazardous Waste Sites* (NYSDEC, 1990).

- United States Environmental Protection Agency (USEPA) guidance document titled, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), Interim Final (USEPA, 1988a).

1.2 Purpose

The purpose of this FS Report is to identify and evaluate remedial alternatives that are:

- Appropriate for site-specific conditions
- Protective of public health and the environment
- Consistent with relevant sections of NYSDEC guidance

The overall objective of this FS Report is to recommend a reliable, cost-effective remedy that achieves the remedial action objectives (RAOs) established for the site.

1.3 Report Organization

This FS Report is organized as follows:

Table 1.1 Report Organization

Section	Purpose
Section 1 – Introduction	Provides background information relevant to the development of remedial alternatives evaluated in this FS Report.
Section 2 – Identification of Standards, Criteria, and Guidance	Identifies standards, criteria, and guidance (SCGs) that govern the development and selection of remedial alternatives.
Section 3 – Development of Remedial Action Objectives	Presents a summary of the site risk assessment and identifies site-specific RAOs that are protective of public health and the environment.
Section 4 – Technology Screening and Development of Remedial Alternatives	Presents the results of a screening process completed to identify potentially applicable remedial technologies and develops remedial alternatives that have the potential to meet the RAOs.
Section 5 – Detailed Evaluation of Remedial Alternatives	Presents a detailed description and analysis of each potential remedial alternative using the evaluation criteria presented in DER-10.
Section 6 – Comparative Analysis of Alternatives	Presents a comparative analysis of each remedial alternative using the evaluation criteria.
Section 7 – Preferred Remedial Alternative	Identifies the preferred remedial alternative for addressing the environmental concerns at the site.
Section 8 – References	Provides a list of references utilized to prepare this FS Report.

1.4 Background Information

This section summarizes site background information relevant to the development and evaluation of remedial alternatives, including site location and physical setting, site history and operation, and previous investigations conducted at the site.

1.4.1 Site Location and Description

The approximately ¾-acre site is located on West Main Street in the Village of Goshen, in Orange County, New York. Figure 1 shows the site location. The site is owned by NYSEG and presently serves as a natural gas service center. A gas regulator is located on northern portion of the site and another gas regulator is located within the eastern portion of the service center building. The site is bounded by Rio Grande Creek at the northwest corner, Village of Goshen property to the north and northeast, private commercial properties to the east and west, and West Main Street to the south (see Figure 2). Based on conversations with the Village of Goshen and according to the Village of Goshen Zoning Map (last updated August 2003), the site is zoned as commercial shopping (i.e., commercial). Areas immediately west of the site are zoned as industrial. Other areas in the immediate vicinity of the site are zoned as central shopping and one and two family residential. The site is also located within the Village of Goshen Architectural Design District. Properties and buildings located within this district are subject to regulations/restrictions regarding historical areas.

Site topography slopes gently downward to the north across most of the site, from West Main Street to the more steeply sloping south bank of Rio Grande Creek. The elevation of the site ranges between 430 and 437 feet above mean sea level (amsl). The eastern site boundary is bordered by a concrete wall that is approximately three feet high in the southeast corner and approximately 10 feet high in the northeast corner. The eastern half of the site contains the service center building (which was formerly the gas house associated with the MGP) and equipment lay-down/storage areas and is surrounded by a chain-link fence with double-swing gates located on the western and southeastern sides of the fenced area. The site contains no distinctive surface water runoff pathways, such as drainage ditches or storm drains. The paved areas, consisting of the driveway and the parking area in the eastern half of the property, allow for surface water runoff to Rio Grande Creek. Rio Grande Creek flows from the northeast to the southwest.

1.4.2 Site History

The known extent of the former MGP is shown on Figure 2. MGP operations began at the site between 1885 and 1889 as a carbureted water gas plant. The plant was apparently converted to a coal gas plant in 1923 and continued to operate as a coal gas plant until sometime between 1945 and 1947, when the facility was converted to a natural gas operations center (Engineering-Science [ES], 1991). During this time, the site was owned by the A. VanDerwerken Water Gas Works (circa 1889 to circa 1905), Goshen Gas Light Company Water Gas Works (circa 1905 to circa 1923), Goshen Illuminating Company Coal Gas Plant (circa 1923 to 1945), Associated Gas & Electric Company (1945 to 1947) and NYSEG (1947 to present). While operational, the MGP consisted of a gas house (composed of a meter house, purifying/purifier houses, oil tanks, a boiler, a generator, a washer, and a superheater), three gas holders, a shed, furnace area, coal storage area, retorts, and a lime kiln.

1.4.3 Summary of Investigations and Site Activities

This section summarizes the previous investigations and remedial measures that have been conducted at the site. The results of the investigations were used to develop the site characterization presented in Section 1.5.

1.4.3.1 Site Prioritization Investigation (1990)

In October and November 1990, ES conducted a Site Prioritization Investigation (SPI) on behalf of NYSEG. The SPI was a preliminary site evaluation designed to assess whether the site posed an imminent threat to human health and/or the environment and to establish a rank for the site relative to NYSEG's other MGP sites.

ES collected a total of five surface-soil samples from the upper 0.5 foot of soil, three surface-water samples from Rio Grande Creek, and three sediment samples (collected at the same locations as the surface-water samples). Surface-soil, surface-water and sediment samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals and cyanide using United States Environmental Protection Agency (USEPA) methods.

SPI findings were presented in a report titled *Prioritization of Former Manufactured Gas Plant Site, Goshen Site (ES, 1991)*. ES concluded that the most significant risk associated with the site was direct contact with surface soil, fill and residues exposed along the banks of Rio Grande Creek. Analytical results for sediment and surface water

collected from Rio Grande Creek showed no indications of MGP impacts. Groundwater and subsurface soil had not been investigated and posed the most significant data gap. Based on these findings and the site priority ranking, NYSEG chose to initiate further investigations of the site by conducting a Task II Remedial Investigation (Task II RI).

1.4.3.2 Task II Remediation Investigation (1992 to 1994)

Following completion of the SPI, NYSEG initiated the Task II RI. In 1992, Blasland, Bouck & Lee, Inc. (BBL; now known as ARCADIS) developed a conceptual model for the site that noted data gaps to be addressed by the Task II RI. These gaps included the nature of potential source areas and the extent of MGP impacts on environmental media, particularly subsurface soil and groundwater.

To address the data gaps identified by BBL, the Task II RI consisted of the following general field activities that were performed in accordance with a Task II Remedial Investigation Work Plan (BBL, 1993):

- excavating six test pits and collecting soil samples for laboratory analysis
- completing seven test borings and collecting soil samples for laboratory analysis
- collecting and submitting water samples from an underground storage tank (UST) and cistern structure (located near former Gas Holder #2) for laboratory analysis
- collecting and submitting five surface soil samples for laboratory analysis
- installing six overburden groundwater monitoring wells in pairs
- collecting and submitting four rounds (October, 1993; January, April and July, 1994) of groundwater samples from the new wells for laboratory analysis
- conducting sediment probing upstream, adjacent to, and downstream from the site and collecting eight sediment samples for laboratory analysis

The results of the Task II RI were documented in the Site Characterization Summary and Data Transmittal (SCSDT), which was submitted to the NYSDEC in February 2001 (BBL, 2001). In general, results of the Task II RI indicated that that the extent of MGP-impacted soil, sediment and groundwater at the site is relatively limited. Subsurface

soils from test borings in former Gas Holders #1 and #2, and north of the former tar drip were observed to contain a coal tar-type non-aqueous phase liquid (NAPL).

1.4.3.3 Tar Drip Remedial Measure (2007)

NYSEG completed a remedial measure in May 2007 to remove tarry material in the apparent former tar drip (i.e., sump-like) structure located in the storage area of the former gas house (current service center building).The top of the 1-foot diameter circular sump was flush with the concrete floor of the storage room and the bottom of the sump was approximately 1.5 feet below the floor slab. Prior to the remedial measures, the surface of the sump was covered with a circular metal plate and the sump contained approximately 4 inches of standing water overlaying a tarry material. In May 2007, ARCADIS removed approximately 1 gallon of water and 4 gallons of tar-like material from the sump and placed the liquids into New York State Department of Transportation- (NYSDOT-) approved 55-gallon drums for characterization and disposal. The sump was then filled with a non-shrink grout.

1.4.3.4 Soil Vapor Intrusion Evaluation (2008)

ARCADIS conducted a soil vapor intrusion (SVI) evaluation at the site on March 14 and 15, 2008 in accordance with the sampling methods and analytical procedures described in the SVI Evaluation Work Plan (ARCADIS, 2008a). The SVI evaluation consisted of:

- walking through the building and completing the New York State Department of Health (NYSDOH) Indoor Air Quality Questionnaire and Building Inventory form
- collecting three co-located sub-slab and indoor air samples inside/beneath the floor slab of the service center building
- collecting two stand-alone indoor air samples inside the service center building
- collecting one upwind ambient air sample outside of the service center building

Each soil vapor/air sample was collected using a 6-liter SUMMA® canister over a 24-hour sampling period and samples were submitted for laboratory analysis in accordance with the USEPA Compendium Method TO-15, titled *Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry*. Results of SVI were presented in the *SVI Evaluation Report* (ARCADIS, 2008b).

1.4.3.5 Remedial Investigation (2008 to 2009)

ARCADIS conducted RI activities from October 2008 to October 2009 to achieve the following objectives:

- Characterize the site by establishing the nature and extent of on- and off-site MGP-related impacts.
- Provide the information needed to prepare a FS for evaluating on- and off-site remedial actions to address MGP-related impacts.

RI activities were conducted in accordance the NYSDEC-approved *Remedial Investigation Work Plan* (ARCADIS, 2008c) and generally consisted of the following:

- completing 50 soil borings and collecting soil samples for laboratory analysis
- excavating two test pits and collecting soil samples for laboratory analysis
- collecting 11 surface soil samples for laboratory analysis
- installing 12 overburden groundwater monitoring wells, three piezometers, and two NAPL monitoring wells
- collecting and submitting three rounds (October 2008, December 2008 and March/April 2009) of groundwater samples from the site wells for laboratory analysis
- conducting specific-capacity testing at each monitoring well to estimate hydraulic conductivity
- completing creek reconnaissance and sediment probing in the Rio Grande Creek at 165 locations along 33 transects
- collecting 18 sediment cores, 61 sediment core samples, and six sediment grab samples for laboratory analysis
- collecting six surface water samples for laboratory analysis

A detailed discussion of the RI activities and results is presented in the *Remedial Investigation Report* (RI Report) (ARCADIS, 2010).

1.5 Site Characterization

This section presents an overall site characterization and a summary of the nature and extent of impacted media at the site based on the results obtained for the site investigation activities conducted to date. The site characterization consists of a summary of site geology and hydrogeology and the nature and extent of impacts. A detailed site characterization is presented in the RI Report.

1.5.1 Site Geology and Hydrogeology

Geologic and hydrogeologic conditions at the site are discussed below.

1.5.1.1 Geology

Site investigations identified three relevant unconsolidated geologic units beneath the site: fill, alluvium, and till. Geologic cross sections are shown on Figures 3 and 4.

Fill

The fill unit is generally 10 to 12 feet thick and consists of reworked alluvial deposits (sands, gravels, silts) and anthropogenic materials (e.g., slag, coal, wood, metal, ash, concrete, brick and foundations from former MGP structures. The saturated thickness of the fill on site is generally 2 to 10 feet, and is thinnest along southern edge of the site and near Rio Grande Creek. The saturated thickness of the unit is greatest in the areas of former Gas Holders #1 and #2 (approximately 10 feet).

Alluvium

An alluvial sand and silt unit is located directly beneath the fill unit and consists of deposits of fine sands, silts, and varying amounts of clay and gravel. In general, this sand and silt unit is less permeable than the overlying fill unit. The alluvial unit is found throughout the site with a relatively uniform thickness between approximately 15 to 19 feet. The alluvial unit is thickest in the area just to the north of the service center building where two depressions are present in the surface of the underlying till. The upper several feet of the sand and silt unit were likely reworked as the site was developed. This unit is fully saturated across the site.

Till

The till unit is located directly beneath the alluvial unit and consists of dense matrix of sand, silt, and varied amounts of gravel and clay. The dense nature of the till suggests that it is a lodgment till. Lodgment till is deposited by ice at the base of the glacier, and is typically very compact due to the immense weight of the overlying glacier that deposited the material. In general, the till unit appears to be slightly less permeable than the overlying sand and silt unit. The bottom of the till unit was not encountered during investigation activities but is estimated to have a thickness greater than 15 feet.

1.5.1.2 Hydrogeology

Groundwater flow beneath the site is primarily within the three above-mentioned geologic units. The water table lies within the fill unit at approximately 3 to 10 feet below grade. Shallow groundwater flow trends northwest (see Figure 5), towards Rio Grande Creek at a fairly steep gradient of 0.09 ft/ft. Groundwater contours indicate irregular flow within the area of former Gas Holders #1 and #2, which suggests that the foundations for these holders may influence shallow groundwater flow.

The general groundwater flow trend in the deeper alluvium and till units is westward, parallel to the creek (see Figure 6). Water-level data suggests a downward hydraulic gradient across most of the site. However, upward gradients appear to exist at well clusters located near Rio Grande Creek. Even though downward and upward gradients exist at the site, the preferred groundwater flow direction is horizontal.

1.5.2 Nature and Extent of Impacts

Manufactured gas-production byproducts, typically dense non-aqueous phase liquid (DNAPL) (i.e., coal tar), often account for the majority of the impacts at former MGP sites. Principal components of coal tar routinely analyzed for at MGP sites consist of benzene, toluene, ethylbenzene, and xlyene (BTEX) compounds, which are VOCs, and polycyclic aromatic hydrocarbons (PAHs), which are SVOCs. Visual characterization of media and laboratory analysis of environmental samples for these two classes of organic compounds is a useful way of identifying the nature and extent of environmental media affected by coal tar. Because coal tar typically contains elevated levels of these compounds, soil samples and groundwater monitoring wells that contain coal tar need not always be analyzed; rather the levels of BTEX and PAHs are assumed to be above applicable SCGs. Therefore, for the purpose of this Feasibility Study, BTEX and PAHs have been identified as the constituents of concern

(COCs) for the site. As indicated in the RI Report, purifier waste was not observed in any subsurface investigation work and only low levels of cyanide were detected in site soil and groundwater. Therefore, cyanide is not a concern at this site and is not considered a COC. The following subsections present a summary of the nature and extent of MGP-related environmental concerns identified for the site based on these COCs and the presence of NAPL.

1.5.2.1 Surface Soil Quality

Surface soil samples were collected from both on-site and off-site locations. Analytical results for the surface soil samples were compared to the NYSDEC 6 NYCRR Part 375-6 soil cleanup objectives for the protection of human health based commercial future use (commercial SCOs) and protection of ecological resources (ecological SCOs). Surface soil samples SB08-21 and SB08-22, collected inside the service center building footprint (i.e., beneath the concrete building floor) contained the greatest total PAHs concentrations: 1,100 and 300 milligrams per kilogram (mg/kg), respectively. In general, other surface soil samples only contained PAHs at concentrations that slightly exceeded the commercial and ecological SCOs. Remaining surface soil samples collected within the service center property boundary contained total PAHs at concentrations up to 100 mg/kg. However, surface soil samples collected from off-site locations (i.e., north of Rio Grande Creek and more than 300 feet west of the site) also contained total PAHs at concentrations up to 100 mg/kg.

Cyanide was detected in 4 of the 21 surface soil samples at concentrations ranging from 2.60 to 19.4 mg/kg. Cyanide concentrations were similar in on-site and off-site surface soil samples. Note that 6 NYCRR Part 375-6 does not specify an ecological SCO for cyanide, but the commercial SCO for cyanide is 27 mg/kg. Additionally, metals were detected in select surface soil samples at concentrations greater than ecological SCOs. The slightly elevated concentrations of PAHs and elevated metals/inorganics concentrations in the surface soil samples outside the service center building can be attributed to urban fill present at the site.

1.5.2.2 NAPL Distribution and Characterization

Coal tar DNAPL in subsurface soil is responsible for the majority of environmental impacts on site. NAPL-containing soil was observed at 13 of the 88 subsurface investigation locations completed during the various site investigations. The distribution of DNAPL observed at the site is likely due a combination of the predominant northwesterly hydraulic gradient, gravitational forces, and heterogeneity of the

overburden materials. DNAPL has been observed generally within the boundary of the eastern half of the site within the alluvial unit in the vicinity of former MGP structures (tar drip, former Gas Holders #1 and #2). The vast majority of the NAPL was encountered in relatively thin, sporadic seams at depths below the water table generally between 12 to 25 feet below grade. NAPL appears to have migrated only a short distance from the assumed NAPL sources (i.e., holders, tar drip). The deepest interval where NAPL (blebs only) was observed was approximately 33.5 feet below grade, where DNAPL appears to have penetrated the till unit at soil boring SB08-30, located west of former Gas Holders #1 and #2 (see Figure 7). Recoverable amounts of NAPL have historically accumulated in NAPL monitoring well NMW08-02. Approximately one foot of NAPL was measured in the well during two NAPL monitoring events conducted in December 2008 and March 2009. NAPL was recovered to the extent practicable during both monitoring events using a peristaltic pump. All DNAPL encountered during site investigations has been observed within the fenced portion (eastern half) of the site.

1.5.2.3 Subsurface Soil Quality

Subsurface soil sampling locations where elevated concentrations of MGP-related COCs were detected generally coincide with locations where DNAPL was observed; specifically north of the former tar drip and in the vicinity of former Gas Holders #1 and #2. At least one subsurface soil sample collected from nine soil borings (57 total soil borings completed at the site) contained concentrations of BTEX and PAHs greater than 10 and 500 mg/kg, respectively. The greatest concentrations of MGP-related COCs were detected in subsurface soil samples collected from soil borings SB08-2(22.5'-23'), SB08-18(19'-19.5'), SB08-29(18.5'-19'), and piezometer PZ08-2(11'-11.5').

Table 1.2 Locations of Greatest BTEX and PAH Concentrations

Sample ID (depth)	BTEX (mg/kg)	PAH (mg/kg)
SB08-2(22.5'-23')	260	1,200 J
SB08-18(19'-19.5')	4,800 J	4,800
SB08-29(18.5'-19')	960 J	3,300 J
PZ08-2(11'-11.5')	800	420

Note:
1. J – Indicates an estimated value.

Visual observations of oil-like material (OLM) were noted at each of these sampling locations/intervals where elevated concentrations of BTEX and PAHs were detected.

Subsurface soil samples also contained cyanide at concentrations ranging from 1.5 to 72.6 mg/kg. Only soil samples collected from test pits TP-1 and TP-2 contained cyanide at concentrations greater than the commercial SCO (i.e. 27 mg/kg). Cyanide is not considered a COC for site soil, based on the relatively low concentrations.

A total of 13 subsurface soil samples collected from soil borings, test borings, and test pits contained individual BTEX compounds and PAHs at concentrations greater than commercial SCOs. Additionally, 24 subsurface soil samples contained individual BTEX compounds and PAHs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs.

1.5.2.4 Groundwater Quality

Dissolved phase BTEX and PAHs were detected at concentrations greater than NYSDEC Class GA Standards or Guidance Values in groundwater samples collected from several shallow monitoring wells (screened within the fill and alluvial units). Elevated concentrations were generally detected on the northern half of the site, downgradient from areas where DNAPL was observed. Groundwater samples collected from monitoring well MW-08-05S contained the greatest concentrations of BTEX and PAHs (see Figure 8); benzene at a concentration of 4,900 micrograms per liter (ug/L) and naphthalene at a concentration of 2,500 ug/L. Monitoring wells MW-08-05D and MW-08-07D were the only deep monitoring wells to contain BTEX compounds and/or PAHs at concentrations greater than NYSDEC Class GA Standards and Guidance Values. Cyanide was detected at a concentration slightly above NYSDEC Class GA Standards and Guidance Values in a groundwater sample collected from monitoring well MW08-03S. However, cyanide was not detected in other groundwater samples collected at the site and is therefore not considered a COC for groundwater.

1.5.2.5 Sediment Quality

During sediment investigations, numerous outfalls were observed upstream, adjacent to, and downstream from the site. Additionally, abundant anthropogenic materials (e.g., general refuse, construction waste, asphalt, paint buckets, and oil cans) were observed within the creek and on the creek banks. Although sheens were observed during the sediment investigations, the sheens were determined to not be related to the MGP.

During the sediment investigations, 67 sediment samples were collected from areas upstream, adjacent to, and downstream from the site. The sample results revealed the following:

- BTEX was detected in only six of the 67 sediment samples. Total detected BTEX concentrations ranged from 0.0019 to 0.48 mg/kg. One sample was collected upstream from the site and the remaining samples were collected adjacent to or downstream from the site.

- Total cyanide was detected in five of the 67 sediment samples at concentrations ranging from 1.10 to 3.70 mg/kg. All five samples were collected either adjacent to or downgradient from the site.

- PAHs were detected in every sediment sample. Total PAH concentrations ranged from 1.10 to 1,700 mg/kg, with a geometric mean of 99 mg/kg. A surface sediment sample (0 to 0.5 foot depth) collected near the mouth of a 24-inch storm sewer outfall contained total PAHs at a concentration of 1,700 mg/kg.

Although several sediment samples appeared to have a PAH signature consistent with coal carbonization tar, the signature can also be attributable to creosote and particles/flakes of coal-tar-based sealcoat contributed by the numerous sewer outfalls and run-off from parking lots along the creek. Given this information and the lack of visually MGP-impacted sediments in the creek, PAHs detected in sediment samples cannot be conclusively attributed to the former MGP. In accordance with NYSDEC's concurrence provided in an August 11, 2010 email to NYSEG, the Feasibility Study does not need to address the Rio Grande Creek sediments.

1.5.2.6 Surface Water Quality

Surface-water samples were collected from two upstream, two adjacent, and two downstream locations. Samples were analyzed for VOCs, SVOCs and total cyanide. BTEX compounds were not detected in any surface-water sample. Several PAHs were detected in four of the six samples. Benzo(a)anthracene was the only PAH that exceeded its associated Guidance Value; these exceedances were observed in two samples collected adjacent to the site and one sample upstream from the site. The highest concentration was detected in a sample collected upstream from the site. As such, it is reasonable to assume the benzo(a)anthracene detections are associated with a source(s) upgradient from the site.

Cyanide was only detected in one sample (collected adjacent to the site) and concentrations in this sample exceeded the applicable NYSDEC criteria. As previously discussed, cyanide is generally not a COC for the site.

1.5.2.7 Soil Vapor Quality

The *SVI Evaluation Report* (ARCADIS, 2008b) concluded that additional soil vapor investigations were not warranted because the service center building is mainly used to store materials and supplies used by NYSEG gasfitters and only low level of VOCs were detected in soil vapor and indoor air. As of the date of this FS Report, the NYSDEC and/or NYSDOH have not commented on the *SVI Evaluation Report*.

2. Identification of Standards, Criteria, and Guidance

This FS Report was prepared in general conformance with the applicable guidelines, criteria and considerations set forth in the following NYSDEC guidance, criteria and regulations:

- NYSDEC *DER-10 Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC, 2010).

- Applicable provisions of the New York State Environmental Conservation Law (ECL) and associated regulations, including Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 375-6 (6 NYCRR Part 375-6).

- NYSDEC TAGM 4025 titled, *Guidelines for Remedial Investigations/Feasibility Studies* (NYSDEC, 1989).

- NYSDEC TAGM 4030 titled, *Selection of Remedial Actions at Inactive Hazardous Waste Sites* (NYSDEC, 1990).

This section presents the SCGs that have been identified for the site.

2.1 Definition of Standards, Criteria, and Guidance

"Standards and criteria" are cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance.

"Guidance" is non-promulgated criteria, advisories and/or guidance that are not legal requirements and do not have the same status as "standards and criteria;" however, remedial programs should be designed with consideration given to guidance documents that, based on professional judgment, are determined to be applicable to the project (6 NYCRR 375-1.8[f][2][ii]).

Standards, criteria and guidance will be applied so that the selected remedy will conform to standards and criteria that are generally applicable, consistently applied and officially promulgated; and that are either directly applicable, or that are not directly applicable but relevant and appropriate, unless good cause (as defined in 6 NYCRR 375-1.8 [f][2][i]) exists why conformity should be dispensed with.

2.2 Types of Standards, Criteria, and Guidance

In accordance with NYSDEC guidance, SCGs are to be progressively identified and applied on a site-specific basis as the Remedial Investigation/Feasibility Study (RI/FS) proceeds. The SCGs considered for the potential remedial alternatives identified in this FS Report were categorized into the following classifications:

- *Chemical-Specific SCGs* – These SCGs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values for each COC. These values establish the acceptable amount or concentration of chemical constituents that may be found in, or discharged to, the ambient environment.

- *Action-Specific SCGs* – These SCGs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste management and remediation of the site.

- *Location-Specific SCGs* – These SCGs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in specific locations.

2.3 Site-Specific Standards, Criteria, and Guidance

2.3.1 Chemical-Specific SCGs

The potential chemical-specific SCGs for the site are summarized in Table 1.The SCOs presented in 6 NYCRR Part 375-6 are chemical-specific SCGs that are relevant and appropriate to the site. Specifically, the commercial SCOs are applicable based on the current and anticipated future site use. Unrestricted use SCOs would apply if the site were restored to pre-release conditions. Chemical-specific SCGs that potentially apply to the waste materials generated during remedial activities are the Resource Conservation and Recovery Act (RCRA) and New York State regulations regarding identifying and listing hazardous wastes outlined in 40 CFR 261 and 6 NYCRR Part 371, respectively. Included in these regulations are the regulated levels for the Toxicity Characteristic Leaching Procedure (TCLP) constituents. The TCLP constituent levels are a set of numerical criteria at which solid waste is considered a hazardous waste by the characteristic of toxicity. In addition, the hazardous characteristics of ignitability, reactivity and corrosivity may also apply, depending upon the results of waste characterization activities.

Another set of chemical-specific SCGs that may apply to waste materials generated at the site (e.g., soil that is excavated and determined to be a hazardous waste) are the USEPA Universal Treatment Standards/Land Disposal Restrictions (UTSs/LDRs), as listed in 40 CFR Part 268. These standards and restrictions identify hazardous wastes for which land disposal is restricted and define acceptable treatment technologies or concentration limits for those hazardous wastes on the basis of their waste code characteristics. The UTSs/LDRs also provide a set of numerical criteria at which a hazardous waste is restricted from land disposal, based on the concentration of select constituents present. In addition, the UTS/LDRs define hazardous waste soil and hazardous waste debris, and specify alternative treatment standards and treatment methods required to treat or destroy hazardous constituents on or in hazardous waste debris.

Pursuant to the USEPA's "Contained-in Policy," environmental media (e.g., soil, groundwater, sediment) and debris impacted by a hazardous waste are subject to RCRA hazardous waste management requirements until they no longer contain the hazardous waste. Specifically, environmental media/debris that has been impacted by a release of characteristic hazardous waste must be managed as hazardous waste until the media/debris no longer exhibits that characteristic (based on laboratory testing). UTS/LDR requirements will continue to apply for the waste in accordance with 40 CFR Part 268. In addition, environmental media/debris containing a listed hazardous waste must be managed as hazardous waste until the media/debris no longer contains the listed hazardous waste at concentrations exceeding health-based levels. Under certain circumstances, the UTS/LDR requirements might continue to apply. Although the USEPA has not established generic health-based "contained-in" levels for listed hazardous wastes, they authorized individual states to establish their own levels. The NYSDEC has established "contained-in" criteria for environmental media and debris, which are presented in TAGM 3028 titled, *"Contained-In Criteria" for Environmental Media; Soil Action Levels* (NYSDEC, 1997).

Groundwater beneath the site is classified as Class GA and, as such, the New York State Groundwater Quality Standards (6 NYCRR Parts 700-705) and ambient water quality standards presented in the NYSDEC's *Division of Water, Technical and Operational Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* (NYSDEC, reissued June 1998 and addended April 2000 and June 2004) are potentially applicable chemical-specific standards even though groundwater at the site is not currently, and will not likely in the future, be used as a potable water supply. These standards identify acceptable levels of constituents in groundwater based on potable use.

The *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH 2006) provides guidance on identifying and addressing current and potential human exposures to contaminated subsurface vapors associated with known or suspected volatile chemical contamination. While vapor intrusion may also occur with "naturally occurring" subsurface gases (e.g., radon, methane and hydrogen sulfide), the guidance discusses soil vapor intrusion in terms of environmental contamination only. The guidance is applicable anywhere a soil vapor intrusion investigation is warranted in New York State. As previously discussed, the service center building is mainly used to store materials and supplies used by NYSEG gasfitters and the soil vapor intrusion investigations conducted at the site indicated that only low level of VOCs were detected in soil vapor and indoor air. Therefore, no further soil vapor intrusion investigations are warranted.

2.3.2 Action-Specific SCGs

Potential action-specific SCGs for this site are summarized in Table 2. Action-specific SCGs include general health and safety requirements, and general requirements regarding handling and disposal of waste materials (including transportation and disposal, permitting, manifesting, disposal and treatment facilities), discharge of water generated during implementation of remedial alternatives, and air monitoring requirements for site activities (including permitting requirements for on-site treatment systems).

The NYSDEC Division of Air Resources (DAR) policy document *DAR-1: Guidelines for the Control of Toxic Ambient Air Contaminants* (formerly issued as Air Guide 1), incorporates applicable federal and New York State regulations and requirements pertaining to air emissions, which may be applicable for soil or groundwater alternatives that result in certain air emissions. Community air monitoring may be required in accordance with the NYSDOH Generic Community Air Monitoring Plan. New York Air Quality Standards provides requirements for air emissions (6 NYCRR Parts 257). Emissions from remedial activities will meet the air quality standards based on the air quality class set forth in the New York State Air Quality Classification System (6 NYCRR Part 256) and the permit requirements in New York Permits and Certificates (6 NYCRR Part 201).

One set of potential action-specific SCGs for the site consists of the LDRs, which regulate land disposal of hazardous wastes. LDRs are applicable to alternatives involving the disposal of hazardous waste (if any). Because MGP wastes resulted from historical operations that ended before the passage of RCRA, material containing

MGP-related impacts is only considered a hazardous waste in New York State if it is removed (generated) and it exhibits a characteristic of a hazardous waste. However, if the impacted material only exhibits the hazardous characteristic of toxicity for benzene (D018), it is conditionally exempt from the hazardous waste management requirements (6 NYCRR Parts 370-374 and 376) when destined for thermal treatment in accordance with the requirements set forth in NYSDEC's TAGM HWR-4061, *Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants* (NYSDEC, 2002). If MGP-related hazardous wastes are destined for land disposal in New York, the state hazardous waste regulations apply, including LDRs and alternative LDR treatment standards for hazardous waste soil.

The NYSDEC will no longer allow amendment of soil at MGP sites with lime kiln dust/ quick lime containing greater than 50% Ca/MgO due to vapor issues associated with free oxides. Guidance issued in the form of a letter from the NYSDEC to the NYS utility companies, dated May 20, 2008, indicated that lime kiln dust/quick lime will not be permitted for use during future remedial activities.

The United States Department of Transportation (USDOT) and New York State rules for the transport of hazardous materials are provided in 49 CFR Parts 107 and 171.1 through 172.558 and 6 NYCRR 372.3. These rules include procedures for packaging, labeling, manifesting and transporting hazardous materials and are potentially applicable to the transport of hazardous materials under any remedial alternative. New York State requirements for waste transporter permits are included in 6 NYCRR Part 364, along with standards for collection, transport and delivery of regulated wastes within New York. Contractors transporting waste materials off site during the selected remedial alternative must be properly permitted.

Remedial alternatives conducted within the site must comply with applicable requirements outlined under the Occupational Safety and Health Administration (OSHA). General industry standards are outlined under OSHA (29 CFR 1910) that specify time-weighted average concentrations for worker exposure to various compounds and training requirements for workers involved with hazardous waste operations. The types of safety equipment and procedures to be followed during site remediation are specified under 29 CFR 1926, and record keeping and reporting-related regulations are outlined under 29 CFR 1904.

On-site water treatment systems could potentially be included as part of remedial alternatives. Treated water could potentially be discharged to surface water (e.g., the Rio Grande Creek) as a final disposal method. Any discharge to surface water must be

completed in accordance with a State Pollution Discharge Elimination Systems (SPDES) permit. Permanent water treatment systems would likely operate under a private/commercial/institutional permit and a temporary system (e.g., used to treat water removed from excavation areas) would likely operate under a one-time construction permit.

In addition to OSHA requirements, the RCRA (40 CFR 264) preparedness and prevention procedures, contingency plan and emergency procedures are potentially relevant and appropriate to those remedial alternatives that include generation, treatment or storage of hazardous wastes.

2.3.3 Location-Specific SCGs

Potential location-specific SCGs for the site are summarized in Table 3. Examples of potential location-specific SCGs include regulations and federal acts concerning activities conducted in floodplains, wetlands and historical areas, and activities affecting navigable waters and endangered/threatened or rare species. Based on the Federal Emergency Management Agency (FEMA) National Flood Insurance Program Map Number 3615710289E, dated August 3, 2009, the northwest corner of the site is located within the limits of a 100-year floodplain.

Location-specific SCGs also include local requirements, such as local building permit conditions for permanent or semi-permanent facilities constructed during the remedial activities (if any). Based on conversations with the Village of Goshen, discharge of treated or untreated groundwater to village sanitary or storm sewers would not be permitted on a short-term basis during remedial construction activities (i.e., as part of excavation area dewatering) or as part of a long-term site remedy (i.e., final disposal of groundwater removed and treated by an on-site system). As indicated previously, the site is located with the Village of Goshen Architectural Design District. Properties and buildings located within this district are subject to regulations/restrictions regarding historical areas. Remedial construction activities would likely have to be approved by the Village of Goshen and demolition of the service center building as part of a site remedy may not be permitted.

3. Development of Remedial Action Objectives

This section presents the RAOs for impacted media identified at the site. These RAOs represent medium-specific goals that are protective of public health and the environment. These RAOs were developed by considering the results of the site investigation activities and with reference to potential SCGs, as well as current and foreseeable future anticipated uses of the site. RAOs are developed to specify the COCs within the site, and to assist in developing goals for cleanup of COCs in each medium that may require remediation.

3.1 Risk Assessment Summary

A Human Health Exposure Assessments (HHEA) was conducted as part of the Remedial Investigation to evaluate the potential for human exposure to site-related constituents. Results of the HHEA were presented in the RI Report.

As presented in the RI Report, all of the following must be present for an exposure pathway to be complete:

- Contaminant source
- Contaminant release and transport mechanisms
- Point of exposure
- Route of exposure
- Receptor populations

The following conclusions were reached by the HHEA:

- Surface Soil – PAHs and metals detected in shallow soil are generally present at concentrations that only slightly exceed commercial or ecological SCOs. Surface soils containing the greatest concentrations of COCs are located below impervious surfaces (i.e., beneath the service center building concrete floor slab) within the fenced portion of the site. Additionally, total PAH concentrations detected in surface soil samples collected from on-site and off-site locations were similar, suggesting that the slightly elevated PAH concentrations may not be site related. Therefore, the HHEA that was conducted as part of the Remedial Investigation concluded that surface soil does not represent a complete exposure pathway.

- Subsurface Soil – Subsurface soil does not represent a complete exposure pathway for on-site workers, trespassers, or nearby off-site residents because these receptors would not be expected to be involved with on-site intrusive activities. The potential for human exposure to MGP-related impacts in subsurface soil is limited to construction or utility workers who may engage in future intrusive activities. Subsurface soils containing MGP-related COCs and NAPL are generally encountered at depths greater than 10 feet below grade. Construction workers, other site workers, and nearby residents could potentially be exposed to airborne VOCs and dust during intrusive work (i.e. excavation activities). However, inhalation of vapors during intrusive activities is not considered a significant exposure pathway.

- Groundwater – Local businesses and residences in the vicinity of the site obtain water from a public water supply. Groundwater containing MGP-related dissolved phase COCs is not used for potable purposes and therefore, does not represent a complete exposure pathway. However, based on the depth to groundwater, construction and/or utility workers may be exposed (via incidental ingestion or dermal contact) to groundwater containing dissolved phase COCs during subsurface excavation/ maintenance activities, similar to subsurface soils.

- Sediment – Due to the limited recreational potential associated with Rio Grande Creek, exposure of off-site receptors (e.g., nearby residents) to PAHs in sediment would be minimal and likely limited to wading activities, which occur infrequently. Off-site residents could be exposed to sediment via dermal contact and/or incidental ingestion. Based on the limited recreational use, exposure to sediment is not expected to be a significant exposure pathway. Site workers are not expected to be exposed to sediment within Rio Grande Creek because this resource is located off site. Additionally, as indicated above, PAHs detected in sediment samples cannot be conclusively attributed to the former MGP.

3.2 Remedial Action Objectives

RAOs are media-specific goals that, if met, would be comprehensive in protecting human health and the environment from the MGP-related impacts identified at the site. Potential site-wide remedial alternatives will be evaluated based on their ability to meet the RAOs and be protective of human health and the environment.

RAOs were developed on a media-specific basis on consideration of COCs and MGP-related waste materials (i.e., DNAPL) identified at the site, as well as the potential

exposure pathways and receptors evaluated as part of the HHEA. The RAOs developed for the site are generally consistent with the Generic RAOs provided on NYSDEC's website (http://www.dec.ny.gov/regulations/67560.html).

Based on the results of the RI and HHEA, RAOs have not been developed for surface soil or Rio Grande Creek sediment. The RI and HHEA indicated that potentially MGP-related COCs detected site surface soil and sediment either cannot be conclusively linked to the site or do not pose a significant risk to human health or the environment. Proposed site-specific RAOs for subsurface soil and groundwater are presented in the following table.

Table 3.1 Remedial Action Objectives

RAOs for Subsurface Soil
RAOs for Public Health Protection 1. Prevent to the extent practicable ingestion/direct contact with MGP-related COCs/NAPL. 2. Prevent, to the extent practicable, inhalation of or exposure to MGP-related COCs from impacted soil. *RAOs for Environmental Protection* 3. Address, to the extent practicable, MGP-related COCs/NAPL in soil that could result in impacts to groundwater or surface water.
RAOs for Groundwater
RAOs for Public Health Protection 1. Prevent, to the extent practicable, ingestion of groundwater containing MGP-related dissolved phase COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values. 2. Prevent, to the extent practicable, contact with or inhalation of VOCs from groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values. *RAOs for Environmental Protection* 3. Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable. 4. Address the source of groundwater impacts to the extent practicable. 5. Mitigate, to the extent practicable, the discharge of groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values to surface water.

4. Technology Screening and Development of Remedial Alternatives

4.1 General

The objective of the technology screening is to identify general response actions (GRAs), associated remedial technology types and technology process options, and then narrow the universe of process options to those that have had documented success at achieving RAOs at other former MGP sites to identify options that are implementable and potentially effective at addressing impacts identified for the project site. Based on this screening, remedial technology types and technology process options were eliminated or retained and subsequently combined into potential site-wide remedial alternatives for further, more detailed evaluation. This approach is consistent with the screening and selection process provided in DER-10.

This section identifies potential remedial alternatives to address impacted site media. As an initial step, GRAs potentially capable of addressing impacted media were identified. GRAs are medium-specific and may include various non-technology specific actions such as treatment, containment, institutional controls, and excavation, or any combination of such actions. Based on the GRAs, potential remedial technology types and process options were identified and screened to determine the technologies and associated process options that were the most appropriate for the site. Technology types/process options that were retained through the screening were used to develop potential remedial alternatives. Detailed evaluations of these assembled remedial alternatives are presented in Section 5.

According to DER-10, the term “technology type” refers to a general category of technologies appropriate to the site-specific conditions and impacts, such as chemical treatment, immobilization, biodegradation, capping. The term “technology process option” refers to a specific process within a technology type. For each GRA identified, a number of technology types and associated technology process options were identified. Each remedial technology type and associated technology process options are briefly described and screened, on a medium-specific basis, to identify those that are technically implementable and potentially effective given site-specific conditions. This approach was used to determine if the application of a particular remedial technology type and technology process option is applicable given site-specific conditions for remediation of the impacted media.

4.2 Identification of Remedial Technologies

Remedial technology types that are potentially applicable for addressing the impacted media were identified through a variety of sources, including vendor information, engineering experience, and review of available literature that included the following documents:

- NYSDEC *DER-10 Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC, 2010)
- NYSDEC TAGM 4030 titled, *Selection of Remedial Actions at Inactive Hazardous Waste Sites* (NYSDEC, 1990)
- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988a)
- *Technology Screening Guide for Treatment of CERCLA Soils and Sludges* (USEPA, 1988b)
- *Remediation Technologies Screening Matrix and Reference Guide* (USEPA and United States Air Force [USAF], 2002)
- *Management of Manufactured Gas Plant Sites* (Gas Research Institute [GRI], 1996)

Although each former MGP site offers its own unique site characteristics, the evaluation of remedial technology types and process options that are applicable to MGP-related impacts, or have been implemented at other MGP sites, is well documented. This collective knowledge and experience, and regulatory acceptance of previous feasibility studies performed on MGP-related sites with similar impacts, were used to reduce the universe of potentially applicable process options for the site to those with documented success in achieving similar RAOs.

4.3 General Response Actions

Based on the RAOs identified in Section 3, the following GRAs have been established for soil and groundwater:

- No Action
- Institutional Controls/Engineering Controls
- In-Situ Containment/Controls
- In-Situ Treatment
- Removal
- Ex-Situ On-Site Treatment and/or Disposal
- Off-Site Treatment and/or Disposal

4.4 Remedial Technology Screening Criteria

Potentially applicable remedial technology types and technology process options were identified for each of the GRAs, and were subjected to preliminary and secondary screening to retain the technology types and process options that could be implemented and would potentially be effective at achieving the RAOs established for the site. As presented above, for the purposes of the screening evaluations, remedial technology type refers to a general category of technologies, such as capping or immobilization, while the technology process option (e.g., asphalt cap, clay/soil cap, jet-grouting, shallow soil mixing) is a specific process within each remedial technology type.

Screening was conducted to identify potential technologies and technology processes to address soil and groundwater. RAOs have been developed for soil and groundwater and also include RAOs for NAPL present within these media. Criteria used to complete the preliminary and secondary screening are presented in the following subsections.

4.4.1 Preliminary Screening

Preliminary screening was performed to reduce the number of potentially applicable technologies on the basis of technical implementability. Technical implementability was determined using existing site characterization information to screen out remedial technology types and technology process options that could not reasonably or practicably be implemented.

4.4.2 Secondary Screening

The technology process options retained through preliminary screening were subjected to a secondary screening to further evaluate potential means to address impacted site media and choose, when possible, one representative remedial technology process option for each retained remedial technology type to simplify the subsequent

development and evaluation of the remedial alternatives. Technology process options were evaluated in relative terms to other technology process options of the same remedial technology type using the following criteria:

- *Effectiveness* – This criterion is used to evaluate each technology process option relative to other process options within the same remedial technology type. This evaluation focused on the process option's:
  - ability to meet and continue to meet the RAOs in the future.
  - impacts to public health and the environment during the construction and implementation phase.
  - reliability with respect to the nature and extent of impacts and site conditions.
- *Implementability* – Implementability encompasses both the technical and administrative feasibility of implementing a process option. Because technical implementability was considered during the preliminary screening, this subsequent, more detailed evaluation places more emphasis on the institutional aspects of implementability (e.g., the ability to obtain necessary permits for off-site actions, the availability of treatment, storage, and disposal services, etc.). This criterion also evaluates the ability to construct and reliably operate the technology process option as well as the availability of specific equipment and technical specialists to design, install, and operate and maintain the remedy.
- *Relative Cost* – This criterion evaluates the overall cost required to implement the remedial technology. As a screening tool, relative capital and operation and maintenance (O&M) costs are used rather than detailed cost estimates. For each technology process option, relative costs are presented as low, moderate or high. Costs are estimated on the basis of engineering judgment and industry experience.

4.5 Remedial Technology Screening

As required by DER-10, the "No Action" technology has been included and retained through the screening evaluation. The "No Action" GRA will serve as a baseline for comparing the potential overall effectiveness of the other technologies. Additionally, evaluation of technologies that would restore the site to "pre-disposal conditions" is also required.

A summary of the preliminary and secondary screening of remedial technologies to address impacted soil and groundwater is presented in the following subsections and in Tables 4 and 5, respectively.

4.5.1 Subsurface Soil

This section describes the basis for retaining representative soil remedial technology types and technology process options through the technology screening.

No Action

No action would be completed to address impacted soil. The "No Action" alternative is readily implementable at no cost and was retained to serve as a baseline against which other alternatives will be compared.

Institutional Controls

The remedial technology types identified under this GRA consist of non-intrusive controls focused on minimizing potential exposure to impacted media. The remedial technology type screened under this GRA consists of institutional controls. Technology process options screened under this remedial technology type include deed restrictions, environmental land use restrictions, enforcement and permit controls, and informational devices. Institutional controls would be utilized to limit permissible future site uses, as well as establish health and safety requirements to be followed during subsurface activities that could result in construction worker exposure to impacted soil.

Institutional controls will not achieve soil RAOs as stand-alone processes as these measures would not treat, contain or remove impacted soil. However, this process option was retained because institutional controls can be readily implemented (at a relatively low cost) in conjunction with other remedial technologies to reduce the potential for exposure to impacted soil.

In-Situ Containment/Control

Remedial technology types associated with this GRA consist of measures to address the impacted media by reducing mobility and/or the potential for exposure without removal or treatment. The remedial technology type evaluated under this GRA consists of capping. Technology process options screened under this remedial technology type include: asphalt/concrete cap, clay/soil cap, and synthetic cap.

None of the capping technology process options were retained for further evaluation. While each of these technology process options is readily implementable at moderate costs, surface soils do not contain MGP-related impacts. Therefore, construction of a site cap would not reduce the potential for future exposures to site impacts.

In-Situ Treatment

Remedial technology types associated with this GRA consist of those that treat or stabilize impacted soil in-situ (i.e., without removal). These technologies would actively address MGP-related COCs in soil to achieve the RAOs established for the site. The remedial technology types evaluated under this GRA consist of immobilization, extraction/in-situ stripping, chemical treatment, and biological treatment. Technology process options screened under these remedial technology types include:

- solidification/stabilization (immobilization)
- dynamic underground stripping and hydrous pyrolysis/oxidation (DUS/HPO) (extraction/in-situ stripping)
- chemical oxidation and surfactant enhanced chemical oxidation (chemical treatment)
- biodegradation and soil vapor extraction/soil venting (biological treatment)

Solidification/stabilization was retained for further evaluation as this technology process option is an effective means to reduce the treatability/mobility of MGP-related COCs, eliminate free liquids, and reduce the hydraulic conductivity of NAPL-impacted soil. The presence of subsurface obstructions (i.e., former MGP structures and utilities) could potentially limit the implementability of solidification/stabilization of site soil. Solidification/stabilization would not be effective at addressing NAPL-impacted soils within the till due to the density of soils (standard penetration testing indicated blow counts > 50). NAPL and impacted media below the top of till could not be treated based on equipment limitation (mixing augers and buckets are not effective in stabilizing dense soils like till). The relative cost associated with solidification/stabilization is moderate.

Based on the results of the screening, DUS/HPO, chemical oxidation, biodegradation, and soil vapor extraction/soil venting were not retained for further evaluation due to general ineffectiveness at addressing NAPL-impacted soil. Additionally, each of these

processes would require long-term operation and monitoring due to the nature of site impacts.

Specific concerns related to DUS/HPO include the potential for the uncontrolled migration of NAPL and the presence of underground structures and obstructions that could limit the effectiveness of the technology process option. DUS/HPO could also increase the potential for soil vapor intrusion due to the increased volatilization of organics from impacted soils. DUS/HPO is typically more effective for addressing chlorinated solvents. Relative costs associated with DUS/HPO are high.

Pilot studies conducted at other former MGP sites have shown that in-situ chemical oxidation (ISCO) (including surfactant enhanced ISCO) is only partially effective in the treatment of NAPL-impacted soil. ISCO has been shown to be effective at treating the dissolved phase impacts associated with the NAPL, but does not effectively treat soil containing NAPL. Multiple applications with large quantities of highly reactive oxidants would be required due to the nature of site impacts. Based on the ineffectiveness in addressing impacted soil, oxidant would need to be administrated over the long-term. The presence of underground utilities and associated preferential pathways and the limited space available at the site for process chemical storage reduces implementability. Similar to DUS/HPO, potential soil vapor intrusion concerns are associated with chemical oxidation. The relative costs to implement chemical oxidation are high.

Removal

Removal is a proven technology to address impacted material and would achieve several RAOs. When combined with proper handling of the excavated material, this technology process would be effective at minimizing potential risks to current and future site workers and residents. Excavation could be implemented (i.e., equipment and contractors needed to complete soil removal are readily available). Excavation below the service center building is considered impracticable. Therefore, site-wide excavations would be significantly difficult to implement at the site, as demolition of the service center building and relocation of subsurface utilities would be required. Targeted excavations would generally be more implementable. The anticipated relative capital cost of removal is high.

Ex-Situ On-Site Treatment and/or Disposal

Remedial technology types associated with this GRA consist of measures to treat impacted soil on-site after soil has been excavated or otherwise removed from the

ground. The remedial technology types evaluated under this GRA consist of immobilization, extraction, thermal destruction, chemical treatment, and disposal. Technology process options screened under these remedial technology types include:

- solidification/stabilization (immobilization)
- low-temperature thermal desorption (LTTD) (extraction)
- incineration (thermal destruction)
- chemical oxidation and soil washing (chemical treatment)
- solid waste landfill and Subtitle C landfill (disposal)

Due to the current and anticipated future uses of the site and the surrounding areas (i.e., mixed commercial/residential setting), none of the ex-situ on-site treatment and/or disposal technology types and associated technology process options are considered practicable, technically implementable, or administratively feasible given lack of available space, public acceptance, and potential for exposures during on-site treatment/disposal. None of these process options were retained for further evaluation.

Off-Site Treatment and/or Disposal

Remedial technology types associated with this GRA consist of measures to treat/dispose of impacted soil at off-site locations after soil has been removed from the ground. The remedial technology types evaluated for this GRA consist of recycle/reuse, thermal destruction, extraction, and disposal. Technology process options screened under these remedial technology types include:

- asphalt batching, brick/concrete manufacturer, and fuel blending/co-burn in utility boiler (recycle/reuse)
- incineration (thermal destruction)
- low-temperature thermal desorption (LTTD) (extraction)
- solid waste landfill and Subtitle C landfill (disposal)

Fuel blending/co-burn in utility boiler, LTTD, and off-site disposal at a solid waste landfill were all retained for further evaluation. The relative cost for fuel blending and LTTD options is moderate and both are considered effective means for treating soil containing MGP-related impacts. Disposal at an off-site soil waste landfill would be reserved for material that is not suitable for reuse on-site as fill and that was not

appropriate for treatment via LTTD (e.g., concrete, debris). While each of these process options were retained, the final off-site treatment or disposal of waste materials will be evaluated as part of the remedial design for the selected site remedy. This will allow for an evaluation of the costs associated with these potential off-site treatment/disposal processes, which can fluctuate significantly based on season, market conditions, and treatment/disposal facility capacity. In addition, multiple off-site treatment technologies could be utilized to treat or dispose of media with different concentrations of COCs. However, for the purpose of preparing this FS Report, LTTD and solid waste landfill are assumed as the off-site treatment/disposal technology process options for hazardous (D018) and non-hazardous materials (respectively) that may be generated during remedial construction.

The asphalt concrete batch plant and brick/concrete manufacturer technology processes are not considered implementable. The number of facilities capable of implementing these process and demand for raw materials are limited. Excavated material would require significant processing (e.g., handling, dewatering, and screening) based on the nature of subsurface material. Incineration and Subtitle C landfill technology processes were not retained through the technology screening. The relative cost for incineration is high and although incineration would be an effective means for treating soil containing MGP-related impacts, LTTD is equally effective for treating impacted soil at a lower cost. Disposal at a Subtitle C landfill was not retained as material that is characteristically hazardous would still require pre-treatment to meet NYS UTSs/LDRs prior to disposal.

4.5.2 Groundwater

This section describes the basis for retaining representative groundwater remedial technology types and technology process options through the technology screening.

No Action

No action would be completed to address impacted groundwater. The “No Action” alternative is readily implementable at no cost and was retained to serve as a baseline against which other alternatives will be compared.

Institutional Controls

Remedial technology types associated with this GRA generally consist of non-intrusive administrative controls used to minimize the potential for contact with, or use of site

groundwater. The remedial technology type screened under this GRA consisted of institutional controls. Technology process options for institutional controls include deed restrictions, groundwater use restrictions, enforcement and permit controls, and informational devices. This technology process is considered readily implementable and therefore, was retained for further evaluation. Because institutional controls would not treat, contain or remove any COCs in site groundwater, institutional controls alone would not achieve the RAOs established for the site. However, institutional controls would work toward the RAOs of preventing potential human exposures to groundwater containing COCs. Institutional controls could enhance the effectiveness of other technology types/technology process options at a relatively low cost when included as part of a site-wide remedy.

In-Situ Containment/Controls

Remedial technology types associated with this GRA involve addressing impacted groundwater without removal or treatment. The remedial technology type evaluated under this GRA consisted of containment. Technology process options screened under this remedial technology type consisted of sheet pile walls and slurry walls. Site-wide containment options would not be effective at preventing future exposures to impacted groundwater and groundwater pumping (and subsequent on-site treatment would likely be required to maintain an inward hydraulic gradient). Although site-wide containment options are not practical, containment options may be effective when utilized in targeted areas to prevent NAPL migration upgradient of the barriers (i.e., potential recontamination of excavated areas) and enhance NAPL collection/recovery. Sheet pile walls are more practicable for containment in targeted areas and therefore, slurry walls were not retained.

In-Situ Treatment

Remedial technology types associated with this GRA involve addressing impacted groundwater without removal. Remedial technology types evaluated under this GRA consist of biological treatment and chemical treatment. Technology process options screened under these remedial technology types included:

- groundwater monitoring and enhanced biodegradation (biological treatment)
- chemical oxidation and permeable reactive barrier (PRB) (chemical treatment)

Although groundwater monitoring alone, without source removal, will likely not achieve groundwater RAOs, this technology process was retained as a measure to monitor and

document groundwater conditions over time based on implementability and low relative costs.

None of the other in-situ treatment remedial technology processes were retained through secondary screening. Enhanced biodegradation and chemical oxidation were not retained as these processes would not be an effective means for treating NAPL (i.e., the source for dissolved phase impacts). Additionally, without a means to address a vast majority of the source for dissolved phase impacts (i.e., NAPL and impacted soil), ongoing treatment of dissolved phase COCs in groundwater (i.e., enhanced biodegradation and chemical oxidation) would not be a cost-effective means for addressing impacted groundwater over the long-term.

Past studies (Doherty, et al., 2006) have found that PRBs designed to address MGP-related impacts were generally highly sorptive and did not inhibit microbiological activity, however, leaching tests revealed that the medium would fail as a long-term barrier material. Therefore, periodic replacement of the wall material would be required. PRBs were not retained for further evaluation based on the nature and extent of dissolved phase impacts, the relatively low potential for exposure to impacted groundwater, and the implementability difficulties associated with installing a PRB into the till layer.

Removal

Remedial technology types associated with this GRA consider removal of groundwater containing MGP-related impacts for treatment and/or disposal. The remedial technology type evaluated under this GRA consisted of hydraulic control and NAPL removal. Technology process options screened under these technology types included:

- vertical extraction wells and horizontal extraction wells (hydraulic control)
- passive and active recovery wells, collection trenches/passive barrier wall, and hot water/steam injection (NAPL removal)

Active and passive NAPL removal technology process options were retained under this GRA based on the potential effectiveness for recovering NAPL, relative cost, and implementability. Collection trenches/passive barriers were also retained, but are considered less implementable than recovery wells.

In general, hydraulic control, by means of vertical or horizontal extraction wells would generate large volumes of water and would require removal coupled with treatment over long periods of time. Additionally, the site has limited space to construct and operate pump and treat equipment. Installation of horizontal extraction wells includes use of specialized drilling equipment that requires a large amount of space, and subsurface site conditions (e.g., multiple obstructions, subsurface utilities, etc.) are not suitable for the installation of horizontal wells. Therefore, vertical and horizontal extractions wells were not retained for further evaluation.

Hot water and steam injection may facilitate uncontrolled migration of NAPL due to its ability to facilitate mobilization of the NAPL. Since the technology is high in both capital and O&M cost, and NAPL movement is difficult to predict, this technology was not retained for further evaluation.

Ex-Situ On-Site Treatment

Remedial technology types associated with this GRA consider the on-site treatment of extracted impacted groundwater. The remedial technology types evaluated under this GRA consisted of chemical treatment and physical treatment. Technology process options screened under these remedial technology types included:

- ultraviolet (UV) oxidation and chemical oxidation (chemical treatment)
- carbon adsorption, filtration, air stripping, precipitation/coagulation/flocculation, and oil/water separation (physical treatment)

As indicated above, no groundwater extraction technology process options were retained through the technology screening. Therefore, ex-situ on-site treatment technology process options will not be required. Additionally, similar to the ex-situ on-site soil treatment technologies, due to the current and anticipated future uses of the site and the surrounding areas (i.e., mixed industrial/commercial/residential setting), none of the ex-situ on-site groundwater treatment technology process options are considered practicable, technically implementable, or cost effective given the population, lack of available space, public acceptance, and potential for long-term exposures as a result of the construction and operation of an on-site water treatment system. Note, although not retained, ex-situ on-site treatment technology process options may be used in support of other remedial technology processes (i.e., treatment of groundwater removed during excavation activities).

Off-Site Treatment and/or Disposal

Remedial technology types associated with this GRA consider the off-site treatment/disposal of extracted groundwater. The remedial technology type evaluated under this GRA consisted of groundwater disposal. Technology process options screened under this technology type included: discharge to a local publically-owned treatment works (POTW), discharge to surface water via a storm sewer, and discharge to a privately-owned and commercially operated treatment facility.

As indicated above, groundwater extraction processes are not considered effective or readily implementable and therefore, were not retained. Potential side-wide remedial alternatives will not require an ongoing discharge/disposal of treated/untreated groundwater removed from the subsurface. Additionally, the Village of Goshen has indicated that discharge of treated or untreated water to the sanitary sewer will not be permitted (either during excavation area dewatering or as part of a long-term on-site groundwater treatment system).

4.6 Summary of Retaining Technologies

As indicated previously, results of the remedial technology screening process for subsurface soil and groundwater are presented in Tables 4 and 5, respectively. Remedial technologies retained for soil and groundwater are summarized in the following tables.

Table 4.1 Retained Soil Technologies

GRA	Technology Type	Technology Process Option
No Action	No Action	No Action
Institutional Controls/ Engineering Controls	Institutional Controls	Deed Restrictions, Environmental Land Use Restrictions, Enforcement and Permit Controls, Informational Devices
Removal	Excavation	Excavation
In-Situ Containment/ Controls	Containment	Solidification/Stabilization
Off-Site Treatment and/or Disposal	Recycle/Reuse Extraction Disposal	Co-Burn in Utility Boiler Low-Temperature Thermal Desorption (LTTD) Solid Waste Landfill

Table 4.2 Retained Groundwater Technologies

GRA	Technology Type	Technology Process Option
No Action	No Action	No Action
Institutional Controls/ Engineering Controls	Institutional Controls	Deed Restrictions, Environmental Land Use Restrictions, Enforcement and Permit Controls, Informational Devices
In-Situ Containment/ Control	Hydraulic Containment	Sheet Pile (targeted areas only)
In-Situ Treatment	Biological Treatment	Groundwater Monitoring
Removal	NAPL Removal	Active Removal, Passive Removal, Collection Trenches

4.7 Assembly of Site-Wide Remedial Alternatives

Retained remedial technology types and technology process options were combined into site-wide remedial alternatives that have the potential to achieve or work toward achieving site-specific RAOs. DER-10 (NYSDEC, 2010) requires an evaluation of the following alternatives:

- The "No-Action" alternative
- An alternative that would restore the site to pre-disposal conditions

Additional alternatives were developed based on:

- Current, intended and reasonably anticipated future use of the site
- Removal of source area(s) of MGP-related contamination
- Containment of source areas of MGP-related contamination

These remedial considerations require varying levels of remediation but provide protection of public health and the environment by preventing or minimizing exposure to the COCs through the use of institutional controls; removing COCs to the extent possible thereby minimizing the need for long-term management; and treating COCs, but vary in the degree of treatment employed and long-term management needed.

4.7.1 Alternative 1 – No Action

No remedial activities would be completed to address MGP-related impacts to site soil and/or groundwater. The "No Action" alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives.

4.7.2 Alternative 2 – NAPL Recovery, Groundwater Monitoring, and Institutional Controls

Under this alternative, potentially mobile NAPL would be collected and recovered via the installation of NAPL collection points to facilitate the recovery of mobile NAPL. NAPL collection points could include wells, trenches, or other subsurface structures that would collect and contain mobile NAPL and facilitate NAPL recovery for off-site treatment/disposal. For the purpose of developing this alternative, it has been assumed that NAPL collection would be conducted using NAPL collection wells placed at locations where NAPL has historically accumulated (i.e., NAPL monitoring well NMW08-02). The exact number, location, and construction details of the NAPL collection points would be determined during the design of this remedial alternative. NAPL recovery activities would be conducted passively by periodically gauging and manually bailing/pumping collection wells that contain NAPL. If NAPL recovery rates are significant, NAPL recovery via an automated pumping system could be a cost-effective option. Appropriate long-term NAPL collection and recovery (i.e., passive or active) methods would be evaluated based on the rate of NAPL recovery after the collection points have been installed and multiple passive NAPL monitoring/recovery events have been conducted.

Alternative 2 would also include conducting annual groundwater monitoring to document the extent of dissolved phase impacts and the potential trends in COC concentrations. Institutional controls (i.e., deed restrictions) would be established to limit the future development and use of the site and site groundwater, as well as limit the permissible invasive (i.e., subsurface) activities at the site.

4.7.3 Alternative 3 – MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

Alternative 3 would include the same NAPL collection/recovery, groundwater monitoring, and institutional control components as Alternative 2. Alternative 3 would also include in-situ stabilization/solidification (ISS) activities to address accessible MGP source material and removal of the former UST located south of former Gas Holder #2. Under this alternative, ISS treatment areas would be excavated to a depth up to 5 feet below grade to clear subsurface obstructions (i.e., former building foundations and utilities). ISS would then be completed to address MGP source material at depths ranging from 12 to 28 feet below grade (i.e., top of till). ISS would likely be conducted via conventional mixing tools (e.g., bucket mixing, shallow mixing tools, small diameter augers, jet grouting).

4.7.4 Alternative 4 – MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

Alternative 4 would include the same NAPL collection/recovery, groundwater monitoring, and institutional control components as Alternatives 2 and 3. Alternative 4 would also include excavation activities to address accessible MGP source material and removal of the former UST located south of former Gas Holder #2. Excavation support systems would be evaluated and developed during the design of this alternative. Excavated material would be transported off-site for treatment and/or disposal at an LTTD facility or a solid waste landfill, or reused as subsurface fill (if material is appropriate for site reuse). Excavation areas would be backfilled to the previously existing grade with reusable excavated material and clean imported fill material. A demarcation layer would be placed between existing site soil and imported clean fill.

4.7.5 Alternative 5 – Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring

Alternative 5 would include excavation of soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs (including all visually-impacted soils) to depths up to 28 feet below grade (i.e., to the top of the till surface). Excavation support systems would be evaluated and developed during the design of this alternative. Excavated material would be transported off-site for treatment and/or disposal at an LTTD facility or a solid waste landfill (as appropriate). Because a vast majority of MGP-related impacts would be removed from the site, this alternative would not include the NAPL collection/recovery and institutional control components included under Alternatives 2, 3, and 4. Alternative 5 would include short-term (e.g., up to two years) groundwater monitoring to confirm that groundwater standards and guidance values are achieved.

5. Detailed Evaluation of Alternatives

This section presents detailed descriptions of the remedial alternatives developed to address site impacts. Each of the retained remedial alternatives is evaluated with respect to the criteria presented in DER-10. The results of the detailed evaluation of remedial alternatives are used to aid in the recommendation of a preferred remedial alternative for addressing impacted site media.

5.1 Description of Evaluation Criteria

Consistent with DER-10, the detailed evaluation of remedial alternatives presented in this section consists of an evaluation of each assembled alternative (presented in Section 4.7) against the following criteria:

- Short-Term Impacts and Effectiveness
- Long-Term Effectiveness and Permanence
- Land Use
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Implementability
- Compliance with SCGs
- Overall Protection of Public Health and the Environment
- Cost Effectiveness

These evaluation criteria encompass statutory requirements and include other gauges such as overall feasibility. Descriptions of the evaluation criteria are presented in the following sections. Additional criteria, including community acceptance, will be addressed following submittal of this FS Report.

Per DER-10, sustainability and green remediation will also be considered in the remedial evaluation with the goal of improving the sustainability of the selected remedy. The evaluation will consider the alternative's ability to minimize energy use; reduce greenhouse gas and other emissions; maximize reuse of land and recycling of materials; and preserve, enhance, or create natural habitats, etc. Sustainability and green remediation will be discussed under the short-term impacts and effectiveness criterion.

5.1.1 Short-Term Impacts and Effectiveness

The short-term effectiveness of the remedial alternative is evaluated relative to its potential effect on public health and the environment during implementation of the alternative. The evaluation of each alternative with respect to its short-term effectiveness will consider the following:

- Potential short-term adverse impacts and nuisances to which the public and environment may be exposed during implementation of the alternative.
- Potential impacts to workers during implementation of the remedial actions and the effectiveness and reliability of protective measures.
- The sustainability and use of green remediation practices utilized during implementation of the remedy.
- Amount of time required until protection of public health and the environment is achieved.

5.1.2 Long-Term Effectiveness and Permanence

The evaluation of each remedial alternative relative to its long-term effectiveness and permanence is made by considering the risks that may remain following completion of the remedial alternative. The following factors will be assessed in the evaluation of the alternative's long-term effectiveness and permanence:

- Potential impacts to public health and the environment from untreated waste or treatment residuals remaining at the completion of the remedial alternative.
- The adequacy and reliability of controls (if any) that will be used to manage treatment residuals or remaining untreated impacted media.

5.1.3 Land Use

This criterion evaluates the current and intended future land use of the site relative to the cleanup objectives of the remedial alternative when unrestricted use cleanup levels would not be achieved. This evaluation considers local zoning laws, proximity to residential property, accessibility to infrastructure, and proximity to natural resources including groundwater drinking supplies.

5.1.4 Reduction of Toxicity, Mobility or Volume through Treatment

This evaluation criterion addresses the degree to which the remedial alternative will permanently and significantly reduce the toxicity, mobility, or volume of the constituents present in the site media. The evaluation will consider the following factors:

- The treatment process and the amount of materials to be treated.
- The anticipated ability of the treatment process to reduce the toxicity, mobility, or volume of site impacts.
- The nature and quantity of treatment residuals that will remain after treatment.
- The degree to which the treatment is irreversible.

5.1.5 Implementability

This criterion addresses the technical and administrative feasibility of implementing the remedial alternative, including the availability of the various services and materials required for implementation. The following factors will be considered during the implementability evaluation:

- *Technical Feasibility* – This factor refers to the relative ease of implementing or completing the remedial alternative based on site-specific constraints. In addition, the remedial alternative's constructability and operational reliability are also considered, as well as the ability to monitor the effectiveness of the remedial alternative.
- *Administrative Feasibility* – This factor refers to the availability of necessary personnel and material along with potential difficulties in obtaining approvals for long-term operation of treatment systems, access agreements for construction, and acquiring necessary approvals and permits for remedial construction.

5.1.6 Compliance with SCGs

This criterion evaluates the remedial alternative's ability to comply with SCGs that were identified in Section 2. Compliance with the following items is considered during evaluation of the remedial alternative:

- Chemical-specific SCGs
- Action-specific SCGs
- Location-specific SCGs

Applicable chemical-, action-, and location-specific SCGs are presented in Tables 1, 2 and 3, respectively.

5.1.7 Overall Protection of Public Health and the Environment

This criterion evaluates whether the remedial alternative provides adequate protection of public health and the environment. This evaluation assesses how exposure pathways are eliminated, reduced, or controlled through removal, treatment, engineering controls, or institutional controls. This evaluation also considers the ability of the remedial alternative to meet the RAOs.

5.1.8 Cost Effectiveness

This criterion evaluates the overall cost of the alternative relative to the effectiveness of the alternative. The estimated total cost to implement the remedial alternative is based on a present worth analysis of the sum of the direct capital costs (materials, equipment, and labor), indirect capital costs (engineering, licenses/permits, and contingency allowances), and O&M costs. O&M costs may include operating labor, energy, chemicals, and sampling and analysis. These costs will be estimated with an anticipated accuracy between -30% to +50%. A 20% contingency factor is included to cover unforeseen costs incurred during implementation of the remedial alternative. Present-worth costs are calculated for alternatives expected to last more than 2 years. A 4% discount (i.e., interest) rate is used to determine the present-worth factor.

5.2 Detailed Evaluation of Site-Wide Remedial Alternatives

This section presents the detailed analysis of each of the site-wide alternatives previously identified in Section 4.

- Alternative 1 – No Action

- Alternative 2 – NAPL Recovery, Groundwater Monitoring, and Institutional Controls

- Alternative 3 – MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

- Alternative 4 – MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

- Alternative 5 – Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring

Each alternative is evaluated against the evaluation criteria described above (as indicated, public acceptance will be evaluated following submittal of this FS Report).

5.2.1 Alternative 1 – No Action

The "No Action" alternative was retained for evaluation at the site as required by DER-10. The "No Action" alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives. The "No Action" alternative would not involve implementation of any remedial activities to address the COCs in the environmental media. The site would be allowed to remain in its current condition and no effort would be made to change or monitor the current site conditions.

Short-Term Impacts and Effectiveness – Alternative 1

No remedial actions would be implemented to address impacted environmental media. Therefore, there would be no short-term environmental impacts nor risks associated with remedial activities would be posed to the community.

Long-Term Effectiveness and Permanence – Alternative 1

Under the "No Action" alternative, the COCs in site media or the potential for on-going releases, exposures, and/or migration of impacts would not be addressed. As a result, this alternative is not considered effective on a long-term basis.

Land Use – Alternative 1

The current zoning for the site is listed as commercial use and areas immediately surrounding the site are zoned for commercial and residential use. The current and foreseeable future use of the area surrounding the site is a mixed commercial/ residential setting. The site will continue to be used by NYSEG as a natural gas service

center. Based on the current and anticipated future land use of the site as a NYSEG service center, the potential for exposure to subsurface soil and groundwater containing MGP-related COCs is minimal. The majority of the site is covered with asphalt, concrete, a building, or vegetated soil, and there is little to no need to conduct subsurface activities at the site. Additionally, drinking water is currently and will continue to be provided via a public supply. Therefore, groundwater containing MGP-related COCs is not and will not be used for potable (or other) purposes.

No remedial actions would be completed under this alternative and the site would remain in its current condition. As routine site activities do not include exposure to MGP-related impacts in soil and groundwater, the "No Action" alternative would not alter the anticipated future intended use of the site.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 1

Under the "No Action" alternative, environmental media would not be treated (other than by natural processes), recycled, or destroyed. Therefore, the toxicity, mobility, and volume of the COCs in the impacted environmental media would not be reduced.

Implementability – Alternative 1

The "No Action" alternative does not require implementation of any remedial activities, and therefore is technically and administratively implementable.

Compliance with SCGs – Alternative 1

- *Chemical-Specific SCGs*: Because removal or treatment is not included as part of this alternative, the chemical-specific SCGs would not be met by this alternative.
- *Action-Specific SCGs*: This alternative does not involve implementation of any remedial activities; therefore, the action-specific SCGs are not applicable.
- *Location-Specific SCGs*: Because no remedial activities would be conducted under this alternative, the location-specific SCGs are not applicable.

Overall Protection of Public Health and the Environment – Alternative 1

The "No Action" alternative does not address the toxicity, mobility, or volume of impacted environmental media and the alternative is not effective on a long-term basis

for eliminating potential migration or potential exposure to impacts. Therefore, the "No Action" alternative would be ineffective and would not meet the RAOs established for the site.

Cost Effectiveness – Alternative 1

The "No Action" alternative does not involve implementation of any active remedial activities or the monitoring of site conditions; therefore, there are no costs associated with this alternative.

5.2.2 Alternative 2 – NAPL Recovery, Groundwater Monitoring, and Institutional Controls

The major components of Alternative 2 include the following:

- Implementing a NAPL recovery program
- Conducting long-term groundwater monitoring
- Developing a site management plan
- Establishing institutional controls

This alternative would address the potential for exposure to subsurface soil and groundwater containing MGP-related COCs through the implementation of institutional controls. Alternative 2 also includes NAPL collection/recovery to facilitate the removal of potentially mobile NAPL from the subsurface. Soil and groundwater containing MGP-related COCs would remain and would not be directly addressed by this remedial alternative. This alternative also includes long-term groundwater monitoring to document the extent of dissolved phase impacts and potential trends in COC concentrations.

Alternative 2 would include the installation of NAPL collection points to facilitate the recovery of potentially mobile NAPL. NAPL collection points could consist of, but not be limited to, wells or trenches constructed to collect, contain, and facilitate NAPL recovery (e.g., via a sump). The final number, location, type, and construction of the NAPL collection points would be determined during the remedial design of this alternative. The NAPL collection points would be installed at locations and to depths where measurable quantities of NAPL have been observed in existing monitoring wells. For the purpose of developing a cost estimate for this alternative, it has been assumed that five NAPL collection wells would be installed near existing NAPL monitoring well NMW08-02 (i.e., where NAPL has historically accumulated).

The NAPL collection wells are assumed to consist of 6-inch diameter stainless steel wells, equipped with 5-foot long sumps, installed to an average depth of 30 feet below grade. Following installation of the collection wells, NAPL recovery may be conducted passively by periodic manual bailing or by pumping (with a portable pump) NAPL from the collection wells. If warranted based on the rate of NAPL recovery, NAPL could be removed via an automated pumping system. Low-flow groundwater pumping could also be conducted in an attempt to enhance the rate of NAPL collection within the wells (or other NAPL collection points). Low-flow groundwater pumping would generate impacted groundwater that would require storage, treatment, and disposal, as appropriate (note that discharge of any groundwater, treated or untreated, to the Village of Goshen sanitary sewer is prohibited). Under an automated pumping scenario, NAPL would be pumped from the wells and stored within a structure(s) that would have to be constructed near the wells (either above or below grade).

For the purpose of developing a cost estimate for this alternative, the NAPL recovery activities are assumed to consist of passive NAPL collection with manual recovery conducted for 30 years. NAPL collection wells would initially be monitored on a semi-annual basis. If no recoverable quantities of NAPL are observed during multiple consecutive NAPL monitoring events (e.g., four consecutive semi-annual monitoring events), NYSEG would request to conduct NAPL monitoring/recovery less frequently or cease NAPL monitoring altogether.

As indicated in Section 1, site groundwater contains BTEX and PAHs at concentrations greater than NYSDEC Class GA groundwater standards and guidance values. Although there are no current users of groundwater or exposures to impacted groundwater, this alternative would also include conducting annual groundwater monitoring to document potential changes in site groundwater conditions. Annual groundwater monitoring activities would include collecting groundwater samples from the existing groundwater monitoring well network at the site. The specific wells to be sampled would be determined during the remedial design for this alternative. Groundwater samples would be submitted for laboratory analysis for BTEX and PAHs. Analytical results would be used to document the extent of dissolved phase impacts and potential trends in COC concentrations. The results of the groundwater monitoring would be presented to NYSDEC in an annual report. Based on the results of the monitoring activities, NYSEG may request to modify the quantity of wells sampled or the frequency of sampling events. However, for the purpose of developing a cost estimate for this alternative, it has been assumed that annual groundwater monitoring activities would be conducted for 30 years.

Alternative 2 would also include establishing institutional controls on the NYSEG property in the form of deed restrictions and environmental easements to control intrusive (i.e., subsurface) activities that could result in potential exposures to subsurface soil and groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values. Additionally, the institutional controls would require compliance with the SMP (described below) that would be prepared as part of this alternative. The institutional controls would also establish requirements for additional investigation activities (e.g., subsurface soil sampling) if the service center building were to be demolished at some point in the future. Although potable water is provided by a municipal supply, the institutional controls would also prohibit the use of non-treated groundwater on the NYSEG property. An annual report would be submitted to NYSDEC to document that institutional controls are maintained and remain effective.

This alternative would include preparation of an SMP to document the following:

- The institutional controls that have been established and will be maintained for the site
- Known locations of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 commercial use SCOs
- Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities
- Protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring
- Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities

Short-Term Impacts and Effectiveness – Alternative 2

Implementation of this alternative could result in short-term exposure to the surrounding community and field personnel. Potential short-term exposures to impacted soil, groundwater, and/or NAPL could occur during installation of new NAPL collection wells that would be installed at the site. Potential exposure mechanisms

would include ingestion of or dermal contact with impacted soil, groundwater and NAPL and/or inhalation of volatile organic vapors.

Potential exposures to field personnel would be minimized through the use of proper training and personal protective equipment (PPE), as specified in a site-specific health and safety plan (HASP) that would be developed as part of the remedial design for this alternative. Air monitoring would be performed during well installation activities to confirm that volatile organic vapors are within acceptable levels (to be specified in the site-specific HASP). Potentially impacted soil and groundwater generated during well installation activities would be properly managed to minimize potential exposures to the surrounding community. Potential risks to the community could occur during periodic groundwater and NAPL monitoring activities via exposure to purged groundwater, groundwater samples, and/or NAPL. Potential exposures to the community would be minimized by following appropriate procedures and protocols that would be described in the SMP.

Although this alternative does not employ green remediation practices, implementation of this alternative would utilize minimal non-renewable resources and is not anticipated to negatively impact the environment (i.e., consume non-renewable resources and energy). The relative carbon footprint of Alternative 2 (compared to the other alternatives) is considered minimal. The greatest contribution to greenhouse gases would occur as a result of equipment used during well installation activities.

Well installation activities could be completed in less than one month and monitoring would be conducted over an assumed 30-year period.

Long-Term Effectiveness and Permanence – Alternative 2

Under Alternative 2, subsurface soil and groundwater containing MGP-related COCs would not actively be addressed. However, Alternative 2 includes NAPL recovery to reduce the volume of mobile NAPL present at the site and groundwater monitoring to evaluate and document the extent of dissolved phase impacts and potential trends in COC concentrations.

A majority of the surface cover at the site consists of asphalt pavement, vegetated soil and a building, which provide a physical barrier to subsurface impacts. Additionally, NAPL is generally encountered at depths greater than 12 feet below grade and the water table is encountered at depths ranging from 3 to 10 feet below grade. Based on the current and foreseeable future use of the site as a NYSEG service center, site

workers do not routinely conduct activities that would potentially result in exposure to site media containing MGP-related COCs. If subsurface activities (e.g., installation of new utilities) were to be conducted at the site, a minimum of 12 feet of urban fill is present above soil containing NAPL. Work activities (including handling potentially impacted material) would be conducted in accordance with the procedures described in the SMP to minimize the potential for exposures to impacted site media. Potential exposures to field personnel and the community during long-term monitoring activities would be minimized by following appropriate procedures and protocols that would be established in the SMP.

Active NAPL recovery and low-flow pumping (if utilized in an attempt to enhance NAPL recovery) would create a greater potential for exposures to MGP-related materials on a long-term basis when compared to passive NAPL recovery. Active NAPL recovery would require construction of a structure(s) to store recovered NAPL. If low-flow groundwater pumping was implemented in an attempt to enhance NAPL collection, assuming each of the NAPL collection wells would be pumped at a constant rate of one gallon per minute (gpm), more than 7,000 gallons of impacted groundwater would be generated each day. A water treatment system would have to be constructed at the site to treat the groundwater. However, the discharge of water from an on-site system to the village sanitary sewer is prohibited; therefore, alternate discharge options would have to be identified.

Additionally, the presence of the water treatment and NAPL storage systems would increase the potential for long-term exposures to site workers and the surrounding community (i.e., during routine system operation or maintenance activities, system malfunctions, or vandalism of the structures and systems). In contrast, passive collection activities could be conducted during non-peak hours and NAPL collected during passive recovery activities would be immediately transported off-site for treatment/disposal, thereby significantly reducing the potential for long-term exposures to site workers and the surrounding public. Based on this rationale, both active NAPL removal and low-flow groundwater pumping would decrease the long-term effectiveness and permanence of this alternative.

Alternative 2 would include the establishment of institutional controls and development of a long-term groundwater monitoring program. Institutional controls would prohibit potable uses of site groundwater. Annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective. Annual groundwater monitoring would be conducted to document the extent of

dissolved phase impacts and potential trends in COC concentrations (i.e., document that impacted groundwater is not migrating beyond the site limits).

Land Use – Alternative 2

The current zoning for the site is listed as commercial use and areas immediately surrounding the site are zoned for commercial and residential use. The site will continue to be used by NYSEG as a natural gas service center. The current and foreseeable future use of the area surrounding the site is a mixed commercial/residential setting. Based on the current land use of site as a NYSEG service center, the potential for exposure to subsurface soil and groundwater containing MGP-related COCs is minimal. The majority of the site is covered with asphalt, concrete, a building, or vegetated soil, and there is little to no need to conduct subsurface activities at the site. Additionally, drinking water is currently and will continue to be provided via a public supply. Therefore, groundwater containing MGP-related COCs is not and will not be used for potable (or other) purposes.

Alternative 2 would not affect the current or anticipated future land use at the site (i.e., use as NYSEG service center). Deed restrictions would be placed on the NYSEG property and groundwater monitoring and NAPL monitoring/recovery would be conducted for an assumed 30 years. If the NYSEG property were to be redeveloped and/or sold to another party, the SMP would be provided to potential future site owners and institutional controls would remain in place. Future site owners/operators would be required to conduct site activities in accordance with the SMP and institutional controls established for the site based on the continued presence of soil and groundwater containing MGP-related COCs.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 2

Alternative 2 does not include direct treatment or containment of impacted site media. However, this alternative does include the installation of NAPL collection wells, periodic NAPL monitoring and passive recovery of mobile NAPL that may collect in the wells. Through the NAPL monitoring/recovery activities, the volume of mobile NAPL would be permanently reduced, thereby reducing the potential for further downgradient migration of mobile NAPL. NAPL removal would also reduce the volume of material that is serving as a source to dissolved phase groundwater impacts. This removal would reduce the flux of COCs from source material to groundwater, which would reduce the toxicity and volume of dissolved phase groundwater impacts. Alternative 2 also

includes annual groundwater monitoring to document the extent and potential long-term reduction (i.e., toxicity and volume) of dissolved phase groundwater impacts.

Implementability – Alternative 2

This remedial alternative would be both technically and administratively implementable. From a technical implementability aspect, equipment and personnel qualified to install NAPL collection wells and conduct groundwater and NAPL monitoring activities are readily available. The NAPL collection wells would be secured in lockable subsurface vaults to prevent access by unauthorized personnel. NAPL collection and recovery methods would also be assessed during the design of this alternative. Active NAPL recovery (i.e., automated pumping) and low-flow groundwater pumping (to enhance NAPL collection) would be more difficult to implement, when compared to passive NAPL collection and manual recovery, as automated recovery would require on-site NAPL storage structures and low-flow groundwater pumping would require construction and operation of an on-site water treatment system.

Administratively, institutional controls would be established for the site, which would require coordination with state agencies (i.e., NYSDEC and NYSDOH). No access agreements would be required, as existing groundwater monitoring and new NAPL collection wells are/will be located on NYSEG property. As indicated by the Village of Goshen, discharge of groundwater to local sanitary sewers is prohibited. Therefore, construction and O&M of NAPL/water storage structures and treatment systems may require special permitting (e.g., SPDES discharge to surface water), making this method a less practicable and administratively feasible alternative for the collection and recovery of NAPL.

Compliance with SCGs – Alternative 2

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 soil cleanup objectives and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 2 would not address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 SCOs. Subsurface soil containing MGP-related impacts would remain in place beneath surface materials (i.e., pavement,

concrete, a building, and vegetated surfaces). Process residuals generated during the implementation of this alternative (e.g., drilling waste and development/purge water from well installation) would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

As indicated in Section 1, site groundwater contains VOCs and SVOCs at concentrations greater than NYSDEC Class GA standards and guidance values. As this alternative does not include removal activities to address soil containing MGP-related impacts (i.e., a source of dissolved phase impacts), this alternative would likely not achieve groundwater SCGs within a determinate period of time.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Process residuals would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved Remedial Design/Remedial Action (RD/RA) Work Plan and using licensed waste transporters and permitted disposal facilities. If any of the materials are characterized as a hazardous waste, NYS LDRs could be applicable.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations for conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting site activities. Additionally, remedial activities would be conducted in accordance with Village and Town of Goshen building/construction codes and ordinances. Discharge of groundwater generated during remedial construction activities (i.e., in support of excavation area dewatering or as part of long-term groundwater treatment system) to the sanitary sewer is prohibited. Although the site is located with the Village of Goshen Architectural Design District,

implementation of this alternative would not impact the potential historical significance of the service center building or the property.

Overall Protection of Public Health and the Environment – Alternative 2

Alternative 2 would mitigate the potential for long-term exposures to impacted subsurface soil and groundwater by recovering mobile NAPL, monitoring groundwater, and implementing of institutional controls. This alternative would not utilize containment, treatment, or removal to address subsurface soil or groundwater containing MGP-related COCs at concentrations greater than applicable standards and guidance values. Soil and ground containing MGP-related COCs would remain and would not be addressed through active containment, treatment, or removal.

This alternative would prevent exposures (i.e., direct contact, ingestion, and inhalation) to MGP-related impacts in subsurface soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) solely through the implementation of institutional controls. Although NAPL is encountered at depths greater than 12 feet below grade and groundwater is generally encountered at depths greater than 3 feet below grade (and not used for potable purposes), potentially complete exposure pathways (i.e., exposures to future construction workers) would remain under this alternative and the reduction of potential exposures would only occur by adhering to the institutional controls and the procedures to be presented in the SMP.

Alternative 2 would partially address MGP-related COCs and NAPL that could cause impacts to groundwater or surface water (soil RAO #3) through the recovery of mobile NAPL. Periodic monitoring would be completed to document the extent of dissolved phase impacts and potential trends in COC concentrations. Although mobile NAPL would be permanently removed under Alternative 2, immobile NAPL and impacted soil (a source to dissolved phase impacts) would remain and therefore, this alternative is not expected to restore groundwater to pre-disposal/pre-release conditions (groundwater RAO #3) nor address all sources of groundwater impacts (groundwater RAO #4).

As indicated in Section 1, Rio Grande Creek surface water does not appear to be impacted by MGP-related COCs and implementation of this alternative would not promote discharge of NAPL or groundwater containing MGP-related impacts to the creek. Removal of mobile NAPL would reduce the volume of material that serves as a source to dissolved phase impacts and groundwater monitoring (including sampling of wells located downgradient of NAPL impacted soil and upgradient of the creek) would

document dissolved phase COC concentrations and groundwater flow direction. Therefore, Alternative 2 would mitigate the discharge of groundwater containing MGP-related COCs to surface water (groundwater RAO #5).

Cost Effectiveness – Alternative 2

The estimated costs associated with Alternative 2 are presented in Table 6. The total estimated 30-year present worth cost for this alternative is approximately $1,200,000. The estimated capital cost, including costs for installing NAPL collection wells and establishing institutional controls, is approximately $200,000. The estimated 30-year present worth cost of O&M activities associated with this alternative, including conducting semi-annual NAPL monitoring and annual groundwater monitoring, is approximately $1,000,000.

5.2.3 Alternative 3 – MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

The major components of Alternative 3 include the following:

- ISS of accessible MGP source material
- Removing the UST located south of Gas Holder #2
- Implementing a NAPL recovery program
- Conducting long-term groundwater monitoring
- Developing a site management plan
- Establishing institutional controls

Alternative 3 would include ISS activities to address accessible MGP source material. As defined in DER-10, a source area typically includes NAPL or grossly contaminated material (i.e., per DER-10: media that contains substantial quantities of mobile NAPL identified through visual inspection, strong odors, or is otherwise readily detectable without laboratory analysis). For the purpose of this FS Report, MGP source material is defined as soil containing visual MGP-related impacts in quantities greater than slight/trace sheens, staining, or isolated blebs. Additionally, accessible MGP source material is defined as:

- source material located above the till unit

- source material that can be removed/treated without demolishing or compromising the structural integrity of the service center building

This alternative would also address the potential for exposure to remaining subsurface soil and groundwater containing residual MGP-related COCs through the implementation of institutional controls. Alternative 3 also includes NAPL recovery to facilitate the removal of inaccessible, mobile NAPL from the subsurface and long-term groundwater monitoring to document the extent of dissolved phase impacts and potential trends in COC concentrations.

The ISS process involves mixing Portland cement (and other pozzolanic materials) with impacted site soil to reduce the leachability and mobility of COCs and NAPL present in site soil. The resulting mixture is generally a homogeneous mixture of soil, groundwater and grout that hardens to become a weakly-cemented material. The ISS process would stabilize site media (i.e., soil and groundwater) containing MGP-related impacts into a solid mass (micro-encapsulation), as well as soil surrounding MGP-related materials (macro-encapsulation), thereby preventing migration of COCs and NAPL beyond the stabilized mass.

Bench-scale testing would be required prior to implementing this alternative. ISS bench-scale testing would consist of an evaluation of various soil stabilization mixtures to determine the effectiveness of each mixture at meeting performance goals for permeability, strength and leachability to be established as part of the remedial design. ISS mixtures could consist of site soil and groundwater, blast furnace slag (BFS), Portland cement, bentonite and water. The mixtures would be tested for density, permeability, strength and leachability of COCs to identify an optimal mix design based on site-specific soil conditions (i.e., physical characteristics and quantity of impacts).

ISS limits are shown on Figure 9. For the purpose of developing this alternative, it has been assumed that a minimum clearance of 10 feet would be maintained near existing buildings and structures and the NYSEG service center building would remain. Alternative 3 would include a pre-ISS excavation of approximately 760 cubic-yards (cy) of soil (i.e., up to 5 feet below grade) to:

- account for material bulking caused by the ISS treatment
- verify the locations of and remove subsurface obstructions (i.e., former MGP foundations and structures)
- locate, protect, and facilitate relocation of subsurface utilities, as appropriate

Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Alternative 3 also includes removal of the UST located south of former Gas Holder #2. The UST and any visually impacted soil immediately surrounding the UST would be removed.

Alternative 3 would include ISS of approximately 2,600 cy of soil to depths ranging from 12 feet below grade to the top of the till (i.e., 26 to 28 feet below grade) to treat an estimated 850 cy of accessible MGP source material. ISS would likely be conducted via conventional mixing shallow mixing methods/tools such as bucket mixing, small diameter augers, dual axis soil blenders, and jet grouting. During implementation of the ISS treatment in areas where the target depth corresponds with the top of the till, if an obstruction (e.g., utilities, obstacles) is encountered along the perimeter of the ISS treatment area at depths below the pre-ISS excavation limits, the obstruction would be cleared or the perimeter of the ISS treatment area would be stabilized to the top of the till surface using all means necessary (e.g., jet grouting around the obstruction) to maintain a continuous perimeter of stabilized soil that would serve as a containment barrier to the top of the till. If obstructions are encountered within the perimeter of the ISS treatment area, ISS treatment activities would be completed at the next adjacent treatment location or jet grouting methods would be used to immobilize impacted soil beneath the obstruction. Note that based on the absence of MGP source material beneath former Gas Holder #2, the target depth for ISS treatment in the vicinity of this holder is 12 feet below grade. ISS treatment in this area would be required to 12 feet below grade regardless of obstructions.

For the purpose of developing this alternative, it has been assumed that the gas distribution piping located within the ISS treatment area could be temporarily deactivated, bypassed, and/or relocated during the remedial construction activities to facilitate ISS treatment of soil beneath the piping. If the piping cannot be temporarily moved or deactivated, jet grouting would be completed to treat soil beneath the gas lines at the five perimeter locations where gas lines transect the ISS treatment area to maintain a continuous perimeter of stabilized soil. Jet grouting would not be completed beneath the entire length of the gas line throughout the ISS treatment area.

Post-ISS quality assurance/quality control (QA/QC) sampling would consist of sampling stabilized material to verify that performance criteria (e.g., strength and permeability.) are met. If performance criteria are not achieved in certain locations, soil would be re-mixed at these locations. In general, ISS spoils (i.e., bulking of stabilized material) would be removed (as necessary) such that the stabilized material would be below the

frost line. As discussed in greater detail under the long-term effectiveness criterion for Alternative 3, predictive simulations indicate that minimal changes to groundwater flow patterns would occur if the top of the stabilized mass were at least 5 feet below grade.

For the purpose of developing this alternative, it has been assumed that 50% of soil removed during excavation/pre-ISS excavation activities would be suitable for reuse (i.e., free of visual impacts, odors, rubble, and debris) as subsurface backfill. Excavation areas and pre-ISS excavation areas would be restored with material suitable for reuse as subsurface backfill and imported clean fill material to match the previously existing lines and grades. A demarcation layer (e.g., geotextile fabric) would be placed between reused excavated soil and imported clean fill material. At a minimum, the top one foot of surface cover would meet the allowable constituent levels for imported fill or soil for commercial use (as presented in DER-10) or the surfaces would be restored with gravel or asphalt pavement. Surface restoration details would be developed as part of the remedial design for this alternative.

Excavated material from 0 to 1 foot below grade would likely be transported off-site for disposal as construction and demolition (C&D) debris. ISS and jet grout spoils would also be transported off-site for disposal as C&D debris. Excavated soil not suitable for on-site reuse would be transported off-site for disposal as a non-hazardous waste at a solid waste landfill. Based on the relatively shallow depth of removal and depth to MGP source material, it is anticipated that no soil removed under this alternative would require treatment via LTTD.

Alternative 3 would also include the same NAPL recovery, groundwater monitoring, and institutional controls components as Alternative 2. As indicated for Alternative 2, NAPL collection points could potentially consist of, but not be limited to, wells or trenches. The final number, location, type, and construction details of the NAPL collection points would be determined during the remedial design of this alternative. For the purpose of developing a cost estimate for this alternative, it has been assumed that five NAPL collection wells would be installed. NAPL collection wells would be installed at the same locations described under Alternative 2 (see Figure 9) and NAPL collection wells would be periodically (i.e., semi-annually) monitored to facilitate the passive recovery of potentially mobile NAPL. NAPL could be potentially recovered by utilizing an active recovery system depending on the rate of NAPL collection following installation of the collection points. Low-flow groundwater pumping could also be considered to potentially enhance the rate of NAPL collection (note that discharge of any groundwater, treated or untreated, to the Village of Goshen sanitary sewer is prohibited).

Alternative 3 would also include conducting annual groundwater monitoring to confirm groundwater flow direction and verify the extent and concentrations of residual dissolved phase COCs. Groundwater samples would be collected and submitted for laboratory analysis for BTEX and PAHs to document the extent of dissolved phase impacts and potential trends in COC concentrations.

Additionally, Alternative 3 would include establishing institutional controls on the NYSEG property in the form of deed restrictions and environmental easements (e.g., groundwater use restrictions) to control intrusive (i.e., subsurface) activities that could result in exposure to residual groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values. The institutional controls would also establish requirements for additional investigation activities (e.g., subsurface soil sampling) if the service center building were to be demolished. Additionally, the institutional controls would require compliance with the SMP (described below) that would be prepared as part of this alternative. Although potable water is provided by a municipal supply, the institutional controls would also prohibit the use of non-treated groundwater on the NYSEG property. An annual report would be submitted to NYSDEC to document that institutional controls are maintained and remain effective.

This alternative would include preparation of an SMP to document the following:

- The institutional controls that have been established and will be maintained for the site
- Extent of solidified soil
- Known locations of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 commercial use SCOs
- Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing stabilized material, if encountered during these activities
- Protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring
- Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities

Short-Term Impacts and Effectiveness – Alternative 3

Implementation of this alternative could result in short-term exposure of site workers and the surrounding community to impacted soil and groundwater as a result of excavation, soil mixing, material handling and off-site transportation activities. Additionally, field personnel may be exposed to impacted soil, groundwater, and/or NAPL during NAPL collection well installation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil, and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design.

Community access to the ISS treatment/excavation area would be restricted by temporary security fencing. A site-specific community air monitoring plan (CAMP) would be prepared and community air monitoring would be performed during excavation and soil mixing activities to evaluate the need for additional engineering controls (e.g., use of water sprays to suppress dust, modify the rate of remedial construction activities, etc.). Based on the proposed excavation/ISS limits, the NYSEG personnel and supporting operations would have to be temporarily relocated during remedial construction activities. At a minimum, the NYSEG service center would be closed for a period of up to 5 months.

Potentially impacted soil and groundwater generated during well installation activities would be properly managed to minimize potential exposures to the surrounding community. Potential risks to the community could occur during periodic groundwater and NAPL monitoring activities via exposure to purged groundwater, groundwater samples, and/or NAPL. Potential exposures to the community would be minimized by following appropriate procedures and protocols that would be described in the SMP.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the site and delivery of ISS aggregate and fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Off-site transportation of excavated material and importation of ISS aggregate and fill materials would result in approximately 130 tractor trailer truck round trips (assuming 35 tons per

dump truck). Transportation activities would be managed to minimize en-route risks to the community.

Although ISS is not considered a green remediation practice, impacted soil and groundwater would be stabilized/solidified in place, thereby significantly reducing the volume of soil that may otherwise require transportation for off-site treatment and/or disposal. The need to import clean fill is also significantly reduced when stabilizing materials in place. Additionally, excavated soil that is suitable for reuse at the site can be utilized as subsurface backfill (above the stabilized soils and below surface material), thereby further reducing the need for imported fill materials. The reduction in volume of imported fill needed would subsequently result in a decrease of truck traffic and non-renewable resources (i.e., fuel) required to export excavated material and to import clean fill. The relative carbon footprint of Alternative 3 (compared to the other alternatives) is considered moderate. The greatest contribution to greenhouse gases would occur as a result of equipment operation during excavation, soil mixing and transportation activities.

ISS treatment and well installation activities could be completed in approximately 4 to 5 months and monitoring would be conducted over an assumed 30-year period.

Long-Term Effectiveness and Permanence – Alternative 3

Under Alternative 3, accessible MGP source material would be treated in place via ISS. As part of the ISS treatment, impacted groundwater within the treatment area would also be stabilized. Although impacted soil and groundwater would be solidified in place, the impacted materials would be encapsulated by the stabilized mass. Post-ISS QA/QC sampling would be completed to confirm that performance criteria are met for the stabilized soil. If performance criteria are not met in specific areas, soil would be remixed until performance criteria are met.

In support of developing this alternative, ARCADIS conducted predictive simulations using a steady-state, three-dimensional MODFLOW groundwater flow model to evaluate the potential hydraulic impacts caused by the implementation of Alternative 3. The predictive simulations were conducted using the following assumptions:

- The ISS monolith (i.e., the stabilized soil and groundwater) would have a hydraulic conductivity of $1x10^{-6}$ centimeters per second (cm/s).

- The top of the ISS monolith would be set at an elevation of 425 ft amsl (i.e., five feet below the existing grade).

- The area above the ISS monolith would be backfilled with a material that has a hydraulic conductivity similar to the existing fill unit and the ground surface at the site would be restored to previous lines and grades.

Based on the results of the predictive simulations, implementation of Alternative 3 is not expected to significantly raise water levels in the area upgradient from (below the service center building) and within the ISS monolith. Modeling predicts that groundwater flow patterns would remain relatively consistent with current site flow patterns and relatively minimal groundwater mounding would be anticipated following the stabilization of site soils. The greatest rise in water table elevation (relative to current conditions) would be approximately one foot and would occur over the downgradient portion of the ISS monolith and little to no mounding would be anticipated upgradient of the ISS monolith near the service center building. The results of the MODFLOW groundwater flow model simulations are discussed in greater detail in the technical memorandum included as Appendix A.

To minimize potential future exposures to MGP-related impacts, the SMP would include protocols (including health and safety requirements) for conducting invasive activities at the property and managing the excavated stabilized material. However, based on the current and foreseeable future use of the site as a NYSEG service center, site workers do not routinely conduct activities that would potentially result in exposure to site media containing MGP-related COCs. If subsurface activities (e.g., installation of new utilities) were to be conducted at the site, activities would likely be conducted in areas restored with reusable site soil and imported clean fill placed above stabilized MGP source material and not in areas containing remaining MGP source material (i.e., beneath the service center building). The potential for exposures to impacted site media would be significantly reduced under this alternative. However, work activities (including handling potentially impacted material) would be conducted in accordance with the procedures described in the SMP to minimize the potential for exposures to impacted site media that would remain at the site.

Alternative 3 would also include the establishment of institutional controls and development of a long-term groundwater monitoring program. Institutional controls (e.g., environment easements in the form of groundwater use restrictions) would prohibit potable (and other) uses of site groundwater. Annual verification of the institutional controls would be completed to document that the controls are maintained

and remain effective. Annual groundwater monitoring would be conducted to document the extent of dissolved phase impacts and potential trends in COC concentrations (i.e., document that COC concentrations are reducing or that impacted groundwater is not migrating beyond the site limits).

Inaccessible MGP source material would remain beneath the NYSEG service center building. Alternative 3 also includes NAPL recovery to reduce the volume of mobile NAPL present at the site. Potential exposures to field personnel and the community during long-term monitoring activities would be minimized by following appropriate procedures and protocols that would be established in the SMP. Active NAPL recovery and low-flow pumping (if utilized in an attempt to enhance NAPL recovery) would create a greater potential for exposures to MGP-related materials on a long-term basis when compared to passive NAPL recovery. Active NAPL recovery would require construction of a structure(s) to store recovered NAPL. If low-flow groundwater pumping was implemented in an attempt to enhance NAPL collection, assuming each of the NAPL collection wells would be pumped at a constant rate of one gpm, more than 7,000 gallons of impacted groundwater would be generated each day. A water treatment system would have to be constructed at the site to treat the groundwater. However, the discharge of water from an on-site system to the village sanitary sewer is prohibited; therefore, alternate discharge options would have to be identified.

Additionally, the presence of the water treatment and NAPL storage systems would increase the potential for long-term exposures to site workers and the surrounding community (i.e., during routine system operation or maintenance activities, system malfunctions, or vandalism of the structures and systems). In contrast, passive collection activities could be conducted during non-peak hours and NAPL collected during passive recovery activities would be immediately transported off-site for treatment/disposal, significantly reducing the potential for long-term exposures to site workers and the surrounding public. Based on this rationale, both active NAPL removal and low-flow groundwater pumping would decrease the long-term effectiveness and permanence of this alternative.

Land Use – Alternative 3

The current zoning for the site is listed as commercial use and areas immediately surrounding the site are zoned for commercial and residential use. The site will continue to be used by NYSEG as a natural gas service center. The current and foreseeable future use of the area surrounding the site is a mixed commercial/ residential setting. Based on the current and anticipated future land use of the site as a

NYSEG service center, the potential for exposure to subsurface soil and groundwater containing MGP-related COCs is minimal. The majority of the site is covered with asphalt, concrete, a building, or vegetated soil, and there is little to no need to conduct subsurface activities at the site. Additionally, drinking water is currently and will continue to be provided via a public supply. Therefore, groundwater containing MGP-related COCs is not and will not be used for potable (or other) purposes.

Alternative 3 would not affect the current land use at the site. MGP source material would be solidified in place and the site would be restored and continue to be used as a NYSEG service center. Additionally, deed restrictions would be placed on the NYSEG property and groundwater monitoring and NAPL monitoring/recovery would be conducted for an assumed 30 years. Although material within 60 inches of the ground surface would not be solidified, the presence of ISS treated material may limit the potential future development of the site. The solidified/stabilized material would provide a working platform that could support construction of a slab-on-grade structure. However, construction of a building with subgrade basement level and foundation would be more difficult based on the nature of the solidified material.

If the NYSEG property were to be redeveloped and/or sold to another party, the SMP would be provided to potential future site owners and institutional controls would remain in place. Future site owners/operators would be required to conduct site activities in accordance with the SMP and the institutional controls established for the site based on the presence of the remaining solidified MGP source material and remaining inaccessible MGP source material.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 3

Alternative 3 would include ISS treatment of approximately 2,600 cy of soil to address an estimated 850 cy of accessible MGP source material. Soil subject to ISS treatment would be stabilized in-place to reduce the mobility of NAPL and leachability of COCs. Impacted groundwater within the ISS treatment area (an estimated 170,000 gallons) would also be stabilized with the soil. While the volume of impacts within the property would not be reduced under Alternative 3, the ISS treatment would solidify NAPL, impacted soil and groundwater in a homogenized mass.

This alternative also includes the installation of NAPL collection wells, periodic NAPL monitoring and removal of mobile NAPL that may collect in the wells. Through the NAPL monitoring/recovery activities, the volume of mobile NAPL would be permanently reduced, thereby reducing the potential for further downgradient migration of mobile

NAPL. NAPL removal would also permanently reduce the volume of residual material (inaccessible to ISS treatment) that is serving as a source to dissolved phase groundwater impacts.

The ISS treatment of accessible MGP source material, in combination with NAPL removal, would reduce the flux of COCs from source material to groundwater, which would reduce the toxicity and volume of residual dissolved phase groundwater impacts. Alternative 3 also includes annual groundwater monitoring to document the extent and likely long-term reduction (i.e., toxicity and volume) of residual dissolved phase groundwater impacts.

Implementability – Alternative 3

Alternative 3 would be both technically and administratively implementable. From a technical implementability aspect, remedial contractors capable of performing excavation and ISS treatment activities are available. A number of ISS applications have been completed on MGP sites in Georgia, Wisconsin, New Hampshire, Massachusetts, Pennsylvania and New York. As indicated previously, bench-scale testing would be required prior to the implementation of this alternative to identify an optimal mix design based on site-specific conditions. Soil loading conditions from nearby buildings/structures would be evaluated as part of the remedial design. Although technically feasible, conducting ISS treatment activities in an urban setting presents numerous logistical challenges. Limited space would be available at the site for material handling and staging. A working area would have to be available to set up and operate the ISS mix plant. Obstructions greater than six inches in diameter could prevent homogenous mixing and potentially damage ISS equipment. The ISS activities could potentially be limited by subsurface obstructions such as cobbles, debris, historical fill materials and subsurface former building foundations and slabs. Pre-ISS excavation would be conducted to identify obstructions and clear the top four to five feet of fill material to allow for the expansion of solidified soil. Jet grouting methods could be used to solidify material near/beneath obstructions.

Based on the ISS treatment/excavation limits, NYSEG service center operations (e.g., personnel and equipment) would have to be temporarily relocated during remedial construction activities. Additionally, NYSEG would have to assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed ISS treatment area during the remedial design. If the gas lines could not be temporarily deactivated/relocated during remedial construction activities, jet grouting methods would be used to treat soil beneath gas lines at perimeter locations where gas

lines transect the ISS treatment area. NYSEG service center operations could resume at the site and gas distribution lines could be reconnected and placed back into service (as necessary) following remedial construction activities.

From a technical implementability aspect, equipment and personnel qualified to install NAPL collection wells and conduct groundwater and NAPL monitoring activities are readily available. NAPL collection wells would be secured in lockable subsurface vaults to prevent access by unauthorized personnel. NAPL collection and recovery methods would also be assessed during the design of this alternative. Active NAPL recovery (i.e., automated pumping) and low-flow groundwater pumping (to enhance NAPL collection) would be more difficult to implement, when compared to passive NAPL collection and manual recovery, as automated recovery would require on-site NAPL storage structures and low-flow groundwater pumping would require construction and operation of an on-site water treatment system.

Administratively, Alternative 3 is implementable. Institutional controls would be established for the site, which would require coordination with state agencies (i.e., NYSDEC and NYSDOH). No access agreements would be required, as excavation and ISS activities would be conducted within the limits of the NYSEG property and existing groundwater monitoring and new NAPL collection wells are/will be located on NYSEG property. As indicated by the Village of Goshen, discharge of groundwater to local sanitary sewers is prohibited. Therefore, construction and O&M of NAPL/water storage structures and treatment systems may require special permitting (e.g., SPDES discharge to surface water), making this method a less practicable and administratively feasible alternative for the collection and recovery of NAPL. As the site is located within the Village of Goshen Architectural Design District, if the service center building were to be demolished as part of this alternative, remedial construction activities, including demolition of the service center building, would likely have to be approved by the Village of Goshen.

<u>Compliance with SCGs – Alternative 3</u>

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 soil cleanup objectives and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

Under Alternative 3, accessible MGP source material would be stabilized in place via ISS. Although this alternative would not address all subsurface soil that contains COCs at concentrations greater than 6 NYCRR Part 375-6 SCOs, the accessible, most heavily impacted soil (and subsequently most heavily impacted groundwater) would be solidified in place. Inaccessible MGP source material and subsurface soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 SCOs would remain beneath surface materials (i.e., pavement, concrete, a building, and vegetated surfaces). All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

As indicated in Section 1, site groundwater contains VOCs and SVOCs at concentrations greater than NYSDEC Class GA standards and guidance values. Although NAPL collection wells would be installed to collect inaccessible, potentially mobile NAPL, this alternative does not include removal activities to address all soil containing MGP-related impacts (i.e., a source of dissolved-phase impacts). Therefore, if this alternative could achieve groundwater SCGs, the SCGs would be achieved over a prolonged period of time.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Excavated soil and process residuals would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved RD/RA Work Plan and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated material from a former MGP site that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable NYS LDRs.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting site activities. Additionally, remedial activities would be conducted in accordance with Village and Town of Goshen building/construction codes and ordinances. Discharge of groundwater generated during remedial construction activities (i.e., in support of excavation area dewatering or as part of long-term groundwater treatment system) to the sanitary sewer is prohibited. As indicated previously, the NYSEG property is located with the Village of Goshen Architectural Design District. Properties and buildings located within this district are subject to regulations/restrictions regarding historical areas. If the ISS treatment limits were to include areas beneath the service center building, remedial construction activities, including demolition of the service center building, would likely have to be approved by the Village of Goshen.

Overall Protection of Public Health and the Environment – Alternative 3

Alternative 3 would mitigate the potential for long-term exposures to impacted subsurface soil and groundwater by stabilizing accessible MGP source material in-place, recovering inaccessible mobile NAPL, monitoring groundwater, and implementing institutional controls. The potential for future construction workers to be exposed to MGP-related impacts while conducting subsurface work at the site would be mitigated through stabilization of accessible MGP source material. ISS would be used to stabilize and solidify in place, an estimated 850 cy of accessible MGP source material (located at depths greater than 12 feet below grade). Inaccessible mobile NAPL would be removed using NAPL collection wells.

Although inaccessible MGP source material would remain at the site, through the stabilization of subsurface soil and groundwater containing MGP-related COCs and NAPL, Alternative 3 would prevent exposures (i.e., direct contact, ingestion, and inhalation) to accessible MGP-related impacts in subsurface soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2). Furthermore, potentially complete exposure pathways (i.e., exposures to future construction workers) to inaccessible/residual impacts that would remain under this alternative would be reduced by establishing/developing and adhering to institutional controls and the procedures to be presented in the SMP. Additionally, the institutional controls would include requirements to assess the presence of inaccessible MGP source material if the service center building were ever demolished.

Alternative 3 would partially address MGP-related COCs and NAPL that could cause impacts to groundwater or surface water (soil RAO #3) through the stabilization of accessible MGP source material and through the recovery of inaccessible mobile NAPL. Periodic monitoring would be completed to document the extent of residual dissolved phase impacts and potential trends in COC concentrations. Through stabilization of accessible MGP source material and removal of inaccessible mobile NAPL, Alternative 3 would work toward restoring groundwater to pre-disposal/pre-release conditions (groundwater RAO #3). However, inaccessible MGP source material would remain at the site. Therefore, all sources of groundwater impacts would not be addressed (groundwater RAO #4) and restoration of groundwater to pre-disposal/pre-release conditions would only occur over a prolonged period time.

As indicated in Section 1, Rio Grande Creek surface water does not appear to be impacted by MGP-related COCs and implementation of this alternative would not promote discharge of NAPL or groundwater containing MGP-related impacts to the creek. As indicated previously, implementation of this alternative is not anticipated to significantly alter hydrogeologic site conditions. Stabilization of accessible MGP source material and removal of inaccessible mobile NAPL would reduce the volume of material that serves as a source to dissolved phase impacts and that could potentially discharge to the creek. Groundwater monitoring (including sampling of wells located downgradient of stabilized MGP source material and upgradient of the creek) would document dissolved phase COC concentrations and groundwater flow direction. Therefore, Alternative 3 would mitigate the discharge of groundwater containing MGP-related COCs to surface water (groundwater RAO #5).

Cost Effectiveness – Alternative 3

The estimated costs associated with Alternative 3 are presented in Table 7. The total estimated 30-year present worth cost for this alternative is approximately $3,400,000. The estimated capital cost, including costs for conducting ISS and soil removal activities, installing NAPL collection wells, and establishing institutional controls, is approximately $2,400,000. The estimated 30-year present worth cost of O&M activities associated with this alternative, including conducting semi-annual NAPL monitoring and annual groundwater monitoring, is approximately $1,000,000.

5.2.4 Alternative 4 – MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls

The major components of Alternative 4 include the following:

- Excavating accessible MGP source material
- Removing the UST located south of Gas Holder #2
- Implementing a NAPL recovery program
- Conducting long-term groundwater monitoring
- Developing a site management plan
- Establishing institutional controls

Alternative 4 would include excavation activities to address MGP source material. Alternative 4 would include the excavation of the same material identified for ISS under Alternative 3. As indicated in Section 5.2.3, DER-10 indicates that a source area typically includes NAPL or grossly contaminated material and, for the purpose of this Feasibility Study, MGP source material will be defined as soil containing visual MGP-related impacts in quantities greater than slight/trace sheens, staining, or isolated blebs. This alternative would also address the potential for exposure to remaining subsurface soil and groundwater containing residual MGP-related COCs through the implementation of institutional controls. Alternative 4 also includes NAPL recovery to facilitate the removal of inaccessible, potentially mobile NAPL from the subsurface and long-term groundwater monitoring to document the extent of dissolved phase impacts and potential trends in COC concentrations.

Excavation limits are shown on Figure 9. For the purpose of developing this alternative, it has been assumed that a minimum clearance of 10 feet would be maintained near existing buildings and structures and the service center building would remain. Alternative 4 would include the excavation of approximately 3,400 cy of soil to depths ranging from 12 feet below grade to the top of till (i.e., 26 to 28 feet below grade). It is anticipated that an excavation enclosure (e.g., Sprung-type structure) equipped with a vapor collection and treatment system would be constructed over the proposed excavation area to reduce the potential for off-site migration of and exposures to vapors and odors during excavation activities. Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Excavation areas would be dewatered to the extent practicable to facilitate soil removal. Based on the proposed extent/depth of excavation activities, excavation support systems (assumed to be steel sheet pile walls equipped with internal bracing) are anticipated to be required for the excavation

activities. The final excavation plan would be developed as part of a remedial design. For the purpose of developing this alternative, it has been assumed that the gas distribution piping located within the excavation area could be temporarily deactivated, bypassed, and/or relocated during the remedial construction activities to facilitate the removal of soil beneath the piping.

An assumed 25% of soil removed during excavation activities would be suitable for reuse (i.e., free of visual impacts, odors, rubble, and debris) as subsurface backfill and staged on-site. Excavation areas would be restored with soil suitable for reuse as subsurface backfill and imported clean fill material to match the previously existing lines and grades. At a minimum, the top one foot of surface cover would meet the allowable constituent levels for imported fill or soil for commercial use (as presented in DER-10) or the surfaces would be restored with gravel or asphalt pavement. Surface restoration details would be developed as part of the remedial design for this alternative.

For the purpose of developing this alternative, it has been assumed that excavated material from 0 to 1 foot below grade would be transported off-site for disposal as C&D debris. An assumed 25% of excavated material (850 cy) would include MGP source material that would be transported off-site for treatment/disposal via LTTD. As indicated above, an assumed 25% of soil removed during excavation activities would be reused as subsurface backfill. The remaining 50% of excavated soil is assumed to be unsuitable for reuse (but not require treatment/disposal via LTTD) due to the presence of debris and/or other fill materials and would be transported off-site for disposal as a non-hazardous waste at a solid waste landfill. Based on conversations with the Village of Goshen, the discharge of groundwater generated during remedial from the site to the sanitary sewer is prohibited. Therefore, an estimated 170,000 gallons water removed from excavation areas would be temporarily containerized on-site (e.g., in 20,000 gallon holding tanks), sampled for waste characterization purposes, and transported off-site for disposal or discharged to the Rio Grande Creek under a one-time construction SPDES permit. For the purpose of developing this alternative, it has been assumed that water generated during remedial construction activities would be transported off-site for disposal.

Alternative 4 would also include the same NAPL recovery, groundwater monitoring, and institutional controls components as Alternatives 2 and 3. NAPL collection points could potentially consist of, but not be limited to, wells or trenches. The final number, location, type, and construction details of the NAPL collection points would be determined during the remedial design of this alternative. For the purpose of developing a cost estimate for this alternative, it has been assumed that five NAPL collection wells would be installed.

Additionally, the steel sheet pile used as excavation support could remain along the upgradient edge of the excavation areas to potentially enhance NAPL collection in the wells that would be installed upgradient of the excavation and downgradient of the service center building. NAPL collection wells would be installed at the same locations described under Alternative 2 (see Figure 9) and would be periodically (i.e., semi-annually) monitored to facilitate the passive recovery of potentially mobile NAPL. NAPL could potentially be recovered utilizing an active recovery system depending on the rate of NAPL collection following installation of the collection points. Low-flow groundwater pumping could also be considered to potentially enhance the rate of NAPL collection (note that discharge of any groundwater, treated or untreated, to the Village of Goshen sanitary sewer is prohibited).

Similar to Alternatives 2 and 3, Alternative 4 would also include conducting annual groundwater monitoring to confirm groundwater flow direction and verify the extent and concentrations of residual dissolved phase COCs. Groundwater samples would be collected and submitted for laboratory analysis for BTEX and PAHs to document the extent of dissolved phase impacts and potential trends in COC concentrations.

Additionally, Alternative 4 would include establishing institutional controls on the NYSEG property in the form of deed restrictions and environmental easements (e.g., groundwater use restrictions) to control intrusive (i.e., subsurface) activities that could result in potential exposures to remaining subsurface soil and groundwater containing residual MGP-related impacts at concentrations greater than applicable standards and guidance values. The institutional controls would also establish requirements for additional investigation activities (e.g., subsurface soil sampling) if the service center building were to be demolished. Additionally, the institutional controls would require compliance with the SMP (described below) that would be prepared as part of this alternative. Although potable water is provided by a municipal supply, the institutional controls would also prohibit the use of non-treated groundwater on the NYSEG property. An annual report would be submitted to NYSDEC to document that institutional controls are maintained and remain effective.

This alternative would include preparation of an SMP to document the following:

- The institutional controls that have been established and will be maintained for the site

- Known locations of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 commercial use SCOs

- Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities

- Protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring

- Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities

Short-Term Impacts and Effectiveness – Alternative 4

Implementation of this alternative could result in short-term exposure of the surrounding community and site workers to site-related COCs as a result of excavation, material handling, and off-site transportation activities. Additionally field personnel may be exposed to impacted soil, groundwater, and/or NAPL during NAPL collection well installation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil, and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design.

Community access to the excavation area would be restricted by temporary security fencing and the excavation enclosure. Based on the proposed excavation limits, the NYSEG personnel and supporting operations would have to be temporarily relocated during remedial construction activities. At a minimum, the NYSEG service center would be closed for a period of up to 7 months during remedial construction activities.

Additional worker safety concerns include working with and around large construction equipment, noise generated from installing sheeting and operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the site and delivery of fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Off-site transportation of excavated material and importation of clean fill materials would result in approximately 290 tractor trailer truck round trips (assuming 35 tons per dump truck and 5,000 gallons per tank truck). Transportation activities would be managed to minimize en-route risks to the community.

Potentially impacted soil and groundwater generated during well installation activities would be properly managed to minimize potential exposures to the surrounding community. Potential risks to the community could occur during periodic groundwater and NAPL monitoring activities via exposure to purged groundwater, groundwater samples, and/or NAPL. Potential exposures to the community would be minimized by following appropriate procedures and protocols that would be described in the SMP.

Although this alternative does not employee green remediation practices, excavated site soil would be utilized as subsurface backfill if suitable. For the purpose of this Feasibility Study it has been assumed that 25% excavated material (850 cy) could be reused as subsurface backfill at the site and 75% of excavated material (2,600 cy) would be transported for off-site treatment and/or disposal. The relative carbon footprint of Alternative 4 (as compared to the other alternatives) is considered moderate to significant. The greatest contribution to greenhouse gases would occur as a result of equipment operation during soil excavation, backfilling, and soil and groundwater transportation activities, as well as LTTD treatment of an assumed 850 cy of MGP source material.

Soil excavation, backfilling, and well installation activities could be completed in approximately 6 to 7 months and monitoring would be conducted over an assumed 30-year period.

Long-Term Effectiveness and Permanence – Alternative 4

Under Alternative 4, accessible MGP source material would be excavated and transported off-site for treatment/disposal. Removal of the accessible, most heavily impacted soil would reduce the potential need to implement the protocols described in the SMP and reduce the potential for exposures to site media containing MGP-related COCs. However, inaccessible MGP source material would remain beneath the NYSEG service center building. Alternative 4 also includes NAPL recovery to reduce the volume of mobile NAPL present at the site.

Based on the current and foreseeable future use of the site as a NYSEG service center, site workers do not routinely conduct activities that would potentially result in exposure to site media containing MGP-related COCs. If subsurface activities (e.g., installation of new utilities) were to be conducted at the site, activities would likely be conducted in areas restored with reusable site soil and imported clean fill and not in areas containing remaining MGP source material (i.e., beneath the service center building). The potential for exposures to impacted site media would be significantly

reduced under this alternative. However, work activities (including handling potentially impacted material) would be conducted in accordance with the procedures described in the SMP to minimize the potential for exposures to impacted site media.

Alternative 4 would also include the establishment of institutional controls and development of a long-term groundwater monitoring program. Institutional controls (e.g., environment easements in the form of groundwater use restrictions) would prohibit potable uses of site groundwater. Annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective. Annual groundwater monitoring would be conducted to document the extent of dissolved phase impacts and potential trends in COC concentrations (i.e., document that COC concentrations are reducing or that impacted groundwater is not migrating beyond the site limits).

Alternative 4 also includes NAPL recovery to reduce the volume of inaccessible mobile NAPL in the subsurface. Potential exposures to field personnel and the community during long-term monitoring activities would be minimized by following appropriate procedures and protocols that would be established in the SMP that would be prepared as part of this alternative. Active NAPL recovery and low-flow pumping (if utilized in an attempt to enhance NAPL recovery) would create a greater potential for exposures to MGP-related materials on a long-term basis when compared to passive NAPL recovery. Active NAPL recovery would require construction of a structure(s) to store recovered NAPL. If low-flow groundwater pumping was implemented in an attempt to enhance NAPL collection, assuming each of the NAPL collection wells would be pumped at a constant rate of one gpm, more than 7,000 gallons of impacted groundwater would be generated each day. A water treatment system would have to be constructed at the site to treat the groundwater. However, the discharge of water from an on-site system to the village sanitary sewer is prohibited; therefore, alternate discharge options would have to be identified.

Additionally, the presence of the water treatment and NAPL storage systems would increase the potential for long-term exposures to site workers and the surrounding community (i.e., during routine system operation or maintenance activities, system malfunctions, or vandalism of the structures and systems). In contrast, passive collection activities could be conducted during non-peak hours and NAPL collected during passive recovery activities would be immediately transported off-site for treatment/disposal, significantly reducing the potential for long-term exposures to site workers and the surrounding public. Based on this rationale, both active NAPL removal

and low-flow groundwater pumping would decrease the long-term effectiveness and permanence of this alternative.

Land Use – Alternative 4

The current zoning for the site is listed as commercial use and areas immediately surrounding the site are zoned for commercial and residential use. The site will continue to be used by NYSEG as a natural gas service center. The current and foreseeable future use of the area surrounding the site is a mixed commercial/residential setting. Based on the current and anticipated future land use of the site as a NYSEG service center, the potential for exposure to subsurface soil and groundwater containing MGP-related COCs is minimal. The majority of the site is covered with asphalt, concrete, a building, or vegetated soil, and there is little to no need to conduct subsurface activities at the site. Additionally, drinking water is currently and will continue to be provided via a public supply. Therefore, groundwater containing MGP-related COCs is not and will not be used for potable (or other) purposes.

Alternative 4 would not affect the current or anticipated future land use at the site (i.e., use as NYSEG service center). Accessible MGP source material would be removed from the site. Deed restrictions would be placed on the NYSEG property and groundwater monitoring and NAPL monitoring/recovery would be conducted for an assumed 30 years. If the NYSEG property were to be redeveloped and/or sold to another party, the SMP would be provided to potential future site owners and institutional controls would remain in place. Future site owners/operators would be required to conduct site activities in accordance with the SMP and the institutional controls established for the site based on the presence of remaining inaccessible MGP source material and residual soil and groundwater containing COCs at concentrations greater than applicable standards.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 4

Alternative 4 would include the excavation of approximately 3,400 cy of material to address accessible MGP source material. An estimated 850 cy MGP source material (i.e., NAPL and impacted soil) would be permanently transported off-site for treatment and/or disposal via LTTD. Additionally, an estimated 170,000 gallons of groundwater containing dissolved phase MGP-related impacts would be permanently removed from the site and transported off-site for disposal.

This alternative also includes the installation of NAPL collection wells, periodic NAPL monitoring and removal of mobile NAPL that may collect in the wells. Through the NAPL monitoring/recovery activities, the volume of mobile NAPL would be permanently reduced, thereby reducing the potential for further downgradient migration of mobile NAPL. NAPL removal would also permanently reduce the volume of residual material (inaccessible to excavation) that is serving as a source to dissolved phase groundwater impacts.

The removal of accessible MGP source material, in combination with NAPL removal, would reduce the flux of COCs from source material to groundwater, which would reduce the toxicity and volume of residual dissolved phase groundwater impacts. Alternative 4 also includes annual groundwater monitoring to document the extent and likely long-term reduction (i.e., toxicity and volume) of residual dissolved phase groundwater impacts.

Implementability – Alternative 4

Alternative 4 would be both technically and administratively implementable. From a technical implementability aspect, remedial contractors capable of performing the excavation activities are readily available. Although technically feasible, conducting excavation activities in an urban setting presents numerous logistical challenges. Limited space would be available at the site for material handling and staging and equipment operation. Transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 to 50 ton) may not be able to access the site and limited space is available on-site for vehicle staging. Additionally, soil removal activities would have to be conducted in a manner as to not jeopardize the health and safety of or cause a nuisance to the surrounding community. Soil loading conditions from nearby buildings/structures would be evaluated as part of the remedial design. A temporary excavation enclosure would likely be constructed over the excavation area to minimize potential exposures to the surrounding community.

Based on the removal limits of this alternative, NYSEG service center operations (e.g., personnel and equipment) would have to be temporarily relocated during remedial construction activities. Additionally, NYSEG would have to assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design. NYSEG service center operations could resume at the site and gas distribution lines could be reconnected and placed into service following remedial construction activities.

From a technical implementability aspect, equipment and personnel qualified to install NAPL collection wells and conduct groundwater and NAPL monitoring activities are readily available. NAPL collection wells would be secured in lockable subsurface vaults to prevent access by unauthorized personnel. NAPL collection and recovery methods would also be assessed during the design of this alternative. Active NAPL recovery (i.e., automated pumping) and low-flow groundwater pumping (to enhance NAPL collection) would be more difficult to implement, when compared to passive NAPL collection and manual recovery, as automated recovery would require on-site NAPL storage structures and low-flow groundwater pumping would require construction and operation of an on-site water treatment system.

Administratively, Alternative 4 is implementable. Institutional controls would be established for the site, which would require coordination with state agencies (i.e., NYSDEC and NYSDOH). No access agreements would be required, as excavation activities would be conducted within the limits of the NYSEG property and existing groundwater monitoring and new NAPL collection wells are/will be located on NYSEG property. As indicated by the Village of Goshen, discharge of groundwater to local sanitary sewers is prohibited. Therefore, construction and O&M of NAPL/water storage structures and treatment systems may require special permitting (e.g., SPDES discharge to surface water), making this method a less practicable and administratively feasible alternative for the collection and recovery of NAPL. As the site is located within the Village of Goshen Architectural Design District, if the service center building were to be demolished as part of this alternative, remedial construction activities, including demolition of the service center building, would likely have to be approved by the Village of Goshen.

Compliance with SCGs – Alternative 4

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 soil cleanup objectives and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 4 would include the removal of accessible MGP source material. Although this alternative would not address all subsurface soil that contains COCs at concentrations greater than 6 NYCRR Part 375-6 SCOs, the accessible, most heavily impacted soil (and subsequently most heavily impacted

groundwater) would be removed from the site. Inaccessible MGP source material and subsurface soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 SCOs would remain beneath surface materials (i.e., pavement, concrete, a building, and vegetated surfaces). All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/ disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

As indicated in Section 1, site groundwater contains VOCs and SVOCs at concentrations greater than NYSDEC Class GA standards and guidance values. Although NAPL collection wells would be installed to collect inaccessible, potentially mobile NAPL, this alternative does not include removal activities to address all soil containing MGP-related impacts (i.e., a source of dissolved-phase impacts). Therefore, if this alternative could achieve groundwater SCGs, the SCGs would be achieved over a prolonged period of time.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Excavated soil and process residuals would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved RD/RA Work Plan and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated material from a former MGP site that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable NYS LDRs. If water generated during remedial construction activities were to be treated on-site and discharged to the Rio Grande Creek, the discharge would be conducted in accordance with a one-time construction SPDES permit.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting site activities. Additionally, remedial activities would be conducted in accordance with Village and Town of Goshen building/construction codes and ordinances. Discharge of water generated during remedial construction activities (i.e., in support of excavation area dewatering or as part of long-term groundwater treatment system) to the sanitary sewer is prohibited. Therefore, water generated during remedial construction activities (i.e., decontamination water, water removed from excavation areas) must be transported off-site for disposal. As indicated previously, the NYSEG property is located with the Village of Goshen Architectural Design District. Properties and buildings located within this district are subject to regulations/restrictions regarding historical areas. If the excavation limits were to include areas beneath the service center building, remedial construction activities, including demolition of the service center building, would likely have to be approved by the Village of Goshen.

Overall Protection of Public Health and the Environment – Alternative 4

Alternative 4 would mitigate the potential for long-term exposures to impacted subsurface soil and groundwater by excavating accessible MGP source material, recovering inaccessible mobile NAPL, monitoring groundwater, and implementing of institutional controls. The potential for future construction workers to be exposed to MGP-related impacts while conducting subsurface work at the site would be mitigated through the removal of an estimated 850 cy of accessible MGP source material (located at depths greater than 12 feet below grade). Inaccessible mobile NAPL would be removed using NAPL collection wells.

Although inaccessible MGP source material would remain at the site, Alternative 4 would include excavation (and excavation area dewatering) and transportation for off-site treatment and/or disposal to prevent exposures (i.e., direct contact, ingestion, and inhalation) to accessible MGP-related impacts in subsurface soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2). Furthermore, potentially complete exposure pathways (i.e., exposures to future construction workers) to inaccessible/residual impacts that would remain under this alternative would be reduced by establishing/developing and adhering to institutional controls and the procedures to be presented in the SMP. Additionally, the institutional controls would

include requirements to assess the presence of inaccessible MGP source material if the service center building were ever demolished.

Alternative 4 would partially address MGP-related COCs and NAPL that could cause impacts to groundwater or surface water (soil RAO #3) through the removal of accessible MGP source material and through the recovery of inaccessible mobile NAPL. Periodic monitoring would be completed to document the extent of residual dissolved phase impacts and potential trends in COC concentrations. Through excavation of accessible MGP source material and removal of inaccessible mobile NAPL, Alternative 4 would work toward restoring groundwater to pre-disposal/pre-release conditions (groundwater RAO #3). However, inaccessible MGP source material would remain at the site. Therefore, all sources of groundwater impacts would not be addressed (groundwater RAO #4) and restoration of groundwater to pre-disposal/pre-release conditions would only occur over a prolonged period time.

As indicated in Section 1, Rio Grande Creek surface water does not appear to be impacted by MGP-related COCs and implementation of this alternative would not promote discharge of NAPL or groundwater containing MGP-related impacts to the creek. Excavation of accessible MGP source material and removal of inaccessible mobile NAPL would reduce the volume of material that serves as a source to dissolved phase impacts and could potentially discharge to the creek. Groundwater monitoring would document dissolved phase COC concentrations and groundwater flow direction. Therefore, Alternative 4 would mitigate the discharge of groundwater containing MGP-related COCs to surface water (groundwater RAO #5).

Cost Effectiveness – Alternative 4

The estimated costs associated with Alternative 4 are presented in Table 8. The total estimated 30-year present worth cost for this alternative is approximately $5,000,000. The estimated capital cost, including costs for conducting soil removal activities, installing NAPL collection wells, and establishing institutional controls, is approximately $4,000,000. The estimated 30-year present worth cost of O&M activities associated with this alternative, including conducting semi-annual NAPL monitoring and annual groundwater monitoring, is approximately $1,000,000.

5.2.5 Alternative 5 – Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring

The major components of Alternative 5 include the following:

- Excavating soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs
- Removing the UST located south of former Gas Holder #2
- Conducting short-term groundwater monitoring

Alternative 5 would include excavation activities to address soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs. As this alternative includes the removal of a vast majority of site soil, only short-term groundwater monitoring would be conducted to confirm that groundwater standards and guidance values are achieved. Implementation of long-term groundwater monitoring, NAPL recovery, development of a site management plan, and establishment of institutional controls are not anticipated to be required following the soil excavation activities.

Excavation limits are shown on Figure 10. For the purpose of developing this alternative, it has been assumed that the service center building would be demolished and gas distribution piping and supporting infrastructure would be removed prior to soil removal activities. Note that as indicated previously, the site is located within the Village of Goshen Architectural Design District and demolition of the service building would ultimately have to be approved by the Village. Alternative 5 would include the excavation of approximately 9,200 cy of soil to depths ranging from 12 to 28 feet below grade (i.e., up to the top of till at select locations). It is anticipated that an excavation enclosure (e.g., Sprung-type structure) equipped with a vapor collection and treatment system would be constructed over the proposed excavation area to reduce the potential for off-site migration of and exposure to vapors and odors during excavation activities. Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. The excavation areas would be dewatered to the extent practicable to facilitate soil removal. Based on the proposed extent/depth of excavation activities, excavation support systems (assumed to be steel sheet pile walls equipped with internal bracing) are anticipated to be required for the proposed excavation activities. The final excavation plan would be developed as part of a remedial design.

Excavation areas would be restored with imported clean fill material to match the previously existing lines and grades. At a minimum, the top one foot of surface cover would meet the allowable constituent levels for imported fill or soil for commercial use (as presented in DER-10) or the surfaces would be restored with gravel or asphalt pavement. Surface restoration details would be developed as part of the remedial design for this alternative.

For the purpose of developing this alternative, it has been assumed that excavated material from 0 to 1 foot below grade would be transported off-site for disposal as C&D debris. An estimated 15% of excavated material (1,400 cy) would include MGP source material and be transported off-site for treatment/ disposal via LTTD. Note that although soil borings have not been completed beneath the service center building, it has been assumed that MGP source material is present beneath the building based on the recoverable amounts of NAPL that have been observed and removed in NAPL monitoring well NMW08-02). The remaining 85% of excavated soil would be transported for off-site disposal as a non-hazardous waste at a solid waste landfill. Based on conversations with the Village of Goshen, the discharge of groundwater generated during construction activities to the sanitary sewer from the site is prohibited. Therefore, potentially more than 400,000 gallons of water removed from excavation areas would temporarily containerized on-site (e.g., in 20,000 gallon holding tanks), sampled for waste characterization purposes, and transported off-site for disposal or discharged to the Rio Grande Creek under a one-time construction SPDES permit. For the purpose of developing this alternative, it has been assumed that water generated during remedial construction activities would be transported off-site for disposal.

Following excavation and backfilling activities, groundwater monitoring would be conducted for a short duration (e.g., up to two years) to confirm that groundwater standards and guidance values are achieved. Because a vast majority of MGP-related impacts would be removed from the site, dissolved phase concentrations of BTEX and PAHs in groundwater downgradient of the excavation areas would be expected to naturally attenuate. Therefore, Alternative 5 does not include long-term groundwater monitoring or institutional control components.

Short-Term Impacts and Effectiveness – Alternative 5

Implementation of this alternative could result in short-term exposure of the surrounding community and site workers to site-related COCs as a result of excavation, material handling, and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil,

and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design.

Community access to the excavation area would be restricted by temporary security fencing and the excavation enclosure. Based on the proposed excavation limits, the NYSEG service center building would be demolished, gas distribution lines and gas regulators would be relocated to an off-site location, and the NYSEG personnel and supporting operations would be permanently moved to an alternate location.

Additional worker safety concerns include working with and around large construction equipment, noise generated from installing sheeting and operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the site and delivery of fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Off-site transportation of excavated material and importation of clean fill materials would result in approximately 920 tractor trailer truck round trips (assuming 35 tons per dump truck and 5,000 gallons per tank truck). Transportation activities would be managed to minimize en-route risks to the community.

The relative carbon footprint of Alternative 5 (as compared to the other alternatives) is considered significant. More than 9,000 cy of soil would be excavated, treated, and/or disposed of at landfills and more than 9,000 cy of clean fill would be imported to the site. Additionally, potentially more than 400,000 gallons of groundwater removed from excavation areas would be transported off-site for disposal. The greatest contribution to greenhouse gases would occur as a result of equipment operation during soil excavation, backfilling, and transportation activities, as well as LTTD treatment of an assumed 1,400 cy of excavated material.

Soil excavation and backfilling activities could be completed in approximately 14 months and monitoring would be conducted over an assumed 2-year period.

Long-Term Effectiveness and Permanence – Alternative 5

Under Alternative 5, soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs would be excavated and transported off-site for treatment and/or disposal. In support of the excavation activities, site groundwater containing

dissolved phase COCs would be removed from excavation areas and transported off-site for disposal. Based on the soil removal limits of Alternative 5, the potential for future long-term impacts from and exposures to MGP-related COCs in site media would be significantly reduced (if not eliminated) through the implementation of this alternative. Short-term groundwater monitoring would be conducted to confirm that groundwater standards and guidance values are achieved. Long-term groundwater monitoring, development of an SMP, establishment of institutional controls would not be required to reduce the potential for long-term exposures as a vast majority of site impacts would be removed from the site under this alternative.

Land Use – Alternative 5

The current zoning for the site is listed as commercial use and areas immediately surrounding the site are zoned for commercial and residential use. Drinking water is currently and will continue to be provided via a public supply. Alternative 5 would impact the current land use of the site as a NYSEG service center. Soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs (including MGP source material) would be removed from the site. Based on the removal limits of this alternative, the NYSEG service center building and utility infrastructure (i.e., gas regulators and distribution lines) would also be removed from the site. Although Alternative 5 would significantly impact current NYSEG site operations, there would be no limitations to the potential further use of the site. Dissolved phase concentrations of COCs in groundwater beyond excavation limits would be expected to naturally attenuate over a relatively short time period and the use of clean imported fill materials would allow for a variety of potential future uses.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 5

Alternative 5 would include the excavation of approximately 9,200 cy of material from to address soil containing COCs at concentrations greater than unrestricted use SCOs. An estimated 1,400 cy MGP source material (i.e., NAPL and impacted soil) would be permanently transported off-site for treatment and/or disposal via LTTD. The remaining 7,800 cy of soil that contains MGP-related COCs at concentrations greater than unrestricted use SCOs would be permanently transported off-site for disposal as a non-hazardous waste at a solid waste landfill. Additionally, more than an estimated 400,000 gallons of site groundwater containing MGP-related COCs would be permanently removed from the site and transported off-site for disposal.

Under this alternative, only isolated residual quantities of NAPL would remain within till (i.e., at soil boring SB08-30). As a vast majority of site soil (including MGP source material) would be permanently removed from the site, the volume of material that is serving as a source to dissolved phase groundwater impacts is significantly reduced. Dissolved phase concentrations of BTEX and PAHs in groundwater downgradient of the excavation areas would be expected to naturally attenuate. Alternative 3 includes short-term (e.g., up to two years) annual groundwater monitoring to document the extent and likely reduction (i.e., toxicity and volume) of dissolved phase groundwater impacts.

Implementability – Alternative 5

Alternative 5 would be both technically and administratively implementable. From a technical implementability aspect, remedial contractors capable of performing the excavation activities, as well as the short-term groundwater monitoring activities, are readily available. Although technically feasible, conducting excavation activities in an urban setting presents numerous logistical challenges. Limited space would be available at the site for material handling and staging and equipment operation. Transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 to 50 ton) may not be able to access the site and limited space is available on-site for vehicle staging. Additionally, soil removal activities would have to be conducted in a manner as to not jeopardize the health and safety of or cause a nuisance to the surrounding community. Soil loading conditions from nearby buildings/structures would be evaluated as part of the remedial design. A temporary excavation enclosure would likely be constructed over the excavation area to minimize potential exposures to the surrounding community. Based on conversations with the Village of Goshen, the discharge of groundwater generated during remedial construction activities to village sanitary sewers is prohibited. Therefore, potentially more than 400,000 gallons of groundwater removed from the excavation area would require management on-site and transportation for off-site disposal.

NYSEG service center operations (e.g., personnel and equipment) would likely be permanently relocated prior remedial construction activities. Based on excavation limits of this alternative, the service center building would be demolished (if demolition activities were approved by the Village of Goshen). Additionally, NYSEG would have to permanently relocate the gas distribution lines and regulators currently located at the service center. Although NYSEG service center operations could resume at the site following remedial construction, a new service center building and supporting gas infrastructure (e.g., distribution piping, gas regulators) would have to

constructed/installed. NYSEG may elect to permanently relocate all service center operations to an alternate location.

Administratively, Alternative 5 is implementable, but would require greater coordination with local (i.e., Village/Town of Goshen) and state agencies (i.e., NYSDEC and NYSDOH). Implementation of this remedial alternative would likely require extended discussions with the Village/Town to obtain Village/Town approval and demonstrate the benefits of the alternative given the current relatively low potential for exposure to the impacted material. As the site is located within the Village of Goshen Architectural Design District, this remedial alternative, including demolition of the service center building, would likely have to be approved by the Village of Goshen. No access agreements would be required, as excavation activities would be conducted within the limits of the NYSEG property. As indicated above, the Village of Goshen prohibits the discharge of groundwater to local sanitary sewers.

Compliance with SCGs – Alternative 5

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 soil cleanup objectives and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 5 would include the removal of a vast majority of soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

  Groundwater containing elevated concentrations of COCs would be removed during excavation area dewatering and transported off-site for disposal. Alternative 5 would likely achieve groundwater SCGs as a vast majority of soil containing MGP-related COCs would be removed from the site.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be

conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

Excavated soil and process residuals would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved RD/RA Work Plan and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated material from a former MGP site that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable NYS LDRs. If water generated during remedial construction activities were to be treated on-site and discharged to the Rio Grande Creek, the discharge would be conducted in accordance with a one-time construction SPDES permit.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting site activities. Additionally, remedial activities would be conducted in accordance with Village and Town of Goshen building/construction codes and ordinances. Discharge of water generated during remedial construction activities (i.e., in support of excavation area dewatering or as part of long-term groundwater treatment system) to the sanitary sewer is prohibited. Therefore, water generated during remedial construction activities (i.e., decontamination water, water removed from excavation areas) must be transported off-site for disposal. As indicated previously, the NYSEG property is located with the Village of Goshen Architectural Design District. Properties and buildings located within this district are subject to regulations/restrictions regarding historical areas. This remedial alternative, including demolition of the service center building, would likely have to be approved by the Village of Goshen.

Overall Protection of Public Health and the Environment – Alternative 5

Alternative 5 would eliminate the potential for long-term exposures to impacted subsurface soil and groundwater by excavating site soil that contains MGP-related

COCs at concentrations greater than unrestricted use SCOs. The potential for future construction workers to be exposed to MGP-related impacts while conducting subsurface work at the site would be eliminated through the removal of more than 9,000 cy of soil.

Alternative 5 would include excavation, excavation area dewatering, and off-site treatment and/or disposal activities to eliminate exposures (i.e., direct contact, ingestion, and inhalation) to MGP-related impacts in subsurface soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2). Only residual quantities of NAPL would remain within the till at the site (i.e., at depths greater than 30 feet below grade).

Alternative 5 would address a vast majority of MGP-related COCs and NAPL that could cause impacts to groundwater or surface water (soil RAO #3) through the removal of removal of soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs. Through the excavation of a majority of site soil, Alternative 5 would likely restore groundwater to pre-disposal/pre-release conditions (groundwater RAO #3) and nearly all sources of groundwater impacts would be addressed (groundwater RAO #4). Short-term periodic groundwater monitoring would be completed to document the likely reduction of residual dissolved phase groundwater impacts.

As indicated in Section 1, Rio Grande Creek surface water does not appear to be impacted by MGP-related COCs and implementation of this alternative would not promote discharge of NAPL or groundwater containing MGP-related impacts to the creek. Excavation of soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs would removal nearly all the material (including NAPL) that serves as a source to dissolved phase impacts that could potentially discharge to the creek. Therefore, Alternative 5 would mitigate the discharge of groundwater containing MGP-related COCs to surface water (groundwater RAO #5).

Cost Effectiveness – Alternative 5

The estimated costs associated with Alternative 5 are presented in Table 9. The total estimated 2-year present worth cost for this alternative is approximately $9,300,000. The estimated capital cost, primarily consisting of conducting soil removal activities, is approximately $9,200,000. The estimated 2-year present worth cost of O&M activities associated with this alternative, including conducting two years of annual groundwater monitoring, is approximately $100,000.

6. Comparative Analysis of Alternatives

This section presents a comparative analysis of the remedial alternatives using the evaluation criteria identified in Section 5.1. The comparative analysis identifies the advantages and disadvantages of each alternative relative to each other and with respect to the evaluation criteria.

The alternatives evaluated in Section 5 consist of the following:

- Alternative 1 – No Action
- Alternative 2 – NAPL Recovery, Groundwater Monitoring, and Institutional Controls
- Alternative 3 – MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls
- Alternative 4 – MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls
- Alternative 5 – Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring

The comparative analysis of these site-wide alternatives is presented below. A summary of the comparative analysis is presented in Table 10.

6.1 Short-Term Impacts and Effectiveness

The short-term effectiveness criterion consists of an evaluation of potential impacts and nuisances to the public and environment, and potential impacts to site workers during implementation of the alternative, the effectiveness of measures used to mitigate the short-term impacts, the sustainability of the remedy, and the relative time frame for implementation.

Alternative 1 would not include any active remediation and subsequently would not present potential short-term impacts to remedial workers, the public, or the environment. Alternatives 2, 3, and 4 would each include installation of NAPL collection points. As Alternative 2 does not include any additional intrusive activities, Alternative 2

would pose minimal potential short-term risks and potential disturbances to remedial workers and the surrounding community.

Alternatives 3, 4, and 5 each include intrusive activities to address soil and groundwater containing MGP-related impacts. Under Alternative 3, accessible MGP source material would be treated in-place via ISS. Alternative 4 would include the excavation of the same volume of accessible MGP source material (compared to Alternative 3) and Alternative 5 would include the excavation of soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs (and subsequently includes the demolition of the NYSEG service center building). Each of these alternatives would pose potential short-term risks to remedial workers and the public from potential exposure to impacted soil, groundwater, and NAPL during ISS treatment (Alternative 3 only), soil excavation, off-site transportation of excavated material and water, and backfilling. Additionally, the excavation activities conducted under these alternatives would pose short-term risks from the operation of construction equipment and generation of noise and dust.

As each of the remedial alternatives includes excavation (and backfilling) of a subsequently larger quantity of soil, each successive alternative would cause greater disruption to the surrounding community. Nuisances to the surrounding community would include noise from driving sheeting and operation construction equipment and an increase in local truck traffic from off-site transportation of excavated materials and the importation of fill materials. Estimated duration of remedial construction activities for each of the alternatives and number of truck trips required for each alternative are presented below.

- Alternative 1 – no time required and no truck trips
- Alternative 2 – 1 month and no truck trips
- Alternative 3 – 5 months and 130 truck trips
- Alternative 4 – 7 months and 290 truck trips
- Alternative 5 – 14 months and 920 truck trips

Potential exposures during implementation of these alternatives would be mitigated, to the extent practicable, by using appropriate PPE, air and work space monitoring, implementation of dust control and noise mitigation measures (as appropriate and if necessary based on monitoring results), proper planning and training of remedial workers, and use of temporary security fencing. Excavation enclosures would be utilized for Alternatives 4 and 5 to minimize the potential for exposures to the surrounding community during excavation and backfilling activities. Additional

mitigation measures for each alternative would be identified in the remedial design. As each successive alternative includes the excavation of a greater quantity of soil, the potential for short-term impacts to the public and remedial workers inherently increases. Although Alternatives 3 and 4 would address the same quantity of MGP source material, Alternative 3 would have less potential for exposures and disruption as soil would be stabilized in-place; smaller quantities of excavated soil would be transported off-site; and smaller quantities of clean fill materials would be imported to the site. The potential for short-term impacts during implementation of Alternatives 4 and 5 is greater than the other alternatives, as these alternatives include larger excavation areas and implementation would cause greater disruption relative to Alternatives 1 through 3.

Alternative 1 would have no carbon footprint and Alternative 2 would have a minimal carbon footprint. Alternatives 3 and 4 would reduce the need for imported fill material (relative to Alternative 5) as excavated soil that is suitable for reuse (i.e., free of visual impacts, odors, rubble, debris) would be utilized as subsurface backfill. Although Alternatives 3 and 4 would address the same quantity of MGP source material, Alternative 3 has a smaller carbon footprint compared to Alternative 4. Alternative 3 would stabilize material in-place, thereby significantly reducing the volume of soil that would require transportation for off-site treatment and/or disposal and a reduced volume soil would be imported to restore the site (relative to Alternative 4). Alternative 5 has the greatest carbon footprint compared to the other alternatives. The greatest contribution to greenhouse gases would occur as a result of equipment operation during excavation, backfilling, and transportation activities, as well as LTTD treatment of the greatest quantity to excavated material.

Compared to the other remedial alternatives, Alternative 5 would be the most disruptive to the NYSEG service center (through demolition of the service center building, if approved by the Village of Goshen) and the surrounding community, has the greatest potential for exposures to remedial workers and the public, would require the longest time to implement, and has the greatest carbon footprint. Therefore, Alternative 5 has the lowest level of short-term effectiveness (i.e., the greatest potential for exposure during implementation).

6.2 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence comparison includes an evaluation of the risks remaining at the site following implementation of the remedy, as well as the effectiveness of the controls implemented to manage the remaining risks (if any).

A majority of the surface cover at the site consists of asphalt pavement, vegetated soil and a building, which provide a physical barrier to subsurface impacts. MGP source material is encountered at depths greater than 12 feet below grade and groundwater is encountered at depths ranging from 3 to 10 feet below grade. Additionally, site groundwater is not used for potable (or any other) purposes and drinking water is provided via a municipal supply. Based on the current and foreseeable future use of the site as a NYSEG service center, site workers do not routinely conduct activities that would potentially result in exposure to site media containing MGP-related COCs. Alternative 1 would not include the implementation of any remedial activities and therefore, would not address potential long-term exposures to or impacts from site media that contain MGP-related impacts. Based on the limited potential for exposures to impacted site media, the periodic groundwater monitoring, institutional control, and SMP components of Alternative 2 could be considered an effective means to reduce the potential for future exposures. However, the long-term effectiveness of Alternative 2 would depend on the degree to which the institutional controls and the SMP were adhered to.

Alternatives 2, 3, and 4 would include NAPL recovery to reduce the volume of mobile NAPL present at the site and groundwater monitoring to evaluate and document the extent of dissolved phase impacts and potential trends in COC concentrations. As indicated in Section 5, passive NAPL collection and manual NAPL recovery is the preferred NAPL recovery method. Other potential NAPL collection/recovery methods (i.e., active NAPL recovery and low-flow groundwater pumping) would create a greater potential for exposures to MGP-related materials on a long-term basis when compared to passive NAPL collection with manual recovery. Active NAPL recovery and low-flow groundwater pumping would require construction of structures and systems to store recovered NAPL and/or treat groundwater. The presence of the water treatment and NAPL storage systems would increase the potential for long-term exposures to site workers and the surrounding community (i.e., during routine system operation or repair activities, system malfunctions, or vandalism of the structures and systems). Additionally, the discharge of water from an on-site treatment system to the village sanitary sewer is prohibited. In contrast, passive collection activities could be conducted during non-peak hours and NAPL collected during passive recovery activities would be immediately transported off-site for treatment/disposal, thereby significantly reducing the potential for long-term exposures to site workers and the surrounding public. Based on this rationale, both active NAPL removal and low-flow groundwater pumping would decrease the long-term effectiveness and permanence of any alternative.

Although the potential for exposures to soil and groundwater containing MGP-related impacts is limited based on the depth to impacts, the greatest potential for future exposures would occur during subsurface activities (e.g., installation of new utilities). Alternatives 3, 4, and 5 would each address the potential for exposure to impacted materials through invasive activities. Alternatives 3 and 4 would address potential exposures to accessible MGP source material through ISS treatment and excavation, respectively. Under Alternative 3, if future subsurface activities were conducted at the site, activities would likely be conducted in areas restored with reusable site soil and imported clean fill placed above stabilized MGP source material and not in areas containing remaining MGP source material (i.e., beneath the service center building). The potential for exposures to impacted site media would be significantly reduced under Alternative 3.

Alternative 4 would remove the same accessible MGP source material subject to ISS treatment under Alternative 3. Similar to Alternative 3, potential future subsurface activities that would be completed following the implementation of Alternative 4 would likely be conducted in areas restored with reusable site soil and imported clean fill, and not in areas containing remaining MGP source material. Under both Alternatives 3 and 4, future subsurface work activities (including handling potentially stabilized and/or impacted material, respectively) would be conducted in accordance with the procedures described in an SMP to minimize the potential for exposures to stabilized and/or impacted site media. Additionally, institutional controls would be established as part of each alternative to prohibit potable (and other) uses of site groundwater and would include requirements to assess the presence of inaccessible MGP source material beneath the service center building if the building were ever demolished. Annual verification of institutional controls would be completed to document that the controls are maintained and remain effective. Both alternatives would also include annual groundwater monitoring to document the extent of dissolved phase impacts and potential trends in COC concentrations (i.e., to document that COC concentrations are reducing, as would be expected following the stabilization or excavation of MGP source material).

Under Alternative 5, soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs would be removed from the site (including soil beneath the service center building). Based on the soil removal limits of Alternative 5, the potential for future long-term impacts from and exposures to MGP-related COCs in site media would be significantly reduced (if not eliminated) through the implementation of this alternative. Short-term groundwater monitoring would be conducted to confirm that groundwater standards and guidance values are achieved.

As indicated above, there is limited potential for exposure to soil and groundwater containing MGP-related impacts based on the depth to impacts. Alternatives 3 and 4 would address the material most-likely to be encountered during potential future subsurface activities. Both alternatives would include conducting passive NAPL recovery, development of an SMP, and establishment of institutional controls to further reduce the potential for future exposures. Therefore, Alternative 3 is considered equally effective on a long-term basis when compared to Alternative 4. Although Alternative 5 would have the highest degree of long-term effectiveness and permanence, Alternative 3 is considered equally effective as Alternative 5 based on the limited potential for exposures to soil and groundwater containing MGP-related impacts.

6.3 Land Use

This criterion evaluates the current and intended future land use of the site relative to the degree to which the remedial alternative addresses site impacts when unrestricted use cleanup levels would not be achieved.

As indicated in Section 5, the current zoning for the site is listed as commercial use and areas immediately surrounding the site are zoned for commercial and residential use. The site will continue to be used by NYSEG as a natural gas service center. The current and foreseeable future use of the area surrounding the site is a mixed commercial/residential setting. Based on the current and anticipated future land use of the site as a NYSEG service center, the potential for exposure to subsurface soil and groundwater containing MGP-related COCs is minimal. The majority of the site is covered with asphalt, concrete, a building, or vegetated soil, and there is little to no need to conduct subsurface activities at the site. Additionally, drinking water is currently and will continue to be provided via a public supply. Therefore, groundwater containing MGP-related COCs is not and will not be used for potable (or other) purposes.

Each of the alternatives would be consistent with current land use at the site. As part of Alternatives 2, 3, and 4, deed restrictions would be placed on the NYSEG property and groundwater monitoring and NAPL monitoring/recovery would be conducted for an assumed 30 years. If the NYSEG property were to be redeveloped and/or sold to another party, the SMP would be provided to potential future site owners and institutional controls would remain in place. Future site owners/operators would be required to conduct site activities in accordance with the SMP and the institutional controls established for the site based on the presence of remaining, solidified, or inaccessible (respectively) MGP source material and remaining or residual soil and groundwater containing COCs at concentrations greater than applicable standards.

Although solidified material would not be placed within 60 inches of the ground surface under Alternative 3, the presence of ISS treated material may limit the potential future redevelopment of the site. The solidified/stabilized material would provide a working platform that could support construction of a slab-on-grade structure. However, construction of a building with subgrade basement level and foundation would be more difficult based on the nature of the solidified material.

Based on the removal limits of Alternative 5, the NYSEG service center building and utility infrastructure (i.e., gas regulators and distribution lines) would also be removed from the site (pending Village of Goshen approval). However, there would be no limitations to the potential further use of the site. Dissolved phase concentrations of COCs in groundwater beyond excavation limits would be expected to naturally attenuate over a relatively short time period and the use of clean imported fill materials would allow for a variety of potential future uses.

6.4 Reduction of Toxicity, Mobility or Volume through Treatment

The comparative analysis for the reduction of toxicity, mobility, or volume consists of an evaluation of the ability of the remedial process to address the impacted material, the mass of material destroyed or treated, the irreversibility of the processes employed, and the nature of the residuals that would remain following implementation of the remedy.

Alternative 1 would not actively treat, remove, recycle, or destroy impacted site media and therefore, is considered the least effective for this criterion. Alternatives 2, 3, and 4 each include installing NAPL collection points, conducting periodic NAPL recovery to reduce the volume of mobile inaccessible (to excavation or ISS treatment) NAPL present within the subsurface, and periodic groundwater monitoring to document the extent of dissolved phase impacts and potential trends in dissolved phase COC concentrations.

Alternatives 3 and 4 both address accessible MGP source material. While Alternative 4 would remove the accessible MGP source material, Alternative 3 would stabilize the MGP source material in-place. The ISS treatment would effectively reduce the mobility and toxicity of subsurface soil, NAPL, and groundwater by stabilizing and encapsulating impacts in the solidified mass. Alternative 5 would address site soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs through excavation.

Alternatives 3 and 4 would address an equivalent volume of accessible MGP source material and total volume of site soil (i.e., 850 and 3,400 cy, respectively). Additionally, Alternatives 3 and 4 would address an equivalent volume of site groundwater containing dissolved phase MGP-related impacts (i.e., an estimated 170,000 gallons) through ISS or excavation area dewatering, respectively. Alternative 5 would address all MGP source material (with the exception of residual material that would remain in the till) and more than an estimated 400,000 gallons of site groundwater containing dissolved phase MGP-related impacts.

6.5 Implementability

The implementability comparison includes an evaluation of the technical and administrative feasibility of implementing the remedial alternative.

No remedial activities would be conducted as part of Alternative 1 and therefore, Alternative 1 is considered the most implementable. Alternatives 2, 3, and 4 would include installation of NAPL collection wells, groundwater monitoring, NAPL recovery, preparation of an SMP, and implementation of institutional controls. From a technical implementability standpoint, these activities do not require highly specialized equipment or personnel and could be easily implemented. Administratively, establishing institutional controls would require coordination with state agencies (i.e., NYSDEC and NYSDOH). The discharge of groundwater to local sanitary sewers is prohibited. Therefore, construction and O&M of NAPL/water storage structures and treatment systems is not a practicable or administratively feasible method for the collection and recovery of NAPL.

Alternatives 3, 4, and 5 each include the treatment or excavation of subsurface soil. ISS, excavation, and transportation for off-site disposal are technically feasible remedial construction activities, although conducting these activities in an urban setting presents numerous logistical challenges. There is limited available space at the site for material handling and staging and small construction equipment would be required to conduct the removal activities. As part of Alternatives 4 and 5, groundwater removed from excavation areas would have to stored on-site prior to transportation for off-site disposal. Alternative 5 poses much greater implementability challenges due to the extent of the proposed excavation, space limitations, and underground utilities and infrastructure. Managing more than 9,000 cy of excavated soil and more than an estimated 400,000 gallons of groundwater would be extremely challenging given the size of the site.

The extent and duration of the disruptions to the NYSEG service center and the surrounding community (through increased truck traffic) increases from Alternatives 3 through 5. Under these alternatives the NYSEG service center and the community would be disrupted by remedial activities for periods ranging from approximately 5 to 14 months. Alternatives 3 and 4 would require the temporary bypass or rerouting of portions of the gas distribution lines located with the treatment/excavation area. Alternative 5 would require the demolition of the service center building (pending Village of Goshen approval) and the permanent relocation of gas distribution lines and regulators. Based on the extent of soil treatment/excavation, NYSEG service center operations would have to be temporarily (Alternatives 3 and 4) or permanently (Alternative 5) relocated for the duration of remedial construction activities. Alternative 5 would have the potential for the most significant disruptions based on the duration and extent of the remedial construction activities.

Transportation planning would be conducted prior to the remedial activities. Full-size tractor trailers (i.e., 40 to 50 tons) may not be able to access the site and limited space is available on-site for vehicle staging. Additionally, soil removal activities would have to be conducted in a manner as to not jeopardize the health and safety of or cause a nuisance to the surrounding community. Soil loading conditions from nearby buildings/ structures would have to be evaluated as part of the remedial design. A temporary excavation enclosure would likely be constructed over the excavation areas for Alternatives 4 and 5 to minimize potential exposures to the surrounding community.

Administratively, the ISS and/or excavation components of Alternatives 3, 4, and 5 are implementable. However, greater coordination with local (i.e., Village/Town of Goshen) and state agencies (i.e., NYSDEC and NYSDOH) would be required to obtain Village/ Town approval and demonstrate the benefits of Alternative 5 given the current relatively low potential for exposures to impacted material. As the site is located within the Village of Goshen Architectural Design District, any remedial alternative that would include the demolition of the service center building would likely have to be approved by the Village of Goshen.

6.6 Compliance with SCGs

The compliance with SCGs comparison includes an evaluation of the alternative's ability to comply with applicable federal, state, and local criteria, advisories, and guidance.

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 soil cleanup objectives and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternatives 1 and 2 do not address subsurface soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 SCOs. Through treatment and/or removal of the most accessible, heavily impacted material, Alternatives 3 and 4 would address accessible MGP source material, as well as soil and groundwater that contain MGP-related COCs (during implementation of these alternatives to address MGP source material). Although some excavated material may be suitable for reuse as subsurface fill at the site, the top one foot of surface cover would meet the allowable constituent levels for imported fill or soil for commercial use (as presented in DER-10) or surface would be restored with gravel or asphalt pavement. Alternative 5 is the only alternative that would address (through excavation and off-site treatment and/or disposal) a vast majority of soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs (isolated residual material would remain within the till). Under each of the alternatives, excavated material and process residuals generated during implementation of the alternatives would be characterized in accordance with 40 CFR Part 261 and 6 NYCRR Part 371 to determine appropriate off-site treatment/disposal requirements.

  Alternative 2 does not include the removal of MGP source material and only addresses the source of dissolved phase groundwater impacts through the collection and recovery of mobile NAPL. Therefore, Alternative 2 is not expected to achieve groundwater SCGs. Although Alternatives 3 and 4 would address accessible MGP source material through stabilization or removal of subsurface soil and groundwater within treatment/excavation areas and recovery of inaccessible mobile NAPL, the residual MGP source material that would remain beneath the service center building could continue to serve as a source for dissolved phase groundwater impacts. While Alternatives 3 and 4 have the potential to achieve groundwater SCGs, a prolonged period of time would be required to achieve the SCGs due to the continued presence of inaccessible residual MGP source material. Alternative 5 would likely achieve groundwater SCGs as a vast majority of soil containing MGP-related COCs would be removed from the site (and impacted groundwater would be removed during excavation area dewatering activities).

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media.

  Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Under each of the alternatives, excavated soil and process residuals generated for each alternative would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved RD/RA Work Plan and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated material from a former MGP site that is characteristically hazardous for benzene only is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (i.e., LTTD). All excavated material and process residuals would be disposed of in accordance with applicable NYS LDRs. If water generated during remedial construction activities were to be treated on-site and discharged to the Rio Grande Creek, the discharge would be conducted in accordance with a one-time construction SPDES permit. Alternatives 2 through 5 would be equally effective at meeting the action-specific SCGs, assuming proper project planning and implementation of appropriate controls.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting excavation, backfilling, and construction activities on flood plains. Location-specific SCGs also include local requirements, such as local building permit conditions for permanent or semi-permanent facilities constructed during the remedial activities (if any).

  Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting site activities. Additionally, remedial activities would be conducted in accordance with Village and Town of Goshen building/ construction codes and ordinances. Discharge of water generated during remedial construction activities (i.e., in support of excavation area dewatering or as part of a long-term groundwater treatment system) to the sanitary sewer is prohibited. Therefore, water generated during remedial construction activities (i.e.,

decontamination water, water removed from excavation areas) must be transported off-site for disposal. The NYSEG property is located with the Village of Goshen Architectural Design District. Properties and buildings located within this district are subject to regulations/restrictions regarding historical areas. Any remedial alternative that would include the demolition of the service center building would likely have to be approved by the Village of Goshen. Alternatives 2 through 5 would be equally effective at meeting the location-specific SCGs, assuming proper project planning and implementation of appropriate controls.

6.7 Overall Protection of Public Health and the Environment

This criterion evaluates the ability of each alternative to protect public health and the environment, and the ability of each alternative to achieve the RAOs.

Alternative 1 does not include any active remedial measures or institutional controls and therefore, Alternative 1 is not considered protective of human health and the environment. Alternatives 2 through 5 would each prevent exposures (i.e., direct contact, ingestion, and inhalation) to MGP-related impacts in subsurface soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2). Alternative 2 would solely rely on the implementation of institutional controls and procedures set forth in an SMP, while Alternatives 3, 4, and 5 would utilize a combination of varying amounts of treatment and/or excavation, institutional controls, and an SMP to achieve these RAOs. Although each of these alternatives is considered protective of human health and the environment, Alternative 5 would solely rely on excavation to mitigate potential exposures to impacted media.

Alternatives 2, 3, and 4 would each work toward addressing MGP-related COCs and materials that could cause impacts to groundwater and surface water (soil RAO #3). Alternative 2 would solely rely on NAPL recovery. Alternatives 3 and 4 would utilize a combination of ISS treatment and/or excavation to address accessible MGP source material and NAPL recovery to remove inaccessible mobile NAPL. Alternatives 2, 3, and 4 would include periodic groundwater monitoring to document the extent of dissolved phase impacts and potential trends in COC concentrations. Alternative 5 would address a vast majority of MGP-related COCs and NAPL that could cause impacts to groundwater and surface water through the removal of soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs.

Alternatives 2, 3, and 4 would work toward restoring groundwater to pre-disposal/pre-release conditions (groundwater RAO #3) and addressing sources of groundwater

impacts (groundwater RAO #4). Although varying amounts of MGP source material would be addressed through ISS treatment or excavation (Alternatives 3 and 4) and NAPL recovery (Alternatives 2 through 5), inaccessible MGP source material (i.e., a source to dissolved phase impacts) would remain beneath the service center building under Alternatives 2, 3, and 4. Through the removal of a vast majority of site soil, Alternative 5 is the only alternative that would be expected to restore groundwater to pre-disposal/pre-release conditions and address all sources of groundwater impacts within a reasonable/predicable time frame.

As indicated in Section 1, Rio Grande Creek surface water does not appear to be impacted by MGP-related COCs. Implementation of any of the alternatives is not anticipated to promote discharge of NAPL or groundwater containing MGP-related impacts to the creek. ISS treatment or excavation of accessible MGP source material (Alternatives 3 and 4) and removal of inaccessible mobile NAPL (Alternatives 2, 3, and 4) or the excavation of a vast majority of site soil (Alternative 5) would reduce the volume of material that serves as a source to dissolved phase impacts and that could potentially discharge to the creek. Additionally, the ISS treatment that would be conducted under Alternative 3 is not anticipated to significantly alter existing groundwater flow patterns at the site. Alternatives 2, 3, and 4 would include groundwater monitoring to document dissolved phase COC concentrations and groundwater flow direction. Therefore, Alternatives 2 though 5 would mitigate the discharge of groundwater containing MGP-related COCs to surface water (groundwater RAO #5).

Although Alternative 5 would remove the greatest amount of media containing MGP-related COCs, Alternatives 3 and 4 are equally effective as Alternative 5 at achieving the soil and groundwater RAOs related to preventing exposures to impacted soil and groundwater. Additionally, Alternatives 3 and 4 would be significantly less disruptive to the surrounding community compared to Alternative 5. Alternatives 3 and 4 would address the material most-likely to be encountered during potential future subsurface activities. Both alternatives would include conducting passive NAPL recovery, development of an SMP, and establishment of institutional controls to further reduce the potential for future exposures. As Alternative 3 achieves the same site-specific RAOs as compared to Alternative 4, the minimal added benefit to long-term effectiveness and the reduction of toxicity, mobility, and volume from implementing Alternatives 4 and 5 do not outweigh the significantly greater short-term impacts and implementability concerns associated with these alternatives when compared to Alternative 3.

6.8 Cost Effectiveness

The following table summarizes the estimated costs associated with implementing each of the remedial alternatives.

Table 6.1 Estimated Costs

Alternative	Estimated Capital Cost	Estimated Present Worth Cost of O&M	Total Estimated Cost
Alternative 1 – No Action	$0	$0[1]	$0
Alternative 2 – NAPL Recovery	$200,000	$1,000,000[1]	$1,200,000
Alternative 3 – Source Material ISS	$2,400,000	$1,000,000[1]	$3,400,000
Alternative 4 – Source Material Removal	$4,000,000	$1,000,000[1]	$5,000,000
Alternative 5 – Removal to Unrestricted Use SCOs	$9,200,000	$100,000[2]	$9,300,000

Notes:
1. Estimated present worth of O&M cost is over an assumed 30-year period.
2. Estimated present worth of O&M cost is over an assumed 2-year period.

The capital cost to implement Alternative 5 is significantly greater relative to the other alternatives. Alternative 5 includes the removal of nearly three times the volume (9,200 cy) of soil treated and/or removed under Alternatives 3 and 4 (3,400 cy), respectively. Although the high cost for Alternative 5 corresponds to the greatest removal volume, approximately 85% of the soil removed under Alternative 5 does not contain MGP source material. Additionally, Alternative 5 corresponds to the greatest disruption to the surrounding community and has greatest potential for exposures during implementation of the alternative. Therefore, Alternative 5 is considered the least cost effective compared to the short-term effectiveness; reduction of toxicity, mobility, and volume; and long-term effectiveness.

Although Alternatives 3 and 4 would address the same volume of site impacts, the capital cost to implement Alternative 3 is approximately $1,600,000 less than Alternative 4. Alternative 3 would stabilize material in-place and Alternative 4 would include the excavation and off-site treatment and/or disposal of accessible MGP source material. Compared to Alternative 4, Alternative 3 significantly reduces the volume of soil that would require transportation for off-site treatment and/or disposal and the volume soil that would be imported to restore the site, thereby addressing the same quantity of impacted site media at a lower cost.

As indicated previously, MGP source material is encountered at depths greater than 12 feet below grade and groundwater is encountered at depths ranging from 3 to 10 feet below grade. Based on the current and foreseeable future use of the site as a NYSEG service center, site workers do not routinely conduct activities that would potentially result in exposure to site media containing MGP-related COCs. Compared to Alternatives 4 and 5, Alternative 3 is the most cost effective alternative due to a higher short-term effectiveness and the fact that, although the potential for future exposure to soil and groundwater containing MGP-related impacts is limited, Alternative 3 would effectively address accessible MGP source material. Alternatives 4 and 5 would provide minimal additional benefits related to long-term effectiveness and reduction of toxicity, mobility, and volume relative to Alternative 3.

7. Preferred Remedial Alternative

The results of the comparative analysis were used as a basis for recommending a remedial alternative for the site. The components of the preferred remedial alternative for the site are presented below.

7.1 Summary of Preferred Remedial Alternative

Based on the comparative analysis of the remedial alternatives presented in Section 6, Alternative 3 is the preferred remedial alternative for the site. This alternative would cost-effectively achieve the best balance of the NYSDEC evaluation criteria. The preferred remedial alternative reduces the potential for future exposure to subsurface soil and groundwater containing MGP-related impacts.

As described in Section 5 and Table 7, the primary components of the preferred remedial alternative consist of the following:

- Pre-ISS excavation of approximately 760 cy of soil to account for material building during ISS treatment; verify the location of and remove subsurface obstructions (i.e., former MGP foundations and structures) that would prohibit ISS treatment to the target depths; and locate, protect, and facilitate relocation of subsurface utilities, as appropriate.

- Removal of the UST located south of former Gas Holder #2.

- ISS treatment of approximately 2,600 cy of subsurface soil (including an estimated 850 cy of MGP source material) to depths ranging from 12 feet to the top of the till unit (i.e., 26 to 28 feet below grade).

- Transportation and off-site disposal of approximately 2,900 tons of surface material and ISS spoils as C&D debris and 330 tons of site soil as a non-hazardous solid waste.

- Reuse of an assumed 380 cy of site soil that is suitable for subsurface backfill (i.e., free of visual impacts, odors, rubble, and debris).

- Importation of approximately 300 cy of clean fill material and the restoration of site surfaces.

- Installation of five NAPL collection wells to facilitate passive NAPL recovery.

- Establishing institutional controls on the NYSEG property in the form of deed restrictions and environmental easements to control intrusive (i.e., subsurface) activities that could result in potential damage to solidified soil and exposure to residual groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of non-treated groundwater on the NYSEG property.

- Preparation of an SMP to document the following:

    - The institutional controls that have been established and will be maintained for the site

    - Extent of solidified soil

    - Known locations of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 commercial use SCOs

    - Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially stabilized material encountered during these activities

    - Protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring

    - Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities

- Conducting semi-annual NAPL monitoring/passive NAPL recovery (i.e., manual bailing or pumping).

- Conducting annual groundwater monitoring to confirm groundwater flow direction and verify the extent and concentrations of dissolved phase COCs.

- Preparing an annual report to summarize semi-annual NAPL and annual groundwater monitoring activities and results.

ISS is the primary component of the preferred alternative. ISS is a proven technology for addressing soil that contains MGP-related impacts. The preferred alternative also includes NAPL recovery and groundwater monitoring. Each of these technologies and processes has been successfully implemented at other MGP sites and are considered technically and administratively implementable. Implementation challenges associated with preferred remedial alternative are primarily related to conducting ISS treatment activities in at a small site in an urban setting. Limited space would be available for material handling/staging and the setup and operation of the ISS mix plant. Pre-ISS excavation would be conducted to identify obstructions and clear the top four to five feet of fill material. Jet grouting methods would be used to solidify material near/beneath obstructions and utilities that could not be removed or relocated.

Potential short-term impacts to the surrounding community and site workers would include potential exposures to soil and groundwater containing MGP-related COCs during excavation, soil mixing, and off-site transportation activities. The potential for exposures would be minimized through the use of appropriate field personnel, PPE, and by conducting work activities and air monitoring in accordance with a site-specific HASP and CAMP that would be prepared as part of the remedial design. NYSEG service center operations would have to be temporarily relocated for approximately 5 months and gas distribution piping would have to be temporarily deactivated, bypassed, or relocated during remedial construction activities.

Alternative 3 would be protective of human health and the environment and effective over the long-term. Alternative 3 would prevent exposures (i.e., direct contact, ingestion, and inhalation) to MGP-related impacts in subsurface soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) through the ISS treatment of MGP source material, recovery of inaccessible mobile NAPL, and implementation of institutional controls. Alternative 3 would partially address MGP-related COCs and materials that could cause impacts to groundwater and surface water (soil RAO #3) through ISS treatment and recovery of mobile NAPL. Based on the results of predictive simulations, implementation of this alternative is not anticipated to significantly alter hydrogeologic site conditions and stabilization of accessible MGP source material and removal of inaccessible mobile NAPL would reduce the volume of material that serves as a source to dissolved phase impacts and that could potentially discharge to the creek. Therefore, Alternative 3 would mitigate the discharge of groundwater containing MGP-related COCs to surface water (groundwater RAO #5).

Alternative 3 is preferred over the other remedial alternatives. As indicated previously, MGP source material is encountered at depths greater than 12 feet below grade and

groundwater is encountered at depths ranging from 3 to 10 feet below grade. Based on the current and foreseeable future use of the site as a NYSEG service center, site workers do not routinely conduct activities that would potentially result in exposure to site media containing MGP-related COCs. Compared to Alternatives 4 and 5, Alternative 3 is the most cost effective alternative due to a higher short-term effectiveness and the fact that, although the potential for future exposure to soil and groundwater containing MGP-related impacts is limited, Alternative 3 would effectively address accessible MGP source material. Alternatives 4 and 5 would provide minimal additional benefits related to long-term effectiveness and reduction of toxicity, mobility, and volume relative to Alternative 3.

7.2 Estimated Cost for Preferred Remedial Alternative

The total estimated cost associated with implementation of the preferred remedial alternative is summarized in the following table.

Table 7.1 Cost Estimate for Alternative 3

Alternative	Estimated Capital Cost	Estimated Present Worth of O&M Cost[1]	Total Estimated Cost
Alternative 3 – Source Material ISS	$2,400,000	$1,000,000	$3,400,000

Note:
1. Estimated present worth of O&M cost is over an assumed 30-year period.

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Tables

Table 1. Summary of Chemical-Specific SCGs, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
National Primary Drinking Water Standards	40 CFR Part 141	S	Establishes maximum contaminant levels (MCLs) which are health-based standards for public water supply systems.	These standards are potentially applicable if an action involves future use of ground water as a public supply source.
RCRA-Regulated Levels for Toxic Characteristics Leaching Procedure (TCLP) Constituents	40 CFR Part 261	S	These regulations specify the TCLP constituent levels for identification of hazardous wastes that exhibit the characteristic of toxicity.	Excavated materials may be sampled and analyzed for TCLP constituents prior to disposal to determine if the materials are hazardous based on the characteristic of toxicity.
Universal Treatment Standards/Land Disposal Restrictions (UTS/LDRs)	40 CFR Part 268	S	Identifies hazardous wastes for which land disposal is restricted and provides a set of numerical constituent concentration criteria at which hazardous waste is restricted from land disposal (without treatment).	Applicable if waste is determined to be hazardous and for remedial alternatives involving off-site land disposal.
New York State				
NYSDEC Guidance on Remedial Program Soil Cleanup Objectives	6 NYCRR Part 375	G	Provides an outline for the development and execution of the soil remedial programs. Includes soil cleanup objective tables.	These guidance values are to be considered, as appropriate, in evaluating soil quality.
NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 (6/98)	G	Provides a compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in the NYSDEC programs.	These standards are to be considered in evaluating groundwater and surface water quality.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 371-376.	Applicable for determining if materials generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
New York State Surface Water and Groundwater Quality Standards	6 NYCRR Part 703	S	Establishes quality standards for surface water and groundwater.	Potentially applicable for assessing water quality at the site during remedial activities.

Table 2. Summary of Action-Specific SCGs, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
Occupational Safety and Health Act (OSHA) - General Industry Standards	29 CFR Part 1910	S	These regulations specify the 8-hour time-weighted average concentration for worker exposure to various compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below required concentrations. Appropriate training requirements will be met for remedial workers.
OSHA - Safety and Health Standards	29 CFR Part 1926	S	These regulations specify the type of safety equipment and procedures to be followed during site remediation.	Appropriate safety equipment will be on-site and appropriate procedures will be followed during remedial activities.
OSHA - Record-keeping, Reporting and Related Regulations	29 CFR Part 1904	S	These regulations outline record-keeping and reporting requirements for an employer under OSHA.	These regulations apply to the company(s) contracted to install, operate and maintain remedial actions at hazardous waste sites.
RCRA - Preparedness and Prevention	40 CFR Part 264.30 - 264.31	S	These regulations outline requirements for safety equipment and spill control when treating, handling and/or storing hazardous wastes.	Safety and communication equipment will be installed at the site as necessary. Local authorities will be familiarized with the site.
RCRA - Contingency Plan and Emergency Procedures	40 CFR Part 264.50 - 264.56	S	Provides requirements for outlining emergency procedures to be used following explosions, fires, etc. when storing hazardous wastes.	Emergency and contingency plans will be developed and implemented during remedial design. Copies of the plan will be kept on-site.
90 Day Accumulation Rule for Hazardous Waste	40 CFR Part 262.34	S	Allows generators of hazardous waste to store and treat hazardous waste at the generation site for up to 90 days in tanks, containers and containment buildings without having to obtain a RCRA hazardous waste permit.	Potentially applicable to remedial alternatives that involve the storing or treating of hazardous materials on-site.
Land Disposal Facility Notice in Deed	40 CFR Parts 264 and 265 Sections 116-119(b)(1)	S	Establishes provisions for a deed notation for closed hazardous waste disposal units, to prevent land disturbance by future owners.	The regulations are potentially applicable because closed areas may be similar to closed RCRA units.
Federal Power Act of 1920	16 USC 79la et.seq. 18 CFR 1-149	S	Authorizes the Federal Energy Regulatory Agency (FERC) to issue licenses for hydropower dams.	Remedial alternatives involving alteration of dam operations would require consideration of existing permits.
RCRA - General Standards	40 CFR Part 264.111	S	General performance standards requiring minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products. Also requires decontamination or disposal of contaminated equipment, structures and soils.	Decontamination actions and facilities will be constructed for remedial activities and disassembled after completion.
Standards Applicable to Transporters of Applicable Hazardous Waste - RCRA Section 3003	40 CFR Parts 170-179, 262, and 263	S	Establishes the responsibility of off-site transporters of hazardous waste in the handling, transportation and management of the waste. Requires manifesting, recordkeeping and immediate action in the event of a discharge.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
United States Department of Transportation (USDOT) Rules for Transportation of Hazardous Materials	49 CFR Parts 107 and 171.1 - 172.558	S	Outlines procedures for the packaging, labeling, manifesting and transporting of hazardous materials.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
Clean Air Act-National Ambient Air Quality Standards	40 CFR Part 60	S	Establishes ambient air quality standards for protection of public health.	Remedial operations will be performed in a manner that minimizes the production of benzene and particulate matter.
USEPA-Administered Permit Program: The Hazardous Waste Permit Program	RCRA Section 3005; 40 CFR Part 270.124	S	Covers the basic permitting, application, monitoring and reporting requirements for off-site hazardous waste management facilities.	Any off-site facility accepting hazardous waste from the site must be properly permitted. Implementation of the site remedy will include consideration of these requirements.

Table 2. Summary of Action-Specific SCGs, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal (Cont.)				
Land Disposal Restrictions	40 CFR Part 368	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes Universal Treatment Standards (UTSs) to which hazardous waste must be treated prior to land disposal.	Excavated materials that display the characteristic of hazardous waste or that are decharacterized after generation must be treated to 90% constituent concentration reduction capped at 10 times the UTS.
RCRA Subtitle C	40 U.S.C. Section 6901 et seq.; 40 CFR Part 268	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes UTSs to which hazardous wastes must be treated prior to land disposal.	Potentially applicable to remedial activities that include the dredging and disposal waste material from the site.
New York State				
NYSDEC's Monitoring Well Decommissioning Guidelines	NPL Site Monitoring Well Decommissioning dated May 1995	G	This guidance presents procedure for abandonment of monitoring wells at remediation sites.	This guidance is applicable for soil or groundwater alternatives that require the decommissioning of monitoring wells onsite.
Guidelines for the Control of Toxic Ambient Air Contaminants	DAR-1 (Air Guide 1)	G	Provides guidance for the control of toxic ambient air contaminants in New York State and outlines the procedures for evaluating sources of air pollution.	This guidance may be applicable for soil or groundwater alternatives that results in certain air emissions.
New York State Air Quality Classification System	6 NYCRR Part 256	G	Outlines the air quality classifications for different land uses and population densities.	Air quality classification system will be referenced during the treatment process design.
New York Air Quality Standards	6 NYCRR Part 257	G	Provides air quality standards for different chemicals (including those found at the site), particles, and processes.	Emissions from the treatment process will meet the air quality standards.
Discharges to Public Waters	New York State Environmental Conservation Law, Section 71-3503	S	Provides that a person who deposits gas tar, or the refuse of a gas house or gas factory, or offal, refuse, or any other noxious, offensive, or poisonous substances into any public waters, or into any sewer or stream running or entering into such public waters, is guilty of a misdemeanor.	During the remedial activities, MGP-impacted materials will not be deposited into public waters or sewers.
New York Hazardous Waste Management System - General	6 NYCRR Part 370	S	Provides definitions of terms and general instructions for the Part 370 series of hazardous waste management.	Hazardous waste is to be managed according to this regulation.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 371-376.	Applicable for determining if solid waste generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	6 NYCRR Part 372	S	Provides guidelines relating to the use of the manifest system and its recordkeeping requirements. It applies to generators, transporters and facilities in New York State.	This regulation will be applicable to any company(s) contracted to do treatment work at the site or to transport or manage hazardous material generated at the site.
New York Regulations for Transportation of Hazardous Waste	6 NYCRR Part 372.3 a-d	S	Outlines procedures for the packaging, labeling, manifesting and transporting of hazardous waste.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
Waste Transporter Permits	6 NYCRR Part 364	S	Governs the collection, transport and delivery of regulated waste within New York State.	Properly permitted haulers will be used if any waste materials are transported off-site.
NYSDEC Technical and Administrative Guidance Memorandums (TAGMs)	NYSDEC TAGMs	G	TAGMs are NYSDEC guidance that are to be considered during the remedial process.	Appropriate TAGMs will be considered during the remedial process.
NYSDEC Technical Guidance for Site Investigation and Remediation	DER-10 (2009)	G	Outlines the minimum technical activities DEC accepts for remedial projects administered under DER.	This guidance is applicable for the remedy selection process and remedial design process.
New York Regulations for Hazardous Waste Management Facilities	6 NYCRR Part 373.1.1 - 373.1.8	S	Provides requirements and procedures for obtaining a permit to operate a hazardous waste treatment, storage and disposal facility. Also lists contents and conditions of permits.	Any off-site facility accepting waste from the site must be properly permitted.

Table 2. Summary of Action-Specific SCGs, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
New York State (Cont.)				
Management of Soil and Sediment Contaminated With Coal Tar From Former Manufactured Gas Plants	NYSDEC Program Policy	G	Purpose of the guidance is to facilitate the permanent treatment of soil contaminated with coal tar from the sites of former MGPs.	Policy will be considered for D018 hazardous and non-hazardous material removed during removal activities.
Land Disposal of a Hazardous Waste	6 NYCRR Part 376	S	Restricts land disposal of hazardous wastes that exceed specific criteria.	New York defers to USEPA for UTS/LDR regulations.
NYSDEC Guidance on the Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants	TAGM 4061(2002) (DER-4)	G	Outlines the criteria for conditionally excluding coal tar waste and impacted soils from former MGPs which exhibit the hazardous characteristic of toxicity for benzene (D018) from the hazardous waste requirements of 6 NYCRR Parts 370 - 374 and 376 when destined for thermal treatment.	This guidance will be used as appropriate in the management of MGP-impacted soil and coal tar waste generated during the remedial activities.
National Pollutant Discharge Elimination System (NPDES) Program Requirements, Administered Under New York State Pollution Discharge Elimination System (SPDES)	40 CFR Parts 122 Subpart B, 125, 301, 303, and 307 (Administered under 6 NYCRR 750-758)	S	Establishes permitting requirements for point source discharges; regulates discharge of water into navigable waters including the quantity and quality of discharge.	Removal activities may involve treatment/disposal of water. If so, water generated at the site will be managed in accordance with NYSDEC SPDES permit requirements.

Table 3. Summary of Location-Specific SCGs, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
National Environmental Policy Act Executive Orders 11988 and 11990	40 CFR 6.302; 40 CFR Part 6, Appendix A	S	Requires federal agencies, where possible, to avoid or minimize adverse impact of federal actions upon wetlands/floodplains and enhance natural values of such. Establishes the “no-net-loss” of waters/wetland area and/or function policy.	To be considered if remedial activities are conducted within the floodplain or wetlands.
Fish and Wildlife Coordination Act	16 USC 661; 40 CFR 6.302	S	Actions must be taken to protect fish or wildlife when diverting, channeling or otherwise modifying a stream or river.	Potentially applicable to remedial activities within and/or adjacent to the Hudson River.
Historical and Archaeological Data Preservation Act	16 USC 469a-1	S	Provides for the preservation of historical and archaeological data that might otherwise be lost as the result of alteration of the terrain.	The National Register of Historic Places website indicated no records present for historical sites in the immediate vicinity of the MGP site.
National Historic and Historical Preservation Act	16 USC 470; 36 CFR Part 65; 36 CFR Part 800	S	Requirements for the preservation of historic properties.	The National Register of Historic Places website indicated several historic sites are present within 0.4 miles of the MGP site.
Hazardous Waste Facility Located on a Floodplain	40 CFR Part 264.18(b)	S	Requirements for a treatment, storage and disposal (TSD) facility built within a 100-year floodplain.	Hazardous waste TSD activities (if any) will be designed to comply with applicable requirements cited in this regulation.
Endangered Species Act	16 USC 1531 et seq.; 50 CFR Part 200; 50 CFR Part 402	S	Requires federal agencies to confirm that the continued existence of any endangered or threatened species and their habitat will not be jeopardized by a site action.	During the Fish and Wildlife evaluation, one candidate (Atlantic sturgeon) and one endangered species (short-nose sturgeon) were identified on the USFWS list of Threatened, Endangered, Sensitive Species for Rockland County.
Floodplains Management and Wetlands Protection	40 CFR 6 Appendix A	S	Activities taking place within floodplains and/or wetlands must be conducted to avoid adverse impacts and preserve beneficial value. Procedures for floodplain management and wetlands protection provided.	To be considered if remedial activities are conducted within the floodplain or wetlands.
New York State				
New York State Floodplain Management Development Permits	6 NYCRR Part 500	S	Provides conditions necessitating NYSDEC permits and provides definitions and procedures for activities conducted within floodplains.	Potentially applicable to remedial activities within and/or adjacent to the Monhagen Brook 100-year flood plain.
New York State Freshwater Wetlands Act	ECL Article 24 and 71; 6 NYCRR Parts 662-665	S	Activities in wetlands areas must be conducted to preserve and protect wetlands.	Does not appear to be applicable as the site is not located in a wetlands area.
New York State Parks, Recreation, and Historic Preservation Law	New York Executive Law Article 14	S	Requirements for the preservation of historic properties.	The National Register of Historic Places website indicated no records present for historical sites in the immediate vicinity of the MGP site.
Endangered & Threatened Species of Fish and Wildlife	6 NYCRR Part 182	S	Identifies endangered and threatened species of fish and wildlife in New York.	The shortnosed sturgeon is a candidate on the List of Endangered, Threatened and Special Concern Fish & Wildlife Species of New York State.
Floodplain Management Criteria for State Projects	6 NYCRR Part 502	S	Establishes floodplain management practices for projects involving state-owned and state-financed facilities.	Portions of the area to be remediated are located within the floodplain. Activities located in these areas would be performed in accordance with this regulation.

Table 3. Summary of Location-Specific SCGs, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Local				
Local Building Permits	N/A	S	Local authorities may require a building permit for any permanent or semi-permanent structure, such as an on-site water treatment system building or a retaining wall.	Substantive provisions are potentially applicable to remedial activities that require construction of permanent or semi-permanent structures.
Local Street Work Permits	N/A	S	Local authorities will require a permits for conducting work within and closing local roadways.	Street work permits will be required to conduct remedial activities within public roadways.
Discharge of Water to Local Sewers	N/A	S	Village of Goshen has indicated that discharge of treated or untreated water from the site to local sanitary sewers would not be permitted.	Water generated remedial construction activities would have to stored (and potentially treated) on-site and transported off-site for final treatment/disposal.
Architectural Design District Zoning	N/A	G	The site is located with the Village of Goshen Architectural Design District. Properties and buildings located within this area are subject to regulations/restrictions regarding historical areas.	The Village of Goshen may not permit the demolition and removal of the service center building as part of site remedy.

Table 4. Remedial Technology Screening Evaluation for Subsurface Soil, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
No Action	No Action	No Action	Alternative would not include any remedial action. A No Action alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a No Action alternative is required by the NYSDEC DER-10.	Implementable.	Would not achieve RAOs for soil.	Low.	Yes
Institutional Controls	Institutional Controls	Governmental Controls, Proprietary Controls, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted soil and/or the potential to jeopardize the integrity of a remedy. Examples of potential institutional controls include establishing land use restrictions and health and safety requirements for subsurface activities.	Implementable.	Institutional controls may be effective to limit and control contact with impacted soils. Can be effective when implemented in combination with other technologies. However, this technology alone would not address the source of MGP-related impacts to soil.	Low.	Yes
In-Situ Containment/ Controls	Capping	Soil Cap	Placing and compacting soil/gravel material over impacted soil to provide a physical barrier to human and biota exposure to impacted soil at the site.	Implementable. Equipment and materials necessary to construct the cap are readily available. Clay/soil cap is not consistent with current and future uses of the site as an active service center.	Long-term effectiveness requires ongoing maintenance. Surface soils are not impacted with MGP-related residuals and therefore, capping does not reduce the potential for exposure to MPG-related impacts relative to current site conditions.	Moderate capital and O&M costs.	No
		Asphalt/Concrete Cap	Application of a layer of asphalt or concrete over impacted soils.	Implementable. Equipment and materials necessary to construct the cap are readily available. Asphalt cap is consistent with current and future uses of the site as an active service center.		Moderate capital and O&M costs.	No
		Multi-Media Cap	Application of a combination of clay/soils and synthetic membrane(s) over impacted soil.	Implementable. Equipment and materials necessary to construct the cap are readily available. Membrane layer would prohibit vegetation of trees, shrubs, etc.		Moderate capital and O&M costs.	No
In-Situ Treatment	Immobilization	Solidification/ Stabilization	Addition of material to the impacted soil that limits the solubility and mobility of the NAPL and COCs in soil and groundwater. Involves treating soil to produce a stable material with low leachability of NAPL and associated COCs.	Potentially implementable. The presence of subsurface obstructions (i.e., former MGP structures and utilities) could hinder the ability for implementation of this technology process. NAPL-impacted soil immediately on top of (i.e., within 5 feet) and within the till may not be addressed due to the uneven till surface, density of the till, and density of material immediately above the till (SPT blow counts > 50). Localized changes in hydrogeology could cause changes in groundwater flow paths and water table elevations.	Overall effectiveness of this process would need to be evaluated during a bench-scale treatability study. Additionally, unknown changes in the hydrogeology within this area of untreated soil could result in uncontrolled migration of NAPL from beneath the service center building.	High capital and O&M costs.	Yes

See Note on Page 5.

Table 4. Remedial Technology Screening Evaluation for Subsurface Soil, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
In-Situ Treatment (Cont'd)	Extraction	Dynamic Underground Stripping and Hydrous Pyrolysis/Oxidation (DUS/HPO)	Steam is injected into the subsurface to mobilize contaminants. The mobilized contaminants are captured and constituents are recondensed, collected, and treated. In addition, HPO can degrade contaminants in subsurface heated zones. In most cases, this technology requires long-term operation and maintenance of onsite injection, collection and/or treatment systems.	Technically implementable. This option would require a pilot scale study to determine effectiveness. Underground structures and obstructions would need to be removed prior to implementation. Process may result in uncontrolled NAPL migration. Not a preferred technology process due to risk of mobilizing NAPL further downgradient and/or further into the till and potential technical implementability issues.	Alone, this technology would not effectively address soil RAOs.	High capital and O&M costs.	No
	Chemical Treatment	Chemical Oxidation	Oxidizing agents are added to oxidize and reduce the mass of organic constituents. In-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate or potassium permanganate.	Technically Implementable. Limited space is available for large quantities of oxidizing agents and equipment at the site. Generation of soil vapors during treatment is a concern given the proximity to commercial and residential buildings.	Would require multiple treatments of chemicals to reduce COCs. Based on results of pilot testing conducted at other sites, would not be effective at treating impacted soil.	High capital and O&M costs.	No
		Surfactant Enhanced Chemical Oxidation	Similar to chemical oxidation, oxidizing agents are added to the subsurface to oxidize and reduce the mass of organic constituents. Unlike chemical oxidation, surfactants are also added to the subsurface to desorb organic constituents from the soil to allow for chemical oxidation in the aqueous phase.	Potentially implementable. The technology is considered innovative and has not been widely used to date. Would require areas to store surfactant and oxidizing chemicals.	Can facilitate uncontrolled migration of NAPL in heterogenous materials (i.e., fill). May not be effective at treating heavy impacted soil and NAPL.	High capital and O&M costs.	No
	Biological Treatment	Biodegradation	Natural biological and physical processes that, under favorable conditions, act without human intervention to reduce the mass, volume, concentration, toxicity, and/or mobility of COCs. This process relies on long-term monitoring to demonstrate the reduction of impacts.	Implementable.	Less effective for PAHs; not effective for soil; would not achieve RAOs in an acceptable time frame.	Low Capital and O&M costs.	No
		Soil Vapor Extraction / Soil Venting	Air/oxygen injection wells are installed within the impacted regions to enhance biodegradation of constituents by increasing oxygen availability. Low-flow injection technology may be incorporated. This technology requires long-term monitoring.	Implementable.	Not effective for heavier hydrocarbons and PAHs associated with MGP-related impacts.	Low Capital and Moderate O&M costs.	No

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Table 4. Remedial Technology Screening Evaluation for Subsurface Soil, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
Removal	Excavation	Excavation	Physical removal of impacted soil. Typical excavation equipment would include excavators, backhoes, loaders, and/or dozers. Extraction wells/sumps and pumps or other methods may be used to obtain hydraulic control (i.e., dewater) to facilitate use of typical excavation equipment to physically remove soil.	Implementable. Equipment capable of excavating the soil is readily available. Potential concerns associated with excavating near subsurface utilities, former MGP structures, and the Rio Grande Creek.	Would achieve RAOs. Proven process for effectively removing impacted soil.	High capital cost and low O&M costs.	Yes
Ex-Situ Onsite Treatment and/or Disposal	Immobilization	Solidification/ Stabilization	Addition of material to excavated soil that limits the solubility or mobility of the constituents present. Involves treating soil to produce a stable material with low leachability, that encapsulates the constituents within the solidified matrix.	Technically implementable. Solidification/ stabilization materials are readily available. Limited space available at the site for grout mixing and material processing operations. Onsite treatment technologies may not be cost effective based on volume of soil to be addressed.	Proven process for effectively reducing mobility and toxicity of organic and inorganic constituents. Overall effectiveness of this process would need to be evaluated during a bench-scale study.	High capital and O&M costs.	No
	Extraction	Low-Temperature Thermal Desorption	Process by which soils containing organics with boiling point temperatures less than 800o Fahrenheit are excavated, conditioned, and heated; the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction. Treated soils are returned to the subsurface. Treatment is conducted in a thermal treatment unit that is mobilized or constructed onsite.	Potential emissions concerns based on site's location in commercial/residential area. Limited amount of space to construct LTTD facility. Onsite treatment technologies may not be cost effective based on volume of soil to be addressed.	Proven process for effectively removing organic constituents from excavated soil. The efficiency of the system and rate of removal of organic constituents would require evaluation during bench-scale and/or pilot-scale testing.	Moderate capital and O&M costs.	No
	Thermal Destruction	Incineration	Use of a mobile incineration unit installed onsite for high temperature thermal destruction of the organic compounds present in the media. Soils are excavated and conditioned prior to incineration. Treated soils are returned to the subsurface.	Potential emissions concerns based on site location in a commercial/residential area. Limited amount of space to construct incineration facility. Onsite treatment technologies may not be cost effective based on volume of soil to be addressed.	Proven process for effectively addressing organic constituents. The efficiency of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	High capital and O&M costs.	No
	Chemical Treatment	Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic by-products.	Implementable. Equipment and materials necessary to apply oxidizing agents are available. Large amounts of oxidizing agents may be required. Limited space for soil management and application of the chemical oxidation. May require special provisions for storage of process chemicals.	More effective for inorganics and halogenated hydrocarbons.	High capital and O&M costs.	No

See Note on Page 5.

Table 4. Remedial Technology Screening Evaluation for Subsurface Soil, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
Ex-Situ Onsite Treatment and/or Disposal (Cont.)	Chemical Treatment (Cont.)	Soil Washing	Soil is dissolved or suspended in a pH-adjusted surfactant wash solution or reduced through particle size separation, gravity separation, and attrition scrubbing. Clean portions of soil can be reused as fill at the site.	Technically implementable. Soil washing has been widely utilized in Northern Europe for remediation of MGP-related soil impacts. Process has not been widely utilized for MGP remediation in the United States. Limited space available at the site to conduct operations.	Process has been proven effective for soil containing metals, non-volatile organics, fuels, and semi-volatile organic compounds.	High capital and O&M costs.	No
	Onsite Disposal	Subtitle C Landfill	Construction of a landfill that would meet Subtitle C requirements.	Space limitations make onsite landfilling infeasible.	This technology process would be effective at meeting the RAOs for soil. Excavated material would be contained in an appropriately constructed Subtitle C landfill. Long-term effectiveness requires ongoing maintenance and monitoring.	High capital and moderate O&M costs.	No
		Solid Waste Landfill	Construction of a landfill that would meet NYSDEC solid waste requirements.	Space limitations make onsite landfilling infeasible.	This technology process would be effective at meeting the RAOs for soil. Excavated material would be contained in an appropriately constructed solid waste landfill. Long-term effectiveness requires ongoing maintenance and monitoring.	High capital and moderate O&M costs.	No
Offsite Treatment and/or Disposal	Recycle/ Reuse	Asphalt Concrete Batch Plant	Soil is used as a raw material in asphalt concrete paving mixtures. The impacted soil is transported to an offsite asphalt concrete facility and can replace part of the aggregate and asphalt concrete fraction. The hot-mix process melts asphalt concrete prior to mixing with aggregate. During the cold-mix process, aggregate is mixed at ambient temperature with an asphalt concrete/water emulsion. Organics and inorganics are bound in the asphalt concrete. Some organics may volatilize in the hot-mix.	Based on the nature of the fill materials at the site, the soil would need excessive processing to make it usable/acceptable for this application. Permitted facilities and demand are limited.	Effective for treating organics and inorganics through volatilization and/or encapsulation. Thermal pretreatment may be required to prevent leaching. Limited number of projects to support evaluation of effectiveness.	Moderate capital costs.	No
		Brick/Concrete Manufacture	Soil is used as a raw material in manufacture of bricks or concrete. Heating in ovens during manufacture volatilizes organics and some inorganics. Other inorganics are bound in the product.	Facilities capable of handling material are limited.	Effective for treating organics and inorganics through volatilization and/or vitrification. A bench-scale/pilot study may be necessary to determine effectiveness.	Moderate-high capital costs.	No
		Co-Burn in Utility Boiler	Soil is blended with feed coal to fire a utility boiler used to generate steam. Organics are destroyed.	Permitted facilities available for burning MGP soils are limited.	Effective for treating organic constituents. Soil would be blended with coal prior to burning. Overall effectiveness of this process would need to be evaluated during a trial burn.	Moderate capital costs.	Yes

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Table 4. Remedial Technology Screening Evaluation for Subsurface Soil, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
Offsite Treatment and/or Disposal (Cont.)	Extraction	Low-Temperature Thermal Desorption	Process by which soils containing organics with boiling point temperatures less than 800° Fahrenheit are heated and the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction. Would be used on materials that are determined to be characteristically hazardous based on TCLP analysis.	Implementable. Treatment facilities are available.	Effective means for treatment of materials that are characteristically hazardous due to the presence of organic compounds (i.e., benzene).	Moderate capital costs.	Yes
	Thermal Destruction	Incineration	Soils are transported offsite for high temperature thermal destruction of the organic compounds present in the media. Soils are excavated and conditioned prior to incineration.	Not implementable. Not a cost effective means for treating impacted soil. Limited number of treatment facilities. LTTD is a more appropriate technology process for thermally treating MGP-impacted media.	Proven process for effectively addressing organic constituents. The efficiency and effectiveness of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	High capital and O&M costs.	No
	Disposal	Solid Waste Landfill	Disposal of impacted soil in an existing permitted non-hazardous landfill.	Implementable for non-hazardous solid waste materials.	Proven process that, in conjunction with excavation, can effectively achieve the RAOs.	Moderate capital costs.	Yes
		Subtitle C Landfill	Disposal of impacted soil in an existing Subtitle C landfill facility.	Not implementable. Hazardous materials would not meet New York State LDRs and USTs without pre-treatment. Effective pre-treatment would be cost prohibitive when considering DER-4 exemption for permanent thermal treatment of D018 characteristically	Proven process that, in conjunction with excavation, can effectively achieve the RAOs.	Moderate capital costs.	No

Note:

1. Shading indicates that technology process has not been retained for development of a remedial alternative.

Table 5. Remedial Technology Screening Evaluation for Groundwater, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
No Action	No Action	No Action	Alternative would not include any remedial action. A No Action alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a No Action alternative is required by the NYSDEC DER-10.	Implementable.	Would not achieve the RAOs for groundwater in an acceptable time frame.	Low	Yes
Institutional Controls	Institutional Controls	Governmental Controls, Proprietary Controls, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted materials and/or jeopardize the integrity of a remedy. Examples of potential institutional controls include health and safety requirements when conducting subsurface activities and restrictions on groundwater use and/or extraction.	Implementable.	May be effective for reducing the potential for human exposure. This option would not meet the RAO for restoring, to the extent practicable, the groundwater to pre-release conditions. This option may be effective when combined with other process options that address source material (i.e., soil containing MGP-related impacts and NAPL).	Low	Yes
In-Situ Containment/ Control	Hydraulic Containment	Sheet Pile	Steel sheet piles are driven into the subsurface to prevent the migration of groundwater. The sheet pile wall is typically keyed into a confining unit.	Potentially implementable. Presence of subsurface fill and shallow depth to till in some areas may make sheet pile installation difficult.	This technology alone would not address potential exposure to impacted groundwater. Site wide containment options alone would require groundwater pumping (and subsequent onsite groundwater treatment) to maintain inward hydraulic gradient. Although site-wide containment options are not practical, containment options may be effective when utilized in targeted areas to prevent NAPL migration upgradient of the barriers (i.e., potential recontamination of excavated areas) and enhance NAPL collection/recovery.	High capital and Low O&M costs.	Yes
		Slurry Walls	Involves excavating a trench and adding a slurry (e.g., soil/cement-bentonite mixture) to prevent the migration of groundwater. Slurry walls are typically keyed into a low permeability unit (e.g., an underlying silt/clay layer or bedrock).	Potentially implementable. Equipment and materials required to install slurry walls are available. Presence of underground obstructions may hinder technology use. Would require trenching through fill material and obstructions to facilitate installation. May require relocation of utilities that cross path of barrier.	This technology alone would not address potential exposure to impacted groundwater. Site wide containment options alone would require groundwater pumping (and subsequent onsite groundwater treatment) to maintain inward hydraulic gradient. Not practicable for targeted areas.	Moderate capital and low O&M costs.	No
In-Situ Treatment	Biological Treatment	Groundwater Monitoring	Natural biological, chemical, and physical processes that under favorable conditions, act without human intervention to reduce the mass, volume, concentration, toxicity, and mobility of chemical constituents. Long-term monitoring is required to demonstrate the reduction of COCs.	Easily implemented. Would require monitoring to demonstrate reduction of COC concentrations and extent of dissolved phase plume.	May be effective if NAPL and impacted soil is removed or is prevented from contributing to the dissolved phase impacts.	Low capital and O&M costs.	Yes

See Note on Page 4.

Table 5. Remedial Technology Screening Evaluation for Groundwater, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
In-Situ Treatment (Cont.)	Biological Treatment (Cont.)	Enhanced Biodegradation	Addition of amendments (e.g., nutrients, oxygen) to the subsurface to enhance indigenous microbial populations to improve the rate of natural biodegradation of constituents.	Implementable. Would require monitoring to demonstrate reduction of COC concentrations and extent of dissolved phase plume. Amendments can be mixed with backfill materials during restoration of excavation areas or applied via injection/application wells.	Would likely require a significant amount of oxygen to enhance aerobic degradation. Would only be potentially effective at treating groundwater if a vast majority of NAPL and impacted soil (i.e., source of dissolved phase impacts) is removed or isolated. May not be effective based on site-specific soil types and slow groundwater velocities.	Low capital and high O&M costs.	No
	Chemical Treatment	Chemical Oxidation	Oxidizing agents are added to oxidize and reduce the concentrations of dissolved phase organic constituents. In-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate, or potassium permanganate.	Technically Implementable. Limited space available for large quantities of oxidizing agents and equipment. Soil vapor issues a concern given the proximity to commercial and residential buildings.	May require long-term treatment to reduce constituents unless combined with source removal technology. A bench scale treatability study would be required to evaluate/estimate the amount of oxidizing agent. Large amounts of oxidizing agents are likely needed. Would not be effective unless a vast majority of NAPL and impacted soil was removed from the site. May not be effective based on site-specific soil types and slow groundwater velocities.	High capital and O&M costs.	No
		Permeable Reactive Barrier (PRB)	PRBs are installed in or downgradient from the flow path of a contaminant plume. The contaminants in the plume react with the media inside the barrier to either break the compound down into harmless products or immobilize contaminants by precipitation or sorption.	Potentially Implementable. Presence of underground obstructions may hinder technology use. May require relocation of utilities that cross path of barrier. Pilot study would be required to evaluate appropriate design given site-specific hydraulic conditions.	NAPL in subsurface would inhibit effectiveness of PRB. Could be effective when combined with source removal.	Moderate capital and low O&M costs.	No
Removal	Hydraulic Control	Vertical Extraction Wells	Vertical wells are installed and utilized to recover groundwater for treatment/ disposal and containment/migration control. Typically requires extensive design/testing to determine required hydraulic gradients and feasibility of achieving those gradients.	Equipment and tools necessary to install and operate vertical extraction wells are readily available. Would require operation for an extended period of time. Limited space available for onsite water treatment.	Inefficient for recovery/treatment of dissolved phase plume. Would require pumping and treating large quantities of water over long periods of time due to proximity of Rio Grande Creek. Implementation of this process could achieve the RAOs over a long period of time.	Moderate capital and high O&M costs.	No
		Horizontal Extraction Wells	Horizontal wells are utilized to replace conventional well clusters in soil and containment/migration control.	Requires specialized horizontal drilling equipment. Would require operation for an extended period of time. Limited space available for onsite water treatment.		Moderate capital and high O&M costs.	No
	NAPL Removal	Active Removal	Process by which automated pumps are utilized to remove NAPL from recovery wells.	Technically implementable. Pilot study would be needed to verify implementability.	May be effective in removing NAPL. Could generate large quantities of groundwater that would have to be treated and/or disposed of.	Moderate capital and O&M costs.	Yes
		Passive Removal	NAPL is passively collected in vertical wells and periodically removed (i.e., via bottom-loading bailers, manually operated pumps, etc.).	Technically implementable. Passive NAPL recovery wells currently used at the site.	May be effective in removing NAPL.	Low capital and O&M costs.	Yes

See Note on Page 4.

Table 5. Remedial Technology Screening Evaluation for Groundwater, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
Removal (Cont.)	NAPL Removal (Cont.)	Collection Trenches/Passive Barrier Wall	A zone of higher permeability material is installed within a trench hydraulically downgradient from the NAPL-impacted capture area. A perforated collection trench/pipe is placed laterally along the base of trench or permeable wall to direct NAPL to a collection sump for recovery and disposal.	Equipment and materials to construct a NAPL collection trench are readily available. Limited space available for large collection trenches/passive barrier walls. The presence of subsurface obstructions (i.e., former MGP structures and utilities) could hinder the ability for implementation of this technology process. Collection trenches cannot be constructed/installed within till at depths where NAPL has been observed.	Recover wells would be a more effective means for recovering NAPL based on site size and available space.	Moderate capital and high O&M costs.	Yes
		Hot Water/Steam Injection	Process involves the injection of hot water and/or steam to heat groundwater and decrease the viscosity of NAPL to facilitate mobilization and removal. Used in conjunction with one (or more) of the above recovery technologies.	Technically feasible. Soil vapor issues a concern given the proximity to commercial and residential buildings.	This process may facilitate uncontrolled migration of NAPL. Would not meet the RAOs as a stand-alone technology. Due to the difficulty in predicting NAPL movement, potentially enhancing NAPL movement poses significant risk.	High capital and high O&M costs.	No
Ex-Situ/Onsite Treatment	Chemical Treatment	Ultra-violet (UV) Oxidation	Oxidation by subjecting groundwater to UV light and ozone. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts.	Potentially implementable. Limited space for a full-scale treatment system. Not typically used as part of a treatment train to treat MGP-related impacts in groundwater. No groundwater extraction process is retained, therefore groundwater treatment is not necessary. No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Proven process for effectively treating organic compounds. Use of this process may effectively achieve the RAOs. A bench-scale treatability study may be required to evaluate the efficiency of this process and to make project-specific adjustments to the process.	High capital and O&M costs.	No
		Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic byproducts.	Potentially implementable. Limited space for a full-scale treatment system. Not typically used as part of a treatment train to treat MGP-related impacts in groundwater.	A bench-scale treatability study may be required to evaluate the efficiency of this process and to make project-specific adjustments to the process. Large amounts of oxidizing agents are likely needed.	High capital and high O&M costs.	No
	Physical Treatment	Carbon Adsorption	Process by which organic constituents are adsorbed to the carbon as groundwater is passed through carbon units.	Not implementable. Limited space onsite for treatment system. Typically used as part of a treatment train to treat MGP-related impacts in groundwater. No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Effective at removing organic constituents. Use of this treatment process may effectively achieve the RAOs.	High capital and O&M costs.	No
		Filtration	Extraction of groundwater and treatment using filtration. Process in which the groundwater is passed through a granular media in order to remove suspended solids by interception, straining, flocculation, and sedimentation activity within the filter.	Not implementable. Limited space available for onsite for treatment system. Typically used as part of a treatment train to treat MGP-related impacts in groundwater. No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Effective pre-treatment process to reduce suspended solids. Use of this process along with other processes (i.e., that address organic constituents) could effectively achieve the RAOs.	Low capital and O&M costs.	No

See Note on Page 4.

Table 5. Remedial Technology Screening Evaluation for Groundwater, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Relative Cost	Retained?
Ex-Situ/Onsite Treatment (Cont.)	Physical Treatment (Cont.)	Air Stripping	A process in which VOCs are removed through volatilization by increasing the contact between the groundwater and air.	Not implementable. Limited space available for onsite for treatment system. No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	This technology process would be effective at removing VOCs from water. Has potential to be used as part of a treatment system to meet the RAOs.	High capital and O&M costs.	No
		Precipitation/ Coagulation/ Flocculation	Process which precipitates dissolved constituents into insoluble solids and improves settling characteristics through the addition of amendments to water to facilitate subsequent removal from the liquid phase by sedimentation/filtration.	Not implementable. Limited space available for onsite for treatment system. No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Process which transforms dissolved constituents into insoluble solids by adding coagulating agents to facilitate subsequent removal from the liquid phase by sedimentation/filtration. Has potential to be used as part of a treatment system to meet the RAOs.	Moderate capital and O&M costs.	No
		Oil/Water Separation	Process by which insoluble oils are separated from water via physical separation technologies, including gravity separation, baffled vessels, etc.	Not implementable. Limited space available for onsite for treatment system. Typically used as part of a treatment train to treat MGP-related impacts in groundwater. No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Effective at separating insoluble oil from groundwater. This process could be used as part of a groundwater treatment train to address separate-phase liquids. Has potential to be used as part of a treatment system to meet the RAOs.	Low capital and O&M costs.	No
Off-site Treatment/ Disposal	Groundwater Discharge	Discharge to a local Publicly-Owned Treatment Works (POTW)	Treated or untreated water is discharged to a sanitary sewer and treated at a local POTW facility.	Not implementable. No space available for onsite for treatment system, therefore, no discharge option required. Discharge of treated or untreated water to village sanitary sewer is not permitted under any conditions.	Proven process for effectively disposing of groundwater. Could be used as a component of an overall remedy to meet the RAOs for groundwater.	Moderate capital and O&M costs.	No
		Discharge to Surface Water via Storm Sewer	Treated or untreated water is discharged to surface water, provided that the water quality and quantity meet the allowable discharge requirements for surface waters (NYSDEC SPDES compliance).	Discharges to surface water must meet substantive requirements of a SPDES permit. Cleanup objectives and sampling requirements may be restrictive. No space available for onsite for treatment system, therefore, no discharge option required.	This technology process would effectively dispose of groundwater. Impacted groundwater would require treatment to achieve water quality discharge limits. Helps in the management of treated water, but does not directly lend to achieving the RAOs for groundwater.	Low capital and O&M costs.	No
		Discharge to a Privately Owned/Commerciall y Operated Treatment Facility.	Treated or untreated water is collected and transported to a privately owned treatment facility. This process option can be used to support long-term technologies (e.g., pump and treat) or short-term activities (e.g., dewatering of excavation area).	Implementable. Equipment and materials to pretreat the water at the site are readily available. No space available for onsite for treatment system, therefore, no discharge option required.	Proven process for effectively disposing of groundwater.	High Capital and O&M Costs	No

Note:

1. Shading indicates that technology process has not been retained for development of a remedial alternative.

Table 6. Cost Estimate for Alternative 2, NAPL Recovery, Groundwater Monitoring, and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Mobilization/Demobilization	1	LS	$2,000	$2,000
2	Install NAPL Collection Wells	5	EACH	$8,000	$40,000
3	Waste Disposal	4	DRUM	$750	$3,000
4	Site Management Plan	1	LS	$50,000	$50,000
5	Establish Institutional Controls	1	LS	$50,000	$50,000
				Subtotal Capital Cost	$145,000
6				Administration & Engineering (15%)	$21,750
				Contingency (20%)	$29,000
				Total Capital Cost	$195,750
Operation and Maintenance Costs					
7	Annual Verification of Institutional Controls	1	LS	$5,000	$5,000
8	Semi-Annual NAPL Monitoring and Passive Recovery	2	EVENT	$2,200	$4,400
9	Annual Groundwater Sampling	1	EVENT	$12,000	$12,000
10	Laboratory Analysis of Groundwater Samples	24	EACH	$250	$6,000
11	Waste Disposal	4	DRUM	$700	$2,800
12	Annual Summary Report	1	LS	$20,000	$20,000
				Subtotal O&M Cost	$50,200
				Contingency (20%)	$10,040
				Total Annual O&M Cost	$60,240
13				30-Year Total Present Worth Cost of O&M	$1,041,672
				Total Estimated Cost:	**$1,237,422**
				Rounded To:	**$1,200,000**

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2011 dollars.
2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.
3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Mobilization/demobilization cost estimate includes mobilization and demobilization of all labor, equipment, and materials necessary to install new groundwater and NAPL collection wells.
2. Install NAPL collection wells cost estimate includes all labor, equipment, and materials necessary to install NAPL collection wells to an average depth of 30 feet below grade. Cost estimate includes oversight by a geologist, and drill rig and crew. Cost estimate assumes no work stoppages during field work due to weather or other potential delays. Cost estimate assumes 6-inch diameter stainless steel well construction and wells equipped with minimum 5-foot long sumps.
3. Waste disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of soil cuttings and decontamination water generated during well installation. Cost assumes all the soil cuttings and decontamination water will be containerized in 55 gallons drums. Cost estimate includes collection and laboratory analysis of two waste characterization samples. Cost estimate includes disposal fee; transportation fuel surcharge; and environmental, transportation, and spotting fees.
4. Site management plan cost estimate includes all labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the site; known locations of soil containing COCs at concentrations greater than 6NYCRR Part 375-6 industrial use SCOs; protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities; protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring; protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities.
5. Establish institutional controls cost estimate includes all legal expenses to institute environmental easements and deed restrictions. Institutional controls would: limit intrusive (i.e., subsurface) activities that could result in potential exposures to subsurface soil and groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of non-treated groundwater on the NYSEG property.
6. Administration and engineering and construction management costs are based on an assumed 15% of the total capital costs.
7. Annual verification of institutional controls cost estimate includes administrative costs for confirming institutional controls to minimize the potential for human exposure to site soil and groundwater are present. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.
8. Semi-annual NAPL monitoring and passive recovery cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual NAPL monitoring. Cost estimate includes passive NAPL recovery via manual bailing or a portable peristaltic pump. Cost estimate assumes two workers will require one day to complete monitoring and recovery per event. Estimate includes field vehicle and equipment.

Table 6. Cost Estimate for Alternative 2, NAPL Recovery, Groundwater Monitoring, and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

9. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 18 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require 4 days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.
10. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 18 groundwater monitoring wells and up to 6 QA/QC samples per sampling event.
11. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, purge water, and NAPL generated/collected during semi-annual NAPL and annual groundwater monitoring activities.
12. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing semi-annual NAPL and annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.
13. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2011.

Table 7. Cost Estimate for Alternative 3, MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitori and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	ISS Treatability Study	1	LS	$75,000	$75,000
2	Mobilization/Demobilization	1	LS	$250,000	$250,000
3	Temporary Site Fencing	400	LF	$50	$20,000
4	Erosion and Sedimentation Control	800	LF	$3	$2,400
5	Construct and Maintain Material Staging Area	1	LS	$15,000	$15,000
6	Construct and Maintain Decontamination Pad	1	LS	$6,000	$6,000
7	Utility Markout and Clearance	1	DAY	$4,000	$4,000
8	Utility Bypass/Relocation/Protection	1	LS	$100,000	$100,000
9	Soil Excavation and Handling	760	CY	$45	$34,200
10	Vapor/Odor Control	9	WEEK	$3,000	$27,000
11	ISS Treatment	2,600	CY	$125	$325,000
12	Jet Grouting	630	CY	$450	$283,500
13	ISS and Jet Grout Spoils Handling	1,300	CY	$15	$19,500
14	ISS QA/QC Sampling	5	EACH	$1,500	$7,500
15	Reuse of Excavated Material	380	CY	$20	$7,600
16	Demarcation Layer	540	SY	$5	$2,700
17	Imported Backfill	300	CY	$40	$12,000
18	Surface Restoration	4,400	SF	$6	$26,400
19	Solid Waste Characterization	7	EACH	$1,200	$8,400
20	Solid Waste Transportation and Disposal - C&D Debris	2,900	TON	$100	$290,000
21	Solid Waste Transportation and Disposal - Non-Haz Landfill	330	TON	$55	$18,150
22	Install NAPL Collection Wells	5	EACH	$8,000	$40,000
23	Site Management Plan	1	LS	$50,000	$50,000
24	Establish Institutional Controls	1	LS	$50,000	$50,000
				Subtotal Capital Cost	$1,674,350
25				Administration & Engineering (15%)	$193,680
				Construction Management (15%)	$193,680
				Contingency (20%)	$334,870
				Total Capital Cost	$2,396,580
Operation and Maintenance Costs					
26	Annual Verification of Institutional Controls	1	LS	$5,000	$5,000
27	Semi-Annual NAPL Monitoring and Passive Recovery	2	EVENT	$2,200	$4,400
28	Annual Groundwater Sampling	1	EVENT	$12,000	$12,000
29	Laboratory Analysis of Groundwater Samples	24	EACH	$250	$6,000
30	Waste Disposal	4	DRUM	$700	$2,800
31	Annual Summary Report	1	LS	$20,000	$20,000
				Subtotal O&M Cost	$50,200
				Contingency (20%)	$10,040
				Total Annual O&M Cost	$60,240
32				30-Year Total Present Worth Cost of O&M	$1,041,672
				Total Estimated Cost:	**$3,438,252**
				Rounded To:	**$3,400,000**

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2011 dollars.
2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.
3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. ISS treatability study cost estimate includes all labor, equipment, and materials necessary to conduct ISS treatability study prior to the implementation of any remedial construction activities. Cost estimate includes collection of soil samples, bench-scale ISS testing using site soil and groundwater, and preparation of an ISS Treatability Summary Report.
2. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.
3. Temporary site fencing cost estimate includes all labor, equipment, and materials necessary to purchase, install, and remove a six-foot tall woven steel chain link fence equipped with barbed wire to secure the project site.
4. Erosion and sedimentation control cost estimate includes placement/maintenance of staked hay bales or silt fence around project work limits.

Table 7. Cost Estimate for Alternative 3, MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitori and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

5. Construct and maintain material staging area cost estimate includes all labor, equipment, and materials necessary to construct a 50-foot by 50-foot material staging area constructed of a 6-inch gravel sub-base, equipped with a 12-inch berm and sloped to a sump for staging excavated material to facilitate waste characterization sampling and material handling/stabilization. Maintenance includes inspecting and repairing staging area as necessary. Estimate assumes a cost of approximately $6 per square-foot of pad.
6. Construct and maintain decontamination pad cost estimate includes all labor, equipment, and materials necessary to construct and remove a 50-foot by 20-foot decontamination pad and appurtenances. The decontamination pad would consist of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner and a 6-inch layer of gravel.
7. Utility markout and clearance cost estimate includes all labor, equipment, and materials necessary to identify, markout, and clear (via hand-digging) underground utilities within excavation/ISS areas. Cost assumes that utility location and markout would be conducted by a private utility locating company.
8. Utility bypass/relocation/protection cost estimate includes all labor, equipment, and materials necessary to temporarily bypass or relocate natural gas distribution piping to facilitate remedial construction activities. Cost estimate assumes that natural gas distribution piping could be bypassed with existing piping or relocated on NYSEG's property with new piping. As the scope of the bypass/relocation activities cannot be assessed at this time, estimated cost is not certified to be within -30% to +50% of the actual cost.
9. Soil excavation and handling includes all labor, equipment, and materials necessary to conduct pre-ISS excavation to identify and clear potential subsurface obstructions and utilities. Cost estimate also includes excavation and removal of the underground steel tank located on the eastern portion of the NYSEG property. Cost estimate assumes the steel tank would be recycled at no net fee/profit. Cost estimate assumes pre-ISS excavation would be completed to depths of 4 to 5 feet below grade (25% of the ISS treatment target depth) and the excavation to facilitate steel tank removal would be completed to 6 feet below grade. Cost estimate is based on in-place soil volume.
10. Vapor/odor control cost estimate includes all labor, equipment, and materials necessary to apply vapor/odor suppressing foam to open excavations and ISS areas.
11. ISS treatment cost estimate includes all labor, equipment, and materials necessary to conduct in-situ soil stabilization to address MGP source material. Cost estimate assumes ISS would be conducted to depths of 12 to 26/28 feet below grade (i.e., top of till) using via bucket mixing or small diameter auger. Cost estimate based on in-place soil volume.
12. Jet grouting cost estimate includes all labor, equipment, and materials necessary to conduct ISS via jet grouting at locations where bucket mixing and augers cannot clear subsurface obstructions. Cost estimate assumes that up to 200 linear-feet of jet grouting would be conducted to an average depth of 28 feet below grade with a 3-foot treatment width. Cost estimate assumes jet grouting applications completed 2.5 feet on center. Cost estimate based on in-place soil volume.
13. ISS and jet grout spoils handling cost estimate includes all labor, equipment, and material necessary to load partially solidified ISS and jet grout spoils for off-site transportation and disposal. Cost estimate assumes spoils volumes of 25% of ISS treatment volume and 100% of jet grout volume.
14. ISS QA/QC sampling cost estimate includes all labor, equipment, and materials necessary to perform quality assurance/quality control testing of ISS treatment area to verify performance criteria have been achieved. Cost estimate assumes QA/QC samples will be collected from a confirmation boring completed for every 1,000 square-feet of wet stabilized material. Cost estimate includes costs for a geologist, drill rig and crew, and laboratory analysis of samples for unconfined compressive strength and permeability.
15. Reuse of excavated material cost estimate includes all labor, equipment, and materials necessary to reuse previously excavated material as subsurface backfill. Cost estimate assumes that 50% of excavated material is suitable for reuse (i.e., free of visual impacts, rubble, and debris).
16. Demarcation layer cost estimate includes labor, equipment, and materials necessary to place a woven, light-weight, non-biodegradable, high-visibility demarcation layer within soil excavation areas between excavated soil reused as subsurface fill and imported clean fill material.
17. Imported backfill cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact imported fill (e.g., general fill, crushed stone, gravel) in excavation/ISS areas to within 6 inches of the surrounding grade. Cost estimate is based on in-place soil volume of remaining void following placement of excavated soil reused for subsurface fill. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.
18. Surface restoration cost estimate includes all labor, equipment, and material necessary restore surfaces disturbed during remedial activities in kind. Final surface restorations include 6-inch layer of asphalt pavement, gravel, and vegetated topsoil.
19. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.
20. Solid waste transportation and disposal - C&D debris cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated surface material (e.g., pavement, concrete, gravel sub-base) and ISS/jet grout spoils as construction and demolition debris. Costs assume excavated material to 1 foot below grade would be transported off-site disposal as C&D debris at an assumed density of 1.75 tons per cubic-yard. Cost estimate includes transportation and disposal of ISS and jet grout spoils at an assumed density of 2.0 tons per cubic-yard. Cost estimate includes disposal fee; transportation fuel surcharge; and environmental, transportation, and spotting fees. Cost estimate assumes that no material will be recycled or reused.
21. Solid waste transportation and disposal - non-haz landfill cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated soil not suitable for site reuse as at a non-hazardous solid waste landfill. Cost estimate includes transportation and disposal of excavated soil at an assumed density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees.
22. Install NAPL collection wells cost estimate includes all labor, equipment, and materials necessary to install NAPL collection wells to an average depth of 30 feet below grade. Cost estimate includes oversight by a geologist, and drill rig and crew. Cost estimate assumes no work stoppages during field work due to weather or other potential delays. Cost estimate assumes 6-inch diameter stainless steel well construction and wells equipped with minimum 5-foot long sumps.

Table 7. Cost Estimate for Alternative 3, MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitori and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

23. Site management plan cost estimate includes all labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the site; extent of solidified soil; known locations of soil containing COCs at concentrations greater than 6NYCRR Part 375-6 industrial use SCOs; protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing stabilized material, if encountered during these activities; protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring; protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities.
24. Establish institutional controls cost estimate includes all legal expenses to institute environmental easements and deed restrictions. Institutional controls would: limit intrusive (i.e., subsurface) activities that could result in potential exposures to stabilized media or remaining subsurface soil and groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of non-treated groundwater on the NYSEG property.
25. Administration and engineering and construction management costs are based on an assumed 15% of the total capital costs, not including costs for off-site transportation and treatment/disposal of excavated material.
26. Annual verification of institutional controls cost estimate includes administrative costs for confirming institutional controls to minimize the potential for human exposure to site soil and groundwater are present. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.
27. Semi-annual NAPL monitoring and passive recovery cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual NAPL monitoring. Cost estimate includes passive NAPL recovery via manual bailing or a portable peristaltic pump. Cost estimate assumes two workers will require one day to complete monitoring and recovery per event. Estimate includes field vehicle and equipment.
28. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 18 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require 4 days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.
29. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 18 groundwater monitoring wells and up to 6 QA/QC samples per sampling event.
30. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, purge water, and NAPL generated/collected during semi-annual NAPL and annual groundwater monitoring activities.
31. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing semi-annual NAPL and annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.
32. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2011.

Table 8. Cost Estimate for Alternative 4, MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Mobilization/Demobilization	1	LS	$200,000	$200,000
2	Temporary Site Fencing	400	LF	$50	$20,000
3	Erosion and Sedimentation Control	800	LF	$3	$2,400
4	Construct and Maintain Material Staging Area	1	LS	$15,000	$15,000
5	Construct and Maintain Decontamination Pad	1	LS	$6,000	$6,000
6	Utility Markout and Clearance	1	DAY	$4,000	$4,000
7	Utility Bypass/Relocation/Protection	1	LS	$100,000	$100,000
8	Install and Remove Temporary Sheet Pile	14,600	VSF	$50	$730,000
	Internal Bracing and Support	1	LS	$90,000	$90,000
9	On-Site Water Handling/Management	4	MONTH	$20,000	$80,000
10	Open Span Structure	1	LS	$270,000	$270,000
	Air Treatment	1	LS	$200,000	$200,000
11	Soil Excavation and Handling	3,400	CY	$45	$153,000
12	Stabilization Admixture	410	TON	$115	$47,150
13	Vapor/Odor Control	18	WEEK	$3,000	$54,000
14	Reuse of Excavated Material	850	CY	$20	$17,000
15	Demarcation Layer	540	SY	$5	$2,700
16	Imported Backfill	2,500	CY	$40	$100,000
17	Surface Restoration	4,400	SF	$6	$26,400
18	Liquid Waste Characterization	3	EACH	$1,200	$4,080
19	Liquid Waste Transportation and Disposal	170,000	GAL	$0.70	$119,000
20	Solid Waste Characterization	9	EACH	$1,200	$10,800
21	Solid Waste Transportation and Disposal - C&D Debris	290	TON	$100	$29,000
22	Solid Waste Transportation and Disposal - Non-Haz Landfill	2,800	TON	$55	$154,000
23	Solid Waste Transportation and Disposal - LTTD	1,400	TON	$85	$119,000
24	Install NAPL Collection Wells	5	EACH	$8,000	$40,000
25	Site Management Plan	1	LS	$50,000	$50,000
26	Establish Institutional Controls	1	LS	$50,000	$50,000
				Subtotal Capital Cost	$2,693,530
27				Administration & Engineering (15%)	$358,730
				Construction Management (15%)	$358,730
				Contingency (20%)	$538,706
				Total Capital Cost	$3,949,695
Operation and Maintenance Costs					
28	Annual Verification of Institutional Controls	1	LS	$5,000	$5,000
29	Semi-Annual NAPL Monitoring and Passive Recovery	2	EVENT	$2,200	$4,400
30	Annual Groundwater Sampling	1	EVENT	$12,000	$12,000
31	Laboratory Analysis of Groundwater Samples	24	EACH	$250	$6,000
32	Waste Disposal	4	DRUM	$700	$2,800
33	Annual Summary Report	1	LS	$20,000	$20,000
				Subtotal O&M Cost	$50,200
				Contingency (20%)	$10,040
				Total Annual O&M Cost	$60,240
34				30-Year Total Present Worth Cost of O&M	$1,041,672
				Total Estimated Cost:	**$4,991,367**
				Rounded To:	**$5,000,000**

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2011 dollars.
2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.
3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.
2. Temporary site fencing cost estimate includes all labor, equipment, and materials necessary to purchase, install, and remove a six-foot tall woven steel chain link fence equipped with barbed wire to secure the project site.

Table 8. Cost Estimate for Alternative 4, MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

3. Erosion and sedimentation control cost estimate includes placement/maintenance of staked hay bales or silt fence around project work limits.
4. Construct and maintain material staging area cost estimate includes all labor, equipment, and materials necessary to construct a 50-foot by 50-foot material staging area constructed of a 6-inch gravel sub-base, equipped with a 12-inch berm and sloped to a sump for staging excavated material to facilitate waste characterization sampling and material handling/stabilization. Maintenance includes inspecting and repairing staging area as necessary. Estimate assumes a cost of approximately $6 per square-foot of pad.
5. Construct and maintain decontamination pad cost estimate includes all labor, equipment, and materials necessary to construct and remove a 50-foot by 20-foot decontamination pad and appurtenances. The decontamination pad would consist of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner and a 6-inch layer of gravel.
6. Utility markout and clearance cost estimate includes all labor, equipment, and materials necessary to identify, markout, and clear (via hand-digging) underground utilities within excavation areas. Cost assumes that utility location and markout would be conducted by a private utility locating company.
7. Utility bypass/relocation/protection cost estimate includes all labor, equipment, and materials necessary to temporarily bypass or relocate natural gas distribution piping to facilitate remedial construction activities. Cost estimate assumes that natural gas distribution piping could be bypassed with existing piping or relocated on NYSEG's property with new piping. As the scope of the bypass/relocation activities cannot be assessed at this time, estimated cost is not certified to be within -30% to +50% of the actual cost.
8. Install and remove temporary sheet pile cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed at an average depth of 35 feet below grade and that sheets can be driven at least 5 feet into till. Cost estimate includes internal bracing and lateral supports. Estimate includes pre-trenching for removal of subsurface obstructions when encountered. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the Remedial Design.
9. On-site water handling/management cost estimate includes all labor, equipment, and material necessary to remove and containerize groundwater from excavation areas. Cost estimate includes the rental of up to three 20,000 gallon holding tanks and all pumps and piping.
10. Open span structure and air treatment cost estimate includes rental of an approximately 120-foot by 70-foot Sprung-type structure to enclose excavation areas. Estimate assumes lease costs of approximately $20 per square-foot and construction cost of approximately $12 per square-foot. Cost estimate assumes structure is equipped with overheard doors for truck and excavator access. Final structure construction details to be determined as part of the Remedial Design. Air treatment cost estimate includes rental of vapor treatment system to collect and treat air within the excavation enclosure. Cost estimate includes lease of all vapor collection and treatment equipment, delivery and set-up fees, and filter media change out. Cost estimate assumes maximum 6-month rental of open span structure and air treatment system.
11. Soil excavation and handling includes all labor, equipment, and materials necessary to excavate MGP source material. Cost estimate also includes excavation and removal of the underground steel tank located on the eastern portion of the NYSEG property. Cost estimate assumes excavation activities would be completed to depths of 12 to 26/28 feet below grade (i.e., top of till) and the excavation to facilitate steel tank removal would be completed to 6 feet below grade. Cost estimate assumes the steel tank would be recycled at no net fee/profit. Cost estimate is based on in-place soil volume.
12. Stabilization admixture cost estimate includes the purchase and importation of stabilizing agents to amend material excavated from the below the water table. Cost estimate assumes stabilization admixture (e.g., Portland cement) will be added at ratio of 10% of the volume of material to be stabilized.
13. Vapor/odor control cost estimate includes all labor, equipment, and materials necessary to apply vapor/odor suppressing foam to open excavations areas.
14. Reuse of excavated material cost estimate includes all labor, equipment, and materials necessary to reuse previously excavated material as subsurface backfill. Cost estimate assumes that 25% of excavated material is suitable for reuse (i.e., free of visual impacts, rubble, and debris).
15. Demarcation layer cost estimate includes labor, equipment, and materials necessary to place a woven, light-weight, non-biodegradable, high-visibility demarcation layer within soil excavation areas between excavated soil reused as subsurface fill and imported clean fill material.
16. Imported backfill cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact imported fill (e.g., general fill, crushed stone, gravel) in excavation areas to within 6 inches of the surrounding grade. Cost estimate is based on in-place soil volume of remaining void following placement of excavated soil reused for subsurface fill. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.
17. Surface restoration cost estimate includes all labor, equipment, and material necessary restore surfaces disturbed during remedial activities in kind. Final surface restorations include 6-inch layer of asphalt pavement, gravel, and vegetated topsoil.
18. Liquid waste characterization cost estimate includes the analysis (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals) of water containerized during remedial construction. Cost estimate assumes one sample collected and analyzed per every 50,000 gallons water requiring transportation and off-site disposal.
19. Liquid waste transportation and disposal cost estimate includes all fees associated transporting and disposing of water collected during remedial construction activities. Volume estimate includes decontamination water and groundwater removed from excavation areas only. Volume estimate based on saturated pore volume of excavation area. Cost estimate assumes water would be removed from on-site holding tanks and transported for off-site disposal via 5,000-gallon tanker trucks. Cost estimate includes disposal fee; transportation fuel surcharge; and environmental, transportation, and spotting fees.
20. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

Table 8. Cost Estimate for Alternative 4, MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

21. Solid waste transportation and disposal - C&D debris cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated surface material (e.g., pavement, concrete, gravel sub-base) as construction and demolition debris. Costs assume excavated material to 1 foot below grade would be transported off-site disposal as C&D debris at an assumed density of 1.75 tons per cubic-yard. Cost estimate includes disposal fee; transportation fuel surcharge; and environmental, transportation, and spotting fees. Cost estimate assumes that no material will be recycled or reused.
22. Solid waste transportation and disposal - non-haz landfill cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated soil not suitable for site reuse as at a non-hazardous solid waste landfill. Cost assumes 25% of excavated soil will be disposed of at a non-hazardous solid waste landfill at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees.
23. Solid waste transportation and disposal - LTTD cost estimate includes labor, equipment, and materials necessary to transport and thermally treat excavated soil exhibiting toxicity characteristic for benzene at a thermal treatment facility. Cost assumes 50% of excavated soil plus stabilization mixture will be treated/disposed of via LTTD at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees. Cost estimate assumes thermally treated soil does not require subsequent treatment or disposal.
24. Install NAPL collection wells cost estimate includes all labor, equipment, and materials necessary to install NAPL collection wells to an average depth of 30 feet below grade. Cost estimate includes oversight by a geologist, and drill rig and crew. Cost estimate assumes no work stoppages during field work due to weather or other potential delays. Cost estimate assumes 6-inch diameter stainless steel well construction and wells equipped with minimum 5-foot long sumps.
25. Site management plan cost estimate includes all labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the site; known locations of soil containing COCs at concentrations greater than 6NYCRR Part 375-6 industrial use SCOs; protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities; protocols and requirements for conducting semi-annual NAPL monitoring and annual groundwater monitoring; protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities.
26. Establish institutional controls cost estimate includes all legal expenses to institute environmental easements and deed restrictions. Institutional controls would: limit intrusive (i.e., subsurface) activities that could result in potential exposures to remaining subsurface soil and groundwater containing residual MGP-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of non-treated groundwater on the NYSEG property.
27. Administration and engineering and construction management costs are based on an assumed 15% of the total capital costs, not including costs for off-site transportation and treatment/disposal of excavated material.
28. Annual verification of institutional controls cost estimate includes administrative costs for confirming institutional controls to minimize the potential for human exposure to site soil and groundwater are present. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.
29. Semi-annual NAPL monitoring and passive recovery cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual NAPL monitoring. Cost estimate includes passive NAPL recovery via manual bailing or a portable peristaltic pump. Cost estimate assumes two workers will require one day to complete monitoring and recovery per event. Estimate includes field vehicle and equipment.
30. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 18 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require 4 days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.
31. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 18 groundwater monitoring wells and up to 6 QA/QC samples per sampling event.
32. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, purge water, and NAPL generated/collected during semi-annual NAPL and annual groundwater monitoring activities.
33. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing semi-annual NAPL and annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.
34. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2011.

Table 9. Cost Estimate for Alternative 5, Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Mobilization/Demobilization	1	LS	$300,000	$300,000
2	Temporary Site Fencing	400	LF	$50	$20,000
3	Erosion and Sedimentation Control	800	LF	$3	$2,400
4	Construct and Maintain Decontamination Pad	1	LS	$6,000	$6,000
5	Structure Demolition and Disposal	1	LS	$95,000	$95,000
6	Utility Markout and Clearance	3	DAY	$4,000	$12,000
7	Utility Relocation	1	LS	$500,000	$500,000
8	Install and Remove Temporary Sheet Pile	28,600	VSF	$50	$1,430,000
	Internal Bracing and Support	1	LS	$240,000	$240,000
9	On-Site Water Handling/Management	9	MONTH	$20,000	$180,000
10	Open Span Structure	1	LS	$780,000	$780,000
	Air Treatment	1	LS	$400,000	$400,000
11	Soil Excavation and Handling	9,200	CY	$45	$414,000
12	Stabilization Admixture	1,120	TON	$115	$128,800
13	Vapor/Odor Control	41	WEEK	$3,000	$123,000
14	Imported Backfill	9,000	CY	$40	$360,000
15	Surface Restoration	11,800	SF	$6	$70,800
16	Liquid Waste Characterization	9	EACH	$1,200	$10,800
17	Liquid Waste Transportation and Disposal	410,000	GAL	$0.70	$287,000
18	Solid Waste Characterization	31	EACH	$1,200	$37,200
19	Solid Waste Transportation and Disposal - C&D Debris	760	TON	$100	$76,000
20	Solid Waste Transportation and Disposal - Non-Haz Landfill	12,100	TON	$55	$665,500
21	Solid Waste Transportation and Disposal - LTTD	2,200	TON	$85	$187,000
				Subtotal Capital Cost	$6,325,500
22				Administration & Engineering (15%)	$809,550
				Construction Management (15%)	$809,550
				Contingency (20%)	$1,265,100
				Total Capital Cost	$9,209,700
Operation and Maintenance Costs					
23	Annual Groundwater Sampling	1	EVENT	$10,000	$10,000
24	Laboratory Analysis of Groundwater Samples	16	EACH	$250	$4,000
25	Waste Disposal	2	DRUM	$700	$1,400
26	Annual Summary Report	1	LS	$15,000	$15,000
				Subtotal O&M Cost	$30,400
				Contingency (20%)	$6,080
				Total Annual O&M Cost	$36,480
27				2-Year Total Present Worth Cost of O&M	$68,805
				Total Estimated Cost:	**$9,278,505**
				Rounded To:	**$9,300,000**

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2011 dollars.
2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. ARCADIS is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.
3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.
2. Temporary site fencing cost estimate includes all labor, equipment, and materials necessary to purchase, install, and remove a six-foot tall woven steel chain link fence equipped with barbed wire to secure the project site.
3. Erosion and sedimentation control cost estimate includes placement/maintenance of staked hay bales or silt fence around project work limits.
4. Construct and maintain decontamination pad cost estimate includes all labor, equipment, and materials necessary to construct and remove a 50-foot by 20-foot decontamination pad and appurtenances. The decontamination pad would consist of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner and a 6-inch layer of gravel.

Table 9. Cost Estimate for Alternative 5, Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

5. Structure demolition and disposal cost estimate includes all labor, equipment, and materials necessary to demolish and dispose of the NYSEG service center building. Cost estimate is based on an assumed demolition cost of $10 per square-foot and disposal cost of $100 per ton. Cost estimate assumes asbestos containing material (ACM) and lead paint is not present in the NYSEG building.
6. Utility markout and clearance cost estimate includes all labor, equipment, and materials necessary to identify, markout, and clear (via hand-digging) underground utilities within excavation areas. Cost assumes that utility location and markout would be conducted by a private utility locating company.
7. Utility relocation cost estimate includes all labor, equipment, and materials necessary to relocate natural gas distribution piping to facilitate remedial construction activities. Cost estimate assumes that natural gas distribution piping, including infrastructure within the NYSEG service center building, would be relocated prior to remedial activities. As the scope of the bypass/relocation activities cannot be assessed at this time, estimated cost is not certified to be within -30% to +50% of the actual cost.
8. Install and remove temporary sheet pile cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed at an average depth of 35 feet below grade and that sheets can be driven at least 5 feet into till. Cost estimate includes internal bracing and lateral supports. Estimate includes pre-trenching for removal of subsurface obstructions when encountered. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the Remedial Design.
9. On-site water handling/management cost estimate includes all labor, equipment, and material necessary to remove and containerize groundwater from excavation areas. Cost estimate includes the rental of up to three 20,000 gallon holding tanks and all pumps and piping.
10. Open span structure and air treatment cost estimate includes rental of an approximately 150-foot by 130-foot Sprung-type structure to enclose excavation areas. Estimate assumes lease costs of approximately $28 per square-foot and construction cost of approximately $12 per square-foot. Cost estimate assumes structure is equipped with overheard doors for truck and excavator access. Final structure construction details to be determined as part of the Remedial Design. Air treatment cost estimate includes rental of vapor treatment system to collect and treat air within the excavation enclosure. Cost estimate includes lease of all vapor collection and treatment equipment, delivery and set-up fees, and filter media change out. Cost estimate assumes maximum 12-month rental of open span structure and air treatment system.
11. Soil excavation and handling includes all labor, equipment, and materials necessary to excavate soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs. Cost estimate also includes excavation and removal of the underground steel tank located on the eastern portion of the NYSEG property. Cost estimate assumes excavation activities would be completed to depths up to 28 feet below grade (assumed top of till) and excavation to facilitate steel tank removal would be completed to 6 feet below grade. Cost estimate assumes the steel tank would be recycled at no net fee/profit. Cost estimate is based on in-place soil volume.
12. Stabilization admixture cost estimate includes the purchase and importation of stabilizing agents to amend material excavated from the below the water table. Cost estimate assumes stabilization admixture (e.g., Portland cement) will be added at ratio of 10% of the volume of material to be stabilized.
13. Vapor/odor control cost estimate includes all labor, equipment, and materials necessary to apply vapor/odor suppressing foam to open excavations areas.
14. Imported backfill cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact imported fill (e.g., general fill, crushed stone, gravel) in excavation areas to within 6 inches of the surrounding grade. Cost estimate is based on in-place soil volume. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.
15. Surface restoration cost estimate includes all labor, equipment, and material necessary restore surfaces disturbed during remedial activities in kind. Final surface restorations include 6-inch layer of asphalt pavement, gravel, and vegetated topsoil.
16. Liquid waste characterization cost estimate includes the analysis (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals) of water containerized during remedial construction. Cost estimate assumes one sample collected and analyzed per every 50,000 gallons water requiring transportation and off-site disposal.
17. Liquid waste transportation and disposal cost estimate includes all fees associated transporting and disposing of water collected during remedial construction activities. Volume estimate includes decontamination water and groundwater removed from excavation areas only. Volume estimate based on saturated pore volume of excavation area. Cost estimate assumes water would be removed from on-site holding tanks and transported for off-site disposal via 5,000-gallon tanker trucks. Cost estimate includes disposal fee; transportation fuel surcharge; and environmental, transportation, and spotting fees.
18. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.
19. Solid waste transportation and disposal - C&D debris cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated surface material (e.g., pavement, concrete, gravel sub-base) as construction and demolition debris. Costs assume excavated material to 1 foot below grade would be transported off-site disposal as C&D debris at an assumed density of 1.75 tons per cubic-yard. Cost estimate includes disposal fee; transportation fuel surcharge; and environmental, transportation, and spotting fees. Cost estimate assumes that no material will be recycled or reused.
20. Solid waste transportation and disposal - non-haz landfill cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated soil as at a non-hazardous solid waste landfill. Cost assumes 80% of excavated soil plus stabilization mixture will be disposed of at a non-hazardous solid waste landfill at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees.

Table 9. Cost Estimate for Alternative 5, Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Assumptions (Cont.):

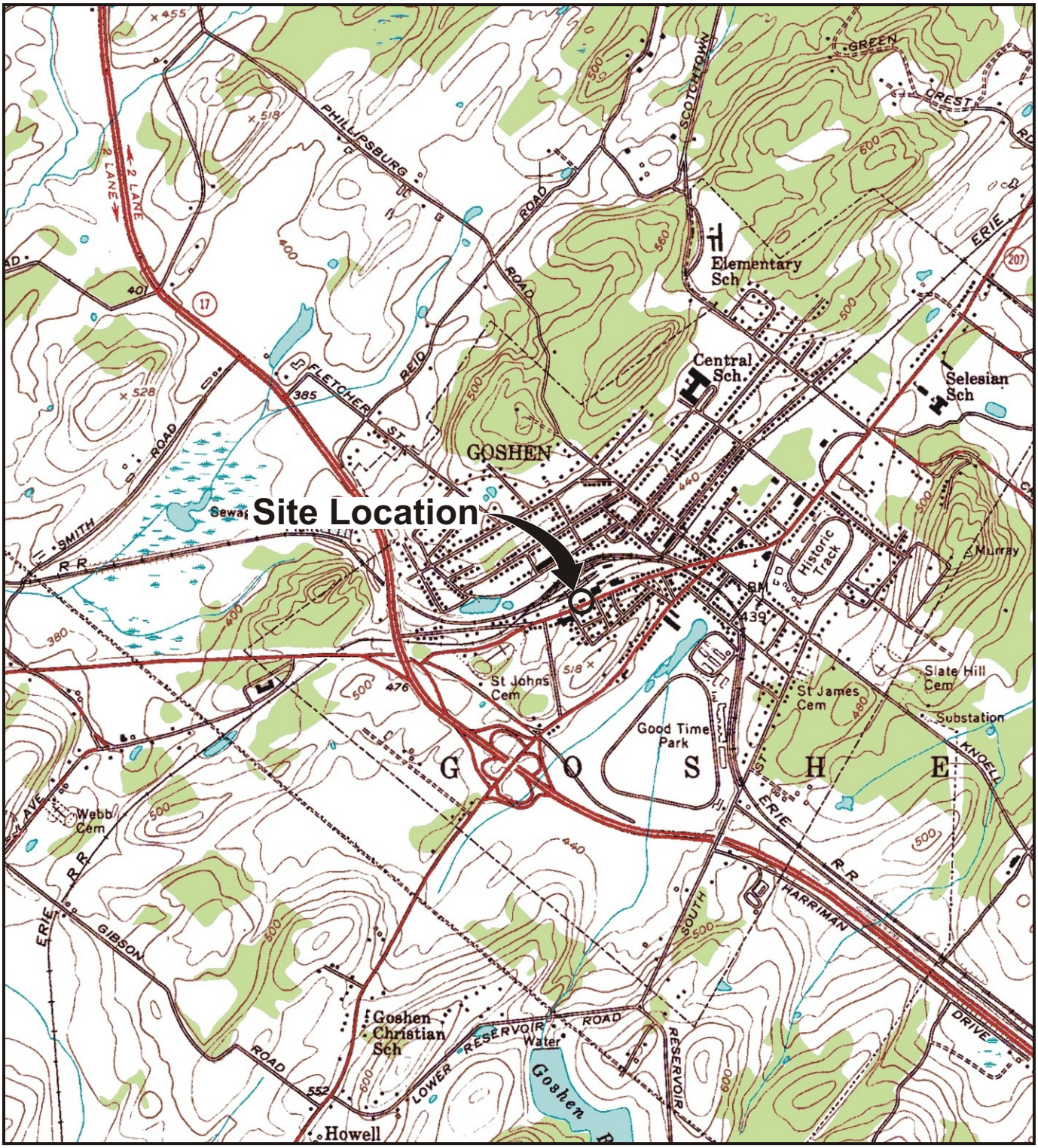
21. Solid waste transportation and disposal - LTTD cost estimate includes labor, equipment, and materials necessary to transport and thermally treat excavated soil exhibiting toxicity characteristic for benzene at a thermal treatment facility. Cost assumes 20% of excavated soil plus stabilization mixture will be treated/disposed of via LTTD at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees. Cost estimate assumes thermally treated soil does not require subsequent treatment or disposal.
22. Administration and engineering and construction management costs are based on an assumed 15% of the total capital costs, not including costs for off-site transportation and treatment/disposal of excavated material.
23. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require 3 days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.
24. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 12 groundwater monitoring wells and up to 4 QA/QC samples per sampling event.
25. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, and purge water generated/collected during annual groundwater monitoring activities.
26. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.
27. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2011.

Table 10. Comparative Analysis Summary, Feasibility Study Report, NYSEG - Goshen Former Manufactured Gas Plant Site - Goshen, New York

Criteria	Alternative 1 No Action	Alternative 2 NAPL Recovery, Groundwater Monitoring, and Institutional Controls	Alternative 3 MGP Source Material ISS, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls	Alternative 4 MGP Source Material Removal, UST Removal, NAPL Recovery, Groundwater Monitoring, and Institutional Controls	Alternative 5 Soil Removal to Unrestricted Use SCOs, UST Removal, and Short-Term Groundwater Monitoring
Remedial Action Objectives					
Soil RAO #1 *Prevent ingestion/direct contact*	No	Yes - Establish institutional controls	Yes - ISS accessible MGP source material	Yes - Excavate accessible MGP source material	Yes - Excavate majority of site soil
Soil RAO #2 *Prevent inhalation*	No	Yes - Establish institutional controls	Yes - ISS accessible MGP source material	Yes - Excavate accessible MGP source material	Yes - Excavate majority of site soil
Soil RAO #3 *Address sources to impacts to groundwater or surface water*	No	Partial - Recover mobile NAPL	Partial - ISS accessible MGP source material and recover inaccessible mobile NAPL	Partial - Excavate accessible MGP source material and recover inaccessible mobile NAPL	Yes - Excavate majority of site soil
Groundwater RAO #1 *Prevent ingestion*	No	Yes - Establish institutional controls	Yes - ISS accessible MGP source material/impacted groundwater and establish institutional controls	Yes - Excavate accessible MGP source material and establish institutional controls	Yes - Excavate majority of site soil
Groundwater RAO #2 *Prevent contact or inhalation*	No	Yes - Establish institutional controls	Yes - ISS accessible MGP source material and establish institutional controls	Yes - Excavate accessible MGP source material and establish institutional controls	Yes - Excavate majority of site soil
Groundwater RAO #3 *Restore groundwater quality*	No	No	Partial - Inaccessible MGP source material would remain	Partial - Inaccessible MGP source material would remain	Yes - Excavate majority of site soil
Groundwater RAO #4 *Address sources*	No	No	No - Inaccessible MGP source material would remain	No - Inaccessible MGP source material would remain	Yes - Excavate majority of site soil
Groundwater RAO #5 *Mitigate discharge to surface water*	No	Yes - Conduct groundwater monitoring	Yes - ISS accessible MGP source material, conduct groundwater monitoring, and recover mobile NAPL	Yes - Excavate accessible MGP source material, conduct groundwater monitoring, and recover mobile NAPL	Yes - Excavate majority of site soil
Short-Term Impacts					
Disruption to Community	None	None, 0 truck trips	Moderate, 130 truck trips	Moderate/Significant, 290 truck trips	Significant, 920 truck trips
Disruption to NYSEG Service Center	None	None	Temporary	Temporary	Permanent Relocation
Length of Disruption	None	Less than 1 month	5 months	7 months	14 months
Reduction of Toxicity, Mobility, and Volume through Treatment					
Total Soil Volume	None	None	3,400 cy (ISS/excavate)	3,400 cy (excavate)	9,200 cy (excavate)
MGP Source Material Addressed	None	None	850 cy (ISS)	850 cy (excavate)	1,400 cy (excavate)
Liquid Volume Addressed	None	Recovery of mobile NAPL, conduct groundwater monitoring to document natural degradation	Stabilize 170,000 gallons of groundwater during ISS, recovery of inaccessible mobile NAPL, conduct groundwater monitoring to document natural degradation	Remove 170,000 gallons of groundwater during excavation, recovery of inaccessible mobile NAPL, conduct groundwater monitoring to document natural degradation	Remove 410,00 gallons of groundwater and NAPL during excavation
Cost					
Capital	$0	$200,000	$2,400,000	$4,100,000	$9,500,000
O&M	$0	$1,000,000	$1,000,000	$1,000,000	$100,000
Total	$0	$1,200,000	$3,400,000	$5,100,000	$9,600,000

ARCADIS

Figures



REFERENCE: BASE MAP USGS 7.5 MIN. QUAD., GOSHEN, NY, 1957.

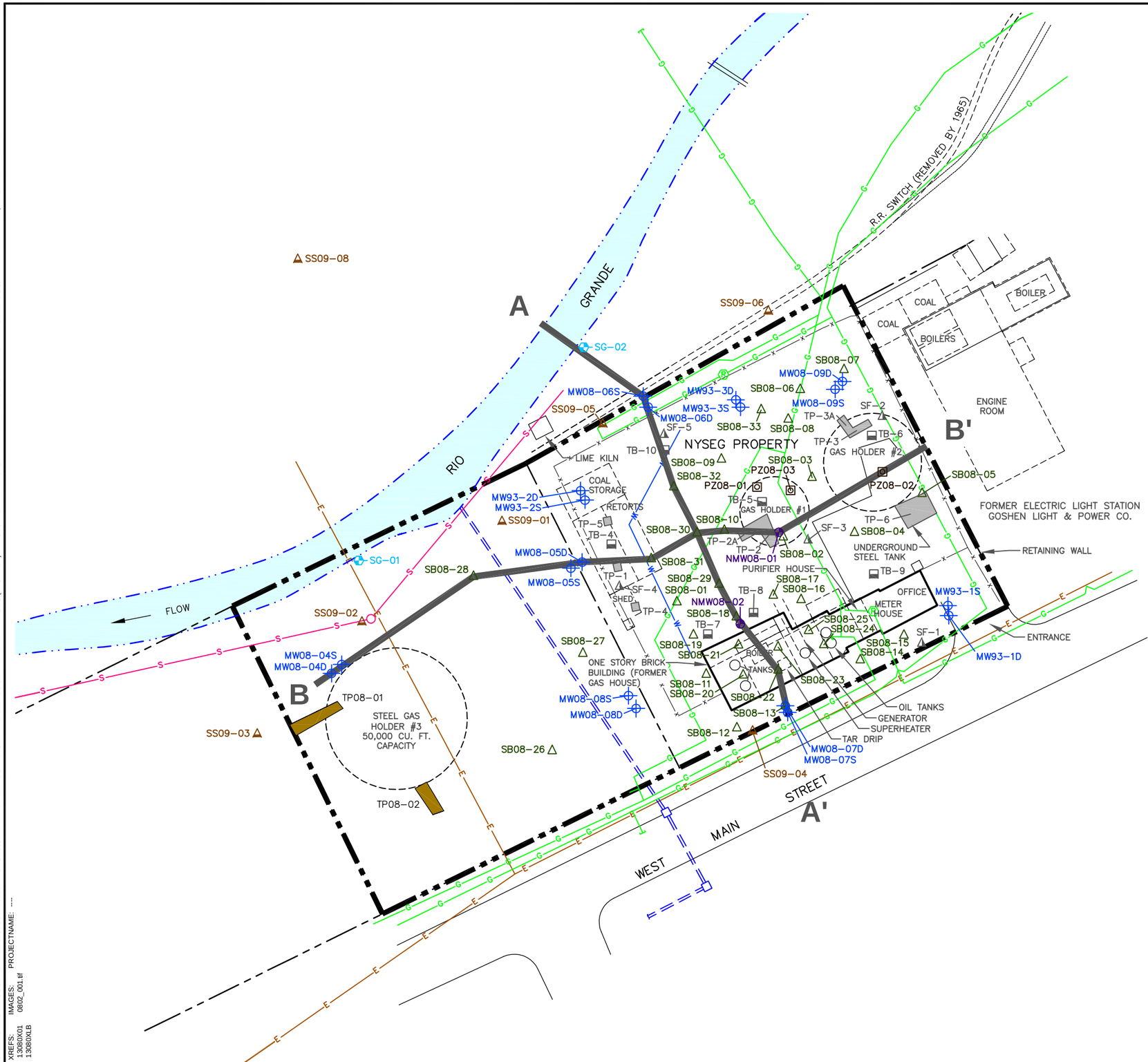
NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

SITE LOCATION MAP

ARCADIS

FIGURE
1

09/09/2010 SYRACUSE, NY-ENV/CAD-DJHOWES
B0013080/0001/00003/CDR/13080N01.CDR



LEGEND:

- MW08-05D — MONITORING WELL LOCATION
- NMW08-01 — NAPL MONITORING WELL LOCATION
- SB08-04 — SOIL BORING LOCATION
- PZ08-02 — PIEZOMETER LOCATION
- SG-01 — STAFF GAUGE LOCATION
- SS09-06 — SURFACE SOIL SAMPLING LOCATION
- TP08-01 — TEST PIT
- TB-9 — PREVIOUS TEST BORING LOCATION
- TP-6 — PREVIOUS TEST PIT LOCATION
- SF-3 — PREVIOUS SURFACE SOIL SAMPLE LOCATION
- FORMER STRUCTURE (1889-1945)
- NYSEG PROPERTY LINE (SITE)
- G — GAS LINE
- W — WATER LINE
- S — SEWER LINE
- E — ELECTRIC LINE
- STORM LINE
- PROPERTY LINE
- x — x — x — FENCE LINE
- A — A' LINE OF CROSS SECTION

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'

GRAPHIC SCALE

NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

SITE MAP WITH CROSS SECTION LOCATIONS

ARCADIS

FIGURE 2

CITY:SYRACUSE, N.Y. DIV/GROUP:ENVCAD-141 DB:AMS, R.ALLEN LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:ON=*;OFF=*REF* G:\ENVCAD\SYRACUSE\ACT\B0013080001000003DWG\FS13080V04.DWG LAYOUT: 2 SAVED: 9/9/2010 3:50 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/9/2010 3:53 PM BY: KRAHMER, ERIC
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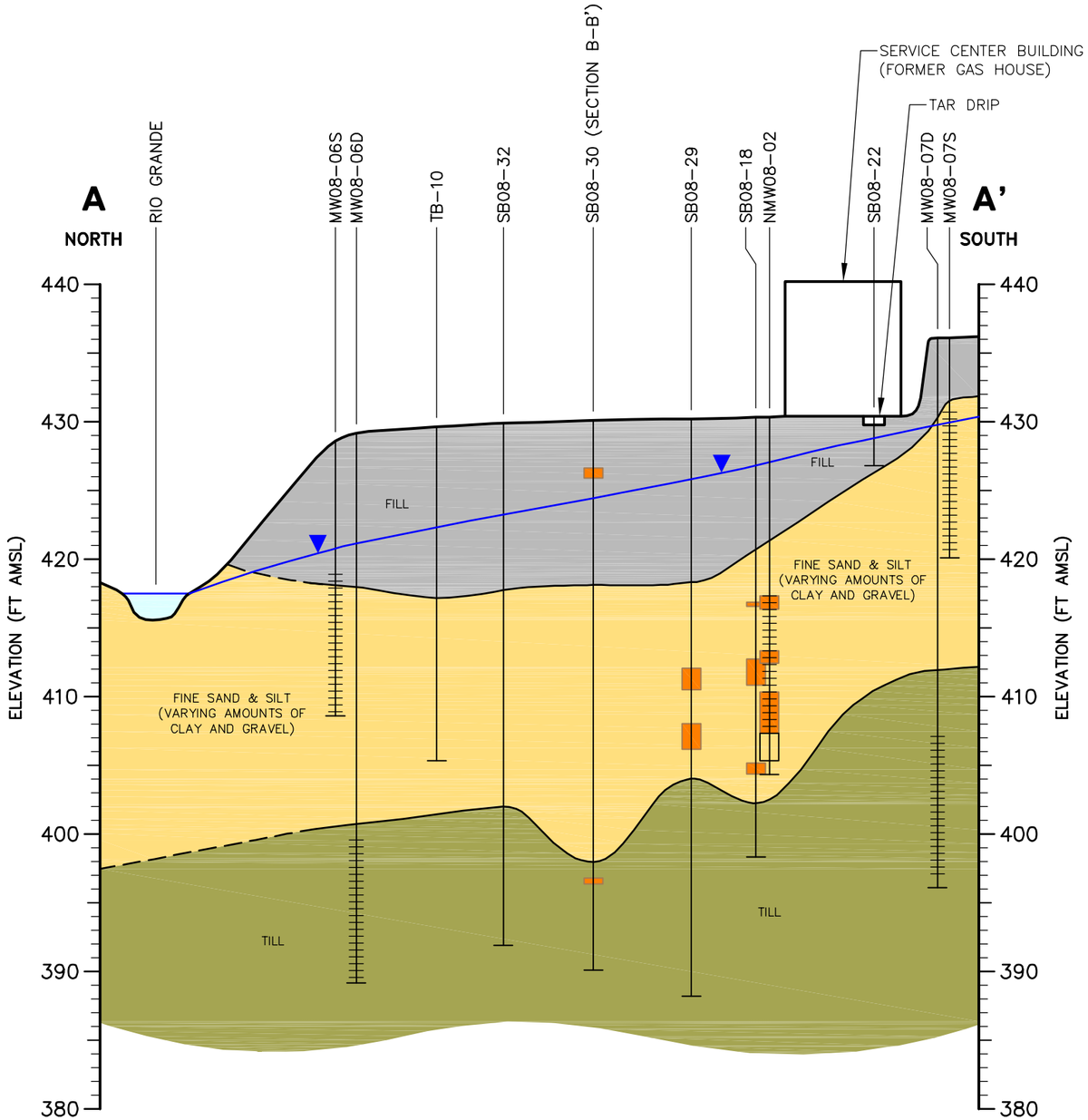


MW08-04D

LEGEND:

- WELL OR BORING ID
- GROUND SURFACE
- WATER TABLE (APPROXIMATED)
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
- SCREEN
- SUMP
- BOTTOM OF BORING
- FILL
- FINE SAND AND SILT
- TILL
- NAPL (TRACE TO HEAVILY IMPACTED)

NOTE:

ELEVATIONS REFERENCED TO NAVD 1988.

0 10' 20'
VERTICAL SCALE

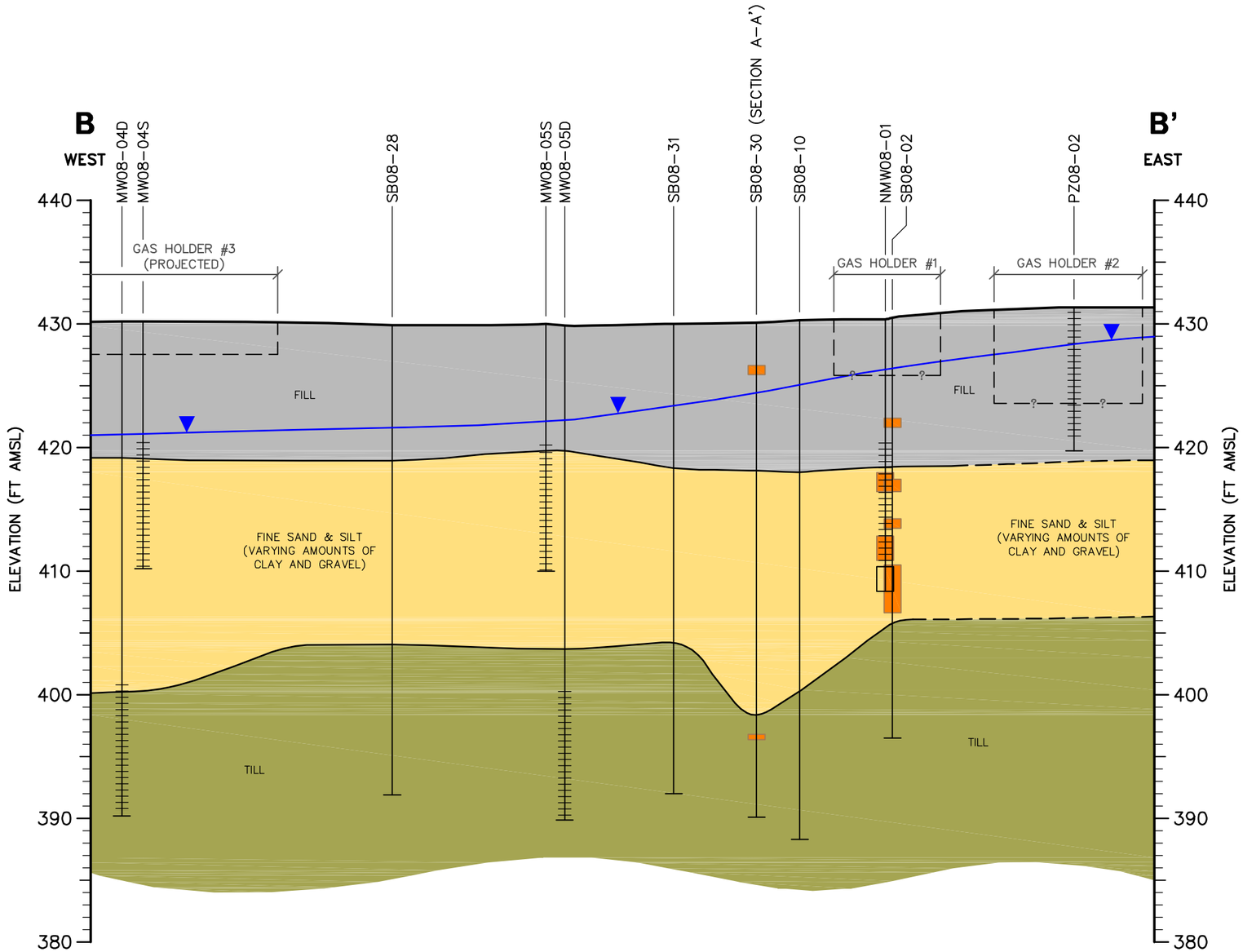
0 30' 60'
HORIZONTAL SCALE

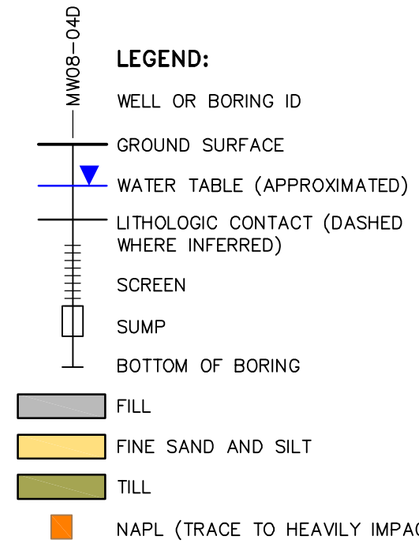
NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

CROSS SECTION A-A'

ARCADIS

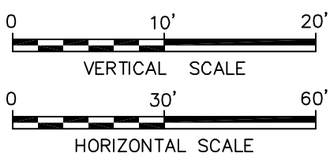
FIGURE 3





NOTE:

ELEVATIONS REFERENCED TO NAVD 1988.



NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

CROSS SECTION B-B'

ARCADIS

FIGURE
4

CITY:SYRACUSE, N.Y. DIVGROUP:ENVCAD-141 DB:AMS, R.ALLEN LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:ON=*;OFF=*REF*
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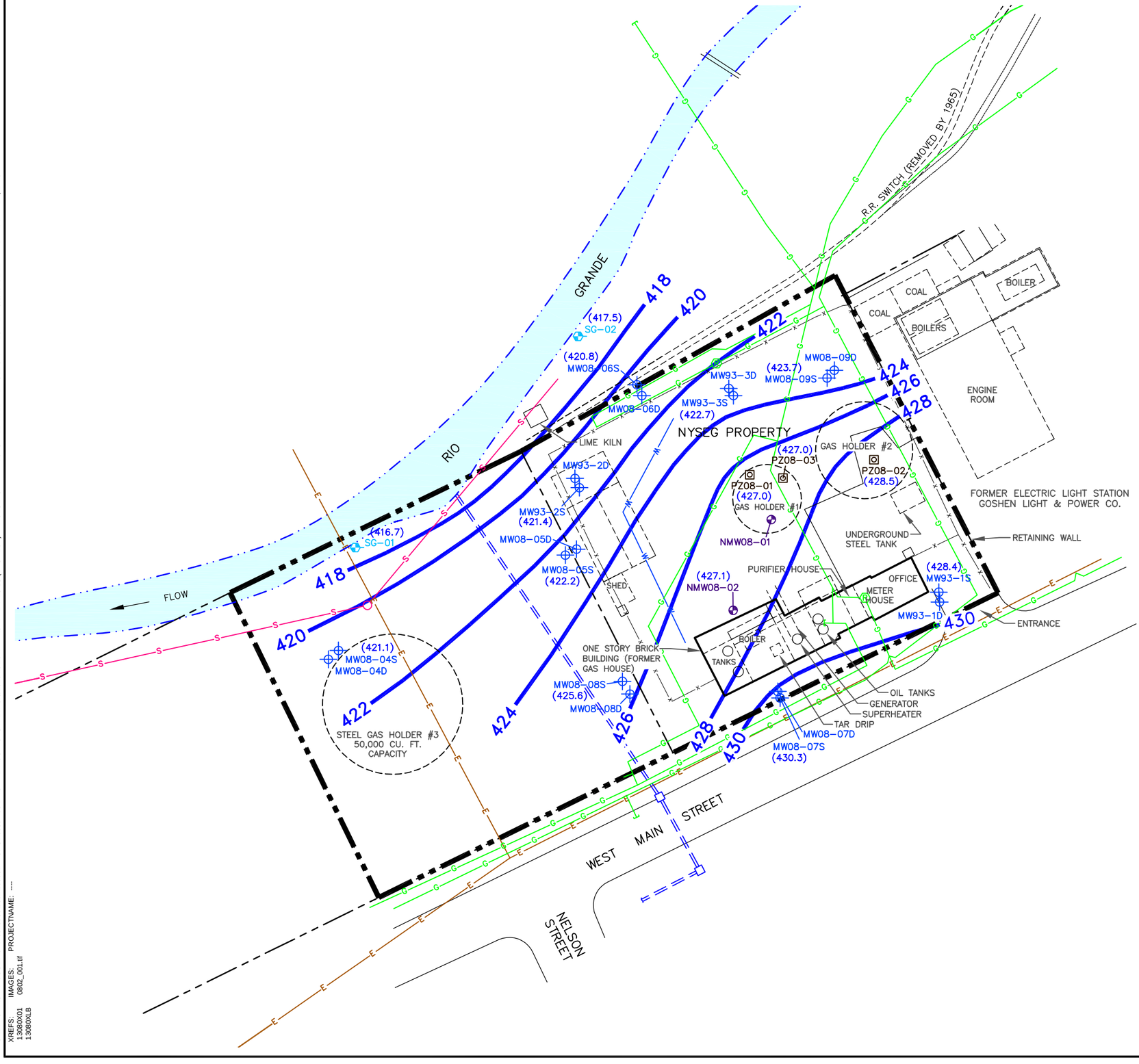

LEGEND:

MW08-05D	MONITORING WELL LOCATION
NMW08-01	NAPL MONITORING WELL LOCATION
PZ08-02	PIEZOMETER LOCATION
SG-01	STAFF GAUGE LOCATION
(421.4)	WATER TABLE ELEVATION
422	WATER TABLE ELEVATION CONTOUR
	FORMER STRUCTURE (1889–1945)
	NYSEG PROPERTY LINE (SITE)
G	GAS LINE
W	WATER LINE
S	SEWER LINE
E	ELECTRIC LINE
	STORM LINE
	PROPERTY LINE
x x x	FENCE LINE

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'

GRAPHIC SCALE

NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

WATER TABLE MARCH 30, 2009

ARCADIS

FIGURE 5

CITY:SYRACUSE, N.Y. DIV/GROUP:ENVCAD-141 DB:AMS, R.ALLEN LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:ON=*;OFF=*REF*
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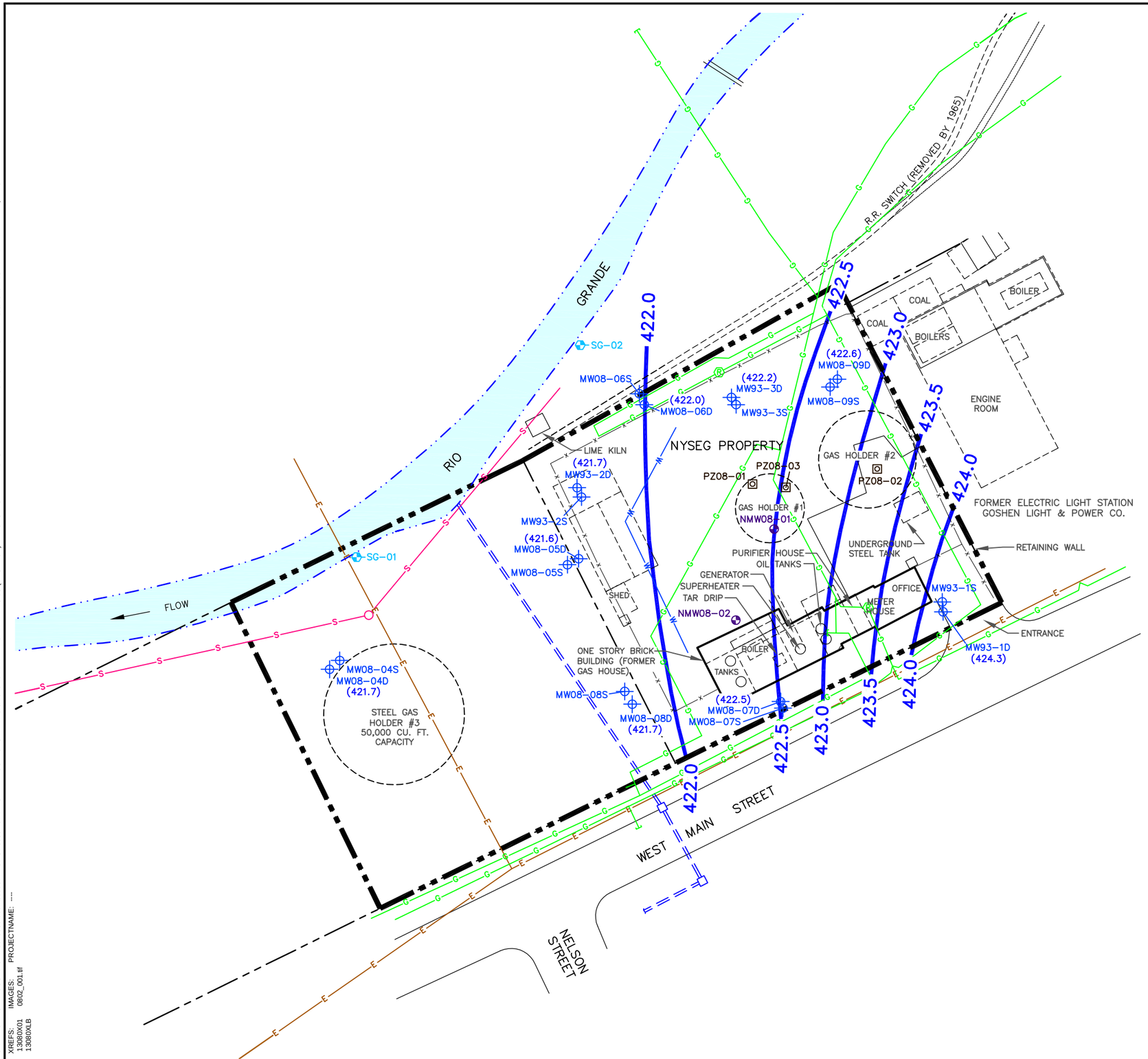


LEGEND:

- MW08-05D — MONITORING WELL LOCATION
- NMW08-01 — NAPL MONITORING WELL LOCATION
- PZ08-02 — PIEZOMETER LOCATION
- SG-01 — STAFF GAUGE LOCATION
- (422.5) — POTENTIOMETRIC SURFACE ELEVATION
- 422.5 — POTENTIOMETRIC SURFACE CONTOURS
- FORMER STRUCTURE (1889–1945)
- NYSEG PROPERTY LINE (SITE)
- G — GAS LINE
- W — WATER LINE
- S — SEWER LINE
- E — ELECTRIC LINE
- STORM LINE
- PROPERTY LINE
- x — x — x — FENCE LINE

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'

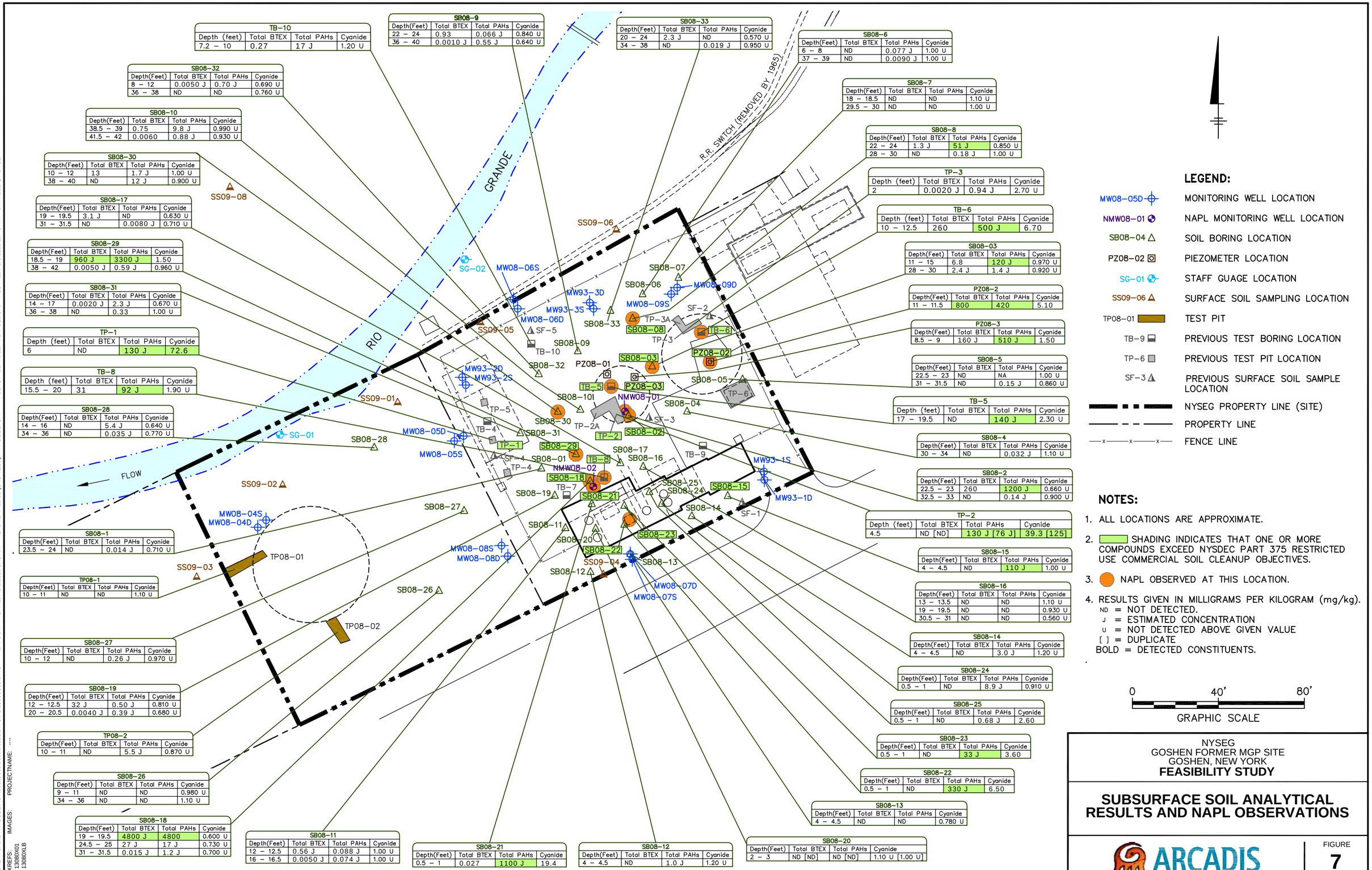
GRAPHIC SCALE

NYSEG
FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

DEEP OVERBURDEN POTENTIOMETRIC SURFACE MARCH 30, 2009

ARCADIS

FIGURE 6



TB-10

Depth (feet)	Total BTEX	Total PAHs	Cyanide
7.2 – 10	0.27	17 J	1.20 U

SB08-9

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
22 – 24	0.93	0.066 J	0.840 U
36 – 40	0.0010 J	0.55 J	0.640 U

SB08-33

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
20 – 24	2.3 J	ND	0.570 U
34 – 38	ND	0.019 J	0.950 U

SB08-6

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
6 – 8	ND	0.077 J	1.00 U
37 – 39	ND	0.0090 J	1.00 U

SB08-32

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
8 – 12	0.0050 J	0.70 J	0.690 U
36 – 38	ND	ND	0.760 U

SB08-7

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
18 – 18.5	ND	ND	1.10 U
29.5 – 30	ND	ND	1.00 U

SB08-10

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
38.5 – 39	0.75	9.8 J	0.990 U
41.5 – 42	0.0060	0.88 J	0.930 U

SB08-8

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
22 – 24	1.3 J	51 J	0.850 U
28 – 30	ND	0.18 J	1.00 U

SB08-30

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
10 – 12	13	1.7 J	1.00 U
38 – 40	ND	12 J	0.900 U

TP-3

Depth (feet)	Total BTEX	Total PAHs	Cyanide
2	0.0020 J	0.94 J	2.70 U

SB08-17

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
19 – 19.5	3.1 J	ND	0.630 U
31 – 31.5	ND	0.0080 J	0.710 U

TB-6

Depth (feet)	Total BTEX	Total PAHs	Cyanide
10 – 12.5	260	500 J	6.70

SB08-29

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
18.5 – 19	960 J	3300 J	1.50
38 – 42	0.0050 J	0.59 J	0.960 U

SB08-03

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
11 – 15	6.8	120 J	0.970 U
28 – 30	2.4 J	1.4 J	0.920 U

SB08-31

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
14 – 17	0.0020 J	2.3 J	0.670 U
36 – 38	ND	0.33	1.00 U

PZ08-2

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
11 – 11.5	800	420	5.10

TP-1

Depth (feet)	Total BTEX	Total PAHs	Cyanide
6	ND	130 J	72.6

PZ08-3

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
8.5 – 9	160 J	510 J	1.50

TB-8

Depth (feet)	Total BTEX	Total PAHs	Cyanide
15.5 – 20	31	92 J	1.90 U

SB08-5

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
22.5 – 23	ND	NA	1.00 U
31 – 31.5	ND	0.15 J	0.860 U

TB-5

Depth (feet)	Total BTEX	Total PAHs	Cyanide
17 – 19.5	ND	140 J	2.30 U

SB08-28

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
14 – 16	ND	5.4 J	0.640 U
34 – 36	ND	0.035 J	0.770 U

SB08-4

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
30 – 34	ND	0.032 J	1.10 U

SB08-2

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
22.5 – 23	260	1200 J	0.660 U
32.5 – 33	ND	0.14 J	0.900 U

SB08-1

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
23.5 – 24	ND	0.014 J	0.710 U

TP-2

Depth (feet)	Total BTEX	Total PAHs	Cyanide
4.5	ND [ND]	130 J [76 J]	39.3 [125]

SB08-15

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
4 – 4.5	ND	110 J	1.00 U

TP08-1

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
10 – 11	ND	ND	1.10 U

SB08-16

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
13 – 13.5	ND	ND	1.10 U
19 – 19.5	ND	ND	0.930 U
30.5 – 31	ND	ND	0.560 U

SB08-14

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
4 – 4.5	ND	3.0 J	1.20 U

SB08-27

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
10 – 12	ND	0.26 J	0.970 U

SB08-24

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
0.5 – 1	ND	8.9 J	0.910 U

SB08-19

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
12 – 12.5	32 J	0.50 J	0.810 U
20 – 20.5	0.0040 J	0.39 J	0.680 U

SB08-25

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
0.5 – 1	ND	0.68 J	2.60

TP08-2

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
10 – 11	ND	5.5 J	0.870 U

SB08-23

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
0.5 – 1	ND	33 J	3.60

SB08-26

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
9 – 11	ND	ND	0.980 U
34 – 36	ND	ND	1.10 U

SB08-22

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
0.5 – 1	ND	330 J	6.50

SB08-13

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
4 – 4.5	ND	ND	0.780 U

SB08-18

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
19 – 19.5	4800 J	4800	0.600 U
24.5 – 25	27 J	17 J	0.730 U
31 – 31.5	0.015 J	1.2 J	0.700 U

SB08-11

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
12 – 12.5	0.56 J	0.088 J	1.00 U
16 – 16.5	0.0050 J	0.074 J	1.00 U

SB08-21

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
0.5 – 1	0.027	1100 J	19.4

SB08-12

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
4 – 4.5	ND	1.0 J	1.20 U

SB08-20

Depth(Feet)	Total BTEX	Total PAHs	Cyanide
2 – 3	ND [ND]	ND [ND]	1.10 U [1.00 U]

LEGEND:

- MW08-05D — MONITORING WELL LOCATION
- NMW08-01 — NAPL MONITORING WELL LOCATION
- SB08-04 — SOIL BORING LOCATION
- PZ08-02 — PIEZOMETER LOCATION
- SG-01 — STAFF GUAGE LOCATION
- SS09-06 — SURFACE SOIL SAMPLING LOCATION
- TP08-01 — TEST PIT
- TB-9 — PREVIOUS TEST BORING LOCATION
- TP-6 — PREVIOUS TEST PIT LOCATION
- SF-3 — PREVIOUS SURFACE SOIL SAMPLE LOCATION
- NYSEG PROPERTY LINE (SITE)
- PROPERTY LINE
- FENCE LINE

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. SHADING INDICATES THAT ONE OR MORE COMPOUNDS EXCEED NYSDEC PART 375 RESTRICTED USE COMMERCIAL SOIL CLEANUP OBJECTIVES.
3. NAPL OBSERVED AT THIS LOCATION.
4. RESULTS GIVEN IN MILLIGRAMS PER KILOGRAM (mg/kg).
   - ND = NOT DETECTED.
   - J = ESTIMATED CONCENTRATION
   - U = NOT DETECTED ABOVE GIVEN VALUE
   - [ ] = DUPLICATE
   - BOLD = DETECTED CONSTITUENTS.

0 40’ 80’

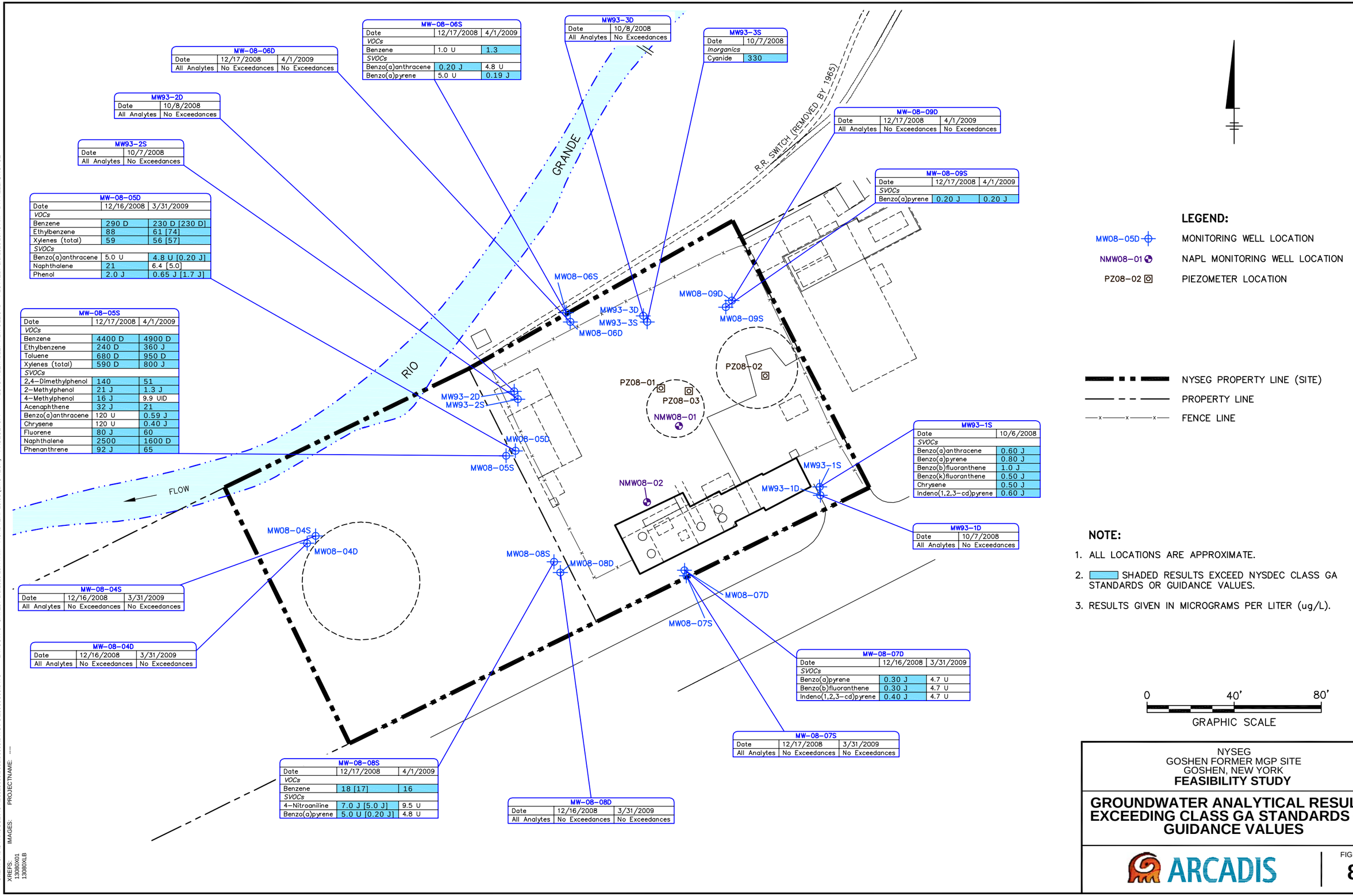
GRAPHIC SCALE

NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

SUBSURFACE SOIL ANALYTICAL RESULTS AND NAPL OBSERVATIONS

ARCADIS

FIGURE 7



LEGEND:

- MW08-05D — MONITORING WELL LOCATION
- NMW08-01 — NAPL MONITORING WELL LOCATION
- PZ08-02 — PIEZOMETER LOCATION
- NYSEG PROPERTY LINE (SITE)
- PROPERTY LINE
- FENCE LINE

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. SHADED RESULTS EXCEED NYSDEC CLASS GA STANDARDS OR GUIDANCE VALUES.
3. RESULTS GIVEN IN MICROGRAMS PER LITER (ug/L).

0 40' 80'

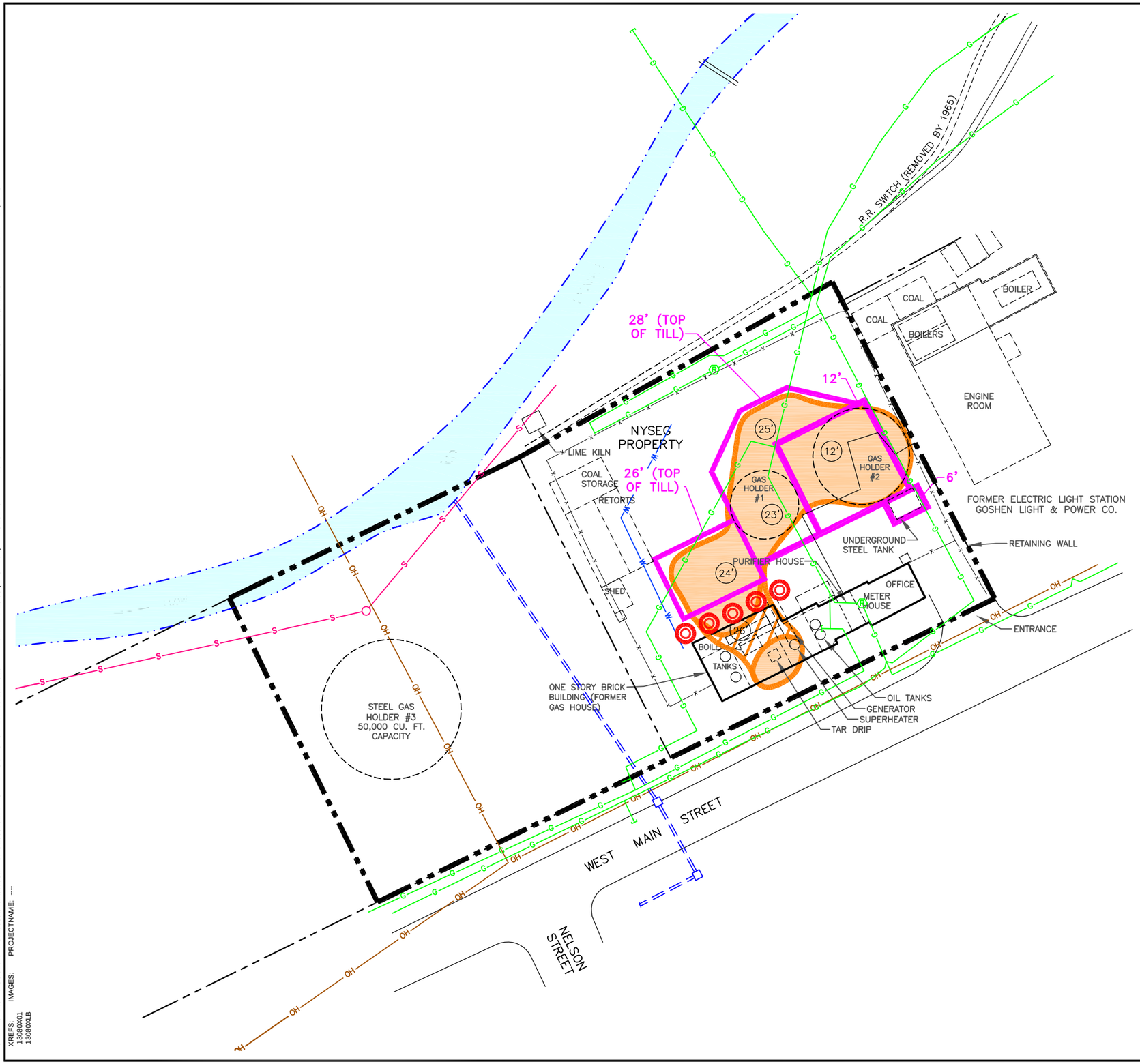
GRAPHIC SCALE

NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

GROUNDWATER ANALYTICAL RESULTS EXCEEDING CLASS GA STANDARDS OR GUIDANCE VALUES

ARCADIS

FIGURE 8



LEGEND:

- FORMER STRUCTURE (1889–1945)
- NYSEG PROPERTY LINE (SITE)
- GAS LINE
- WATER LINE
- SEWER LINE
- OVERHEAD ELECTRIC LINE
- STORM LINE
- PROPERTY LINE
- FENCE LINE
- APPROXIMATE EXTENT OF SOIL CONTAINING MGP–RELATED SOURCE MATERIAL (HATCHED WHERE INFERRED)
- (12') APPROXIMATE MAXIMUM DEPTH TO SOURCE MATERIAL
- APPROXIMATE EXTENT OF EXCAVATION OR ISS TREATMENT
- 12' APPROXIMATE DEPTH OF EXCAVATION OR ISS TREATMENT
- PROPOSED NAPL COLLECTION WELL

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'

GRAPHIC SCALE

NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

ALTERNATIVES 3 & 4

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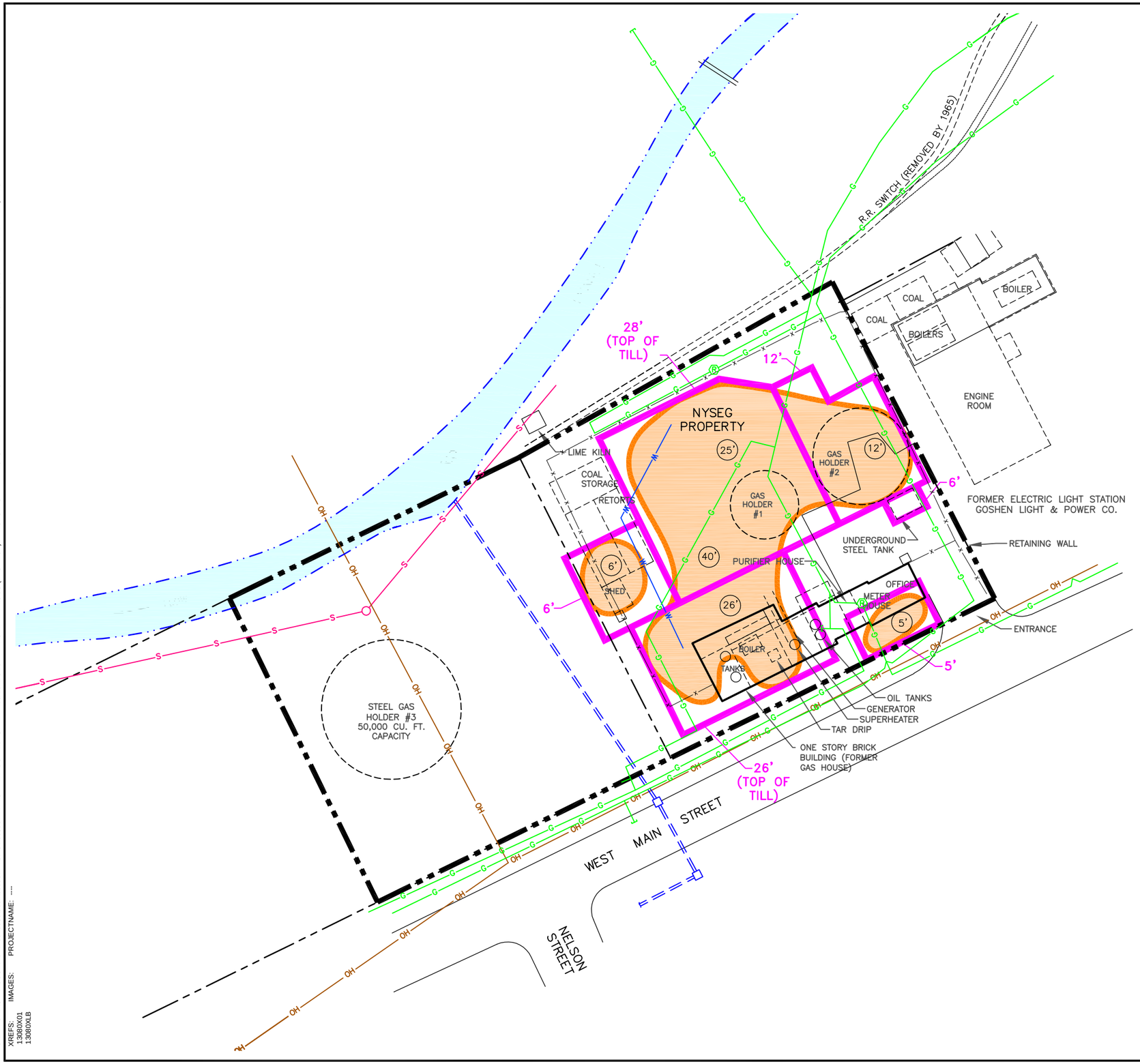
FIGURE
9



LEGEND:

- FORMER STRUCTURE (1889–1945)
- NYSEG PROPERTY LINE (SITE)
- GAS LINE
- WATER LINE
- SEWER LINE
- OVERHEAD ELECTRIC LINE
- STORM LINE
- PROPERTY LINE
- FENCE LINE
- APPROXIMATE EXTENT OF SOIL CONTAINING MGP–RELATED COCs AT CONCENTRATIONS GREATER THAN NYSDEC 6NYCRR PART 375–6 UNRESTRICTED USE SOIL CLEANUP OBJECTIVES
- (12') APPROXIMATE DEPTH TO IMPACT
- APPROXIMATE EXTENT OF EXCAVATION
- 12' APPROXIMATE DEPTH OF EXCAVATION

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'

GRAPHIC SCALE

NYSEG
GOSHEN FORMER MGP SITE
GOSHEN, NEW YORK
FEASIBILITY STUDY

ALTERNATIVE 5

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FIGURE
10

Appendix A

Technical Memorandum –
MODFLOW Groundwater Model

ARCADIS U.S., Inc.
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Tel 410.987.0032
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MEMO

To:
Scott Powlin

Copies:

From:
Khandaker Ashfaque
Michael Kladias

Date:
January 20, 2011

ARCADIS Project No.:
B0013080.0001.00003

Subject:
Groundwater Flow Model Development and Remedial Evaluation
NYSEG's Goshen Former MGP Site
Goshen, New York

This technical memorandum summarizes the development of a groundwater flow model for NYSEG's former MGP site located in Goshen, New York (site). The purpose of the groundwater flow model is to simulate the groundwater flow system at the site, and to evaluate potential changes to groundwater flow patterns, hydraulic heads, and hydraulic gradients due to implementation of Alternative 3 (In-Situ Soil Stabilization [ISS]) of the Feasibility Study (ARCADIS, 2011). Of particular interest is the determination of whether a lower permeability ISS monolith would cause water levels to rise enough to produce potential flooding conditions in the basement of the service center building. This memo consists of the following sections: a brief review of the conceptual site model, construction of the groundwater flow model, calibration of the groundwater flow model to measured site conditions, and simulation results from remedial scenario evaluation.

Conceptual Site Model (CSM)

A conceptual groundwater flow model is a narrative description of the principle components of a groundwater flow system and is developed from regional, local, and site-specific data. The primary components of a groundwater flow system include: (1) aerial extent, configuration, and type of aquifers and aquitards; (2) hydraulic properties of aquifers and aquitards; (3) natural groundwater recharge and discharge zones; (4) anthropogenic influence on groundwater (sources and sinks); and, (5) aerial and vertical distribution of groundwater hydraulic head potential. These aquifer system components serve as the framework for the construction of a numerical groundwater flow model. The following sections describe the site setting, site geology and hydrogeology based on literature review and ARCADIS investigations.

Site Setting

As outlined in the Remedial Investigation Report (ARCADIS, 2010), the approximately ¾-acre site is located in a mixed residential/commercial neighborhood on West Main Street in the Village of Goshen, in

Orange County, New York (**Figure 1**). The site (containing the limits of the known former MGP operations) is owned by NYSEG and presently serves as a natural gas service center. The site is bounded by Rio Grande Creek at the northwest corner, by property belonging to the Village of Goshen to the north and northeast, by private commercial property to the east and west, and by West Main Street to the south (**Figure 2**).

Site Geology/Hydrogeology

The land surface at the site slopes gently to the north across most of the site, from West Main Street to the more steeply sloping south bank of Rio Grande Creek. The elevation of the site ranges between 430 and 437 feet above Mean Sea Level (MSL).

Based on site investigations (ARCADIS 2010), USGS report (Bugliosi et al, 1998) and regional information, three major hydrogeologic units were identified (**Figures 3 and 4**):

- Fill and an assortment of man-made structures, originating from the site's industrial history
- Post-glacial alluvial sand and silt (with varying amounts of sand and gravel), probably deposited in an abandoned river channel
- Dense basal till deposited by the Pleistocene glacier(s)

The fill unit consists of the saturated fill that overlies the alluvial sand and silt unit. The fill is composed of a wide variety of materials including silt, sand, gravel, ash, cinders, slag and demolition debris from the former MGP structures that occupied the site. The thickness of the unit usually ranges from 10 to 12 feet across the site. The majority of water moving through this unit is likely derived from upgradient sources south and southeast of the site. Infiltrating precipitation also contributes a small fraction of groundwater in this unit.

The alluvial sand and silt unit consists of the alluvial deposit of primarily sand and silt that is gray in color. Some intervals within the unit are nearly all coarse sand and gravel, while others have significant percentages of silt and clay. The alluvial unit is found across the entire site, with a relatively uniform thickness between approximately 15 to 19 feet. In general, the sand and silt unit is poorly permeable, with hydraulic conductivity ranging from 0.04 to 0.32 ft/day as estimated from specific capacity and slug tests (ARCADIS, 2010).

The composition of till is somewhat variable across the site, though the unit is generally very dense, with a matrix of sand and silt and varied amounts of gravel and clay. Site boring logs extending down to till indicate that the top 10 to 12 ft of till contains significant amount of coarse sand and medium to coarse gravel. The till becomes quite dense and compact with increased depth. Hydraulic conductivity estimates

for the till unit have been found to vary from approximately 0.01 to 2.6 ft/day based on specific-capacity tests (ARCADIS, 2010).

Recent groundwater monitoring results from March 2009 show that groundwater elevations at the site range approximately from 426 to 428 ft MSL in the fill unit, 421 to 427 ft MSL in the sand-silt unit, and 421 to 426 ft MSL in the till. The general direction of shallow groundwater flow at the site is northwest, toward Rio Grande Creek, at a fairly steep gradient averaging approximately 0.09 ft/ft.

Regionally, net recharge to the shallow zone is approximately 10 inches per year (in/y) (Bugliosi et al, 1998).

Groundwater Flow Model Development

Groundwater Flow Model Construction

The primary phases in the development of a numerical groundwater flow model include the construction of a finite-difference grid for the model area, specification of model structure, assignment of boundary conditions, specification of hydraulic parameter values and zones, and selection of appropriate water-level measurements for calibration of the model. These elements form the conceptual-mathematical site model, which serves as the basis for the construction and subsequent calibration of the numerical model to observed groundwater flow conditions at the site.

Based on recent site-specific data, relevant literature and regional information, the groundwater flow model was developed in phases as described in the following sections.

Code Selection and Description

For the construction and calibration of the numerical groundwater flow model for the site, ARCADIS selected the simulation program MODFLOW, a publicly-available groundwater flow simulation program developed by the U.S. Geological Survey (USGS) (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. In addition, ARCADIS has developed utilities for use with MODFLOW to ease in the construction and calibration of groundwater models.

MODFLOW can simulate transient or steady-state saturated groundwater flow in one, two, or three dimensions and offers a variety of boundary conditions including specified head, aerial recharge, injection or extraction wells, evapotranspiration, horizontal flow barriers (HFB), drains, and rivers or streams. Aquifers simulated by MODFLOW can be confined or unconfined, or convertible between confined and unconfined conditions. For the site, which consists of a heterogeneous geologic system with variable unit thicknesses and boundary conditions, MODFLOW's three-dimensional capability and boundary condition versatility are essential for the proper simulation of groundwater flow conditions.

Model Discretization

The finite-difference technique employed in MODFLOW to simulate hydraulic head distributions in multi-aquifer systems requires aerial and vertical discretization, or subdivision of the continuous aquifer system into a set of discrete blocks that form a three-dimensional model grid. In the block-centered finite-difference formulation used in these codes, the center of each grid block corresponds to a computational point or node. When MODFLOW solves the set of linear algebraic finite-difference equations for the complete set of blocks, the solution yields values of hydraulic head at each node (or three-dimensional block) in the three-dimensional grid.

Water levels computed for each block represent an average water level over the volume of the block. Thus, adequate discretization (i.e., a sufficiently fine grid) is required to resolve features of interest, and yet not be computationally burdensome. MODFLOW allows the use of variable grid spacing such that a model may have a finer grid in areas of interest where greater accuracy is required and a coarser grid in areas requiring less detail.

Figures 5 and 6 show the extents of the three-dimensional numerical model for the site. The boundaries of the model grid are specified to coincide with natural hydrogeologic boundaries where possible, while elsewhere the boundaries are set at a significant distance from the site to minimize the influence of model boundaries on simulation results at the site. Accordingly, the model area was bounded by natural tributaries and bedrock outcrop on the north-west and south-east, bedrock outcrop on the south-west and an inferred regional head to the north-east. The finite-difference grid is composed of 293 columns, 224 rows, and 4 layers for a total of approximately 262,528 nodes (**Figure 7**). The model grid was refined in the vicinity of the site to improve the accuracy of the groundwater flow analyses. The grid spacing ranges from 10 ft in the vicinity of the site to 100 ft near the model boundaries.

The ground surface in the model was delineated from on-site survey and USGS digital elevation map (DEM) data. The elevation and segregation of the model layers were delineated from available on-site as well as regional boring logs, cross-sections and relevant literature. Four model layers were defined in the model in such a way as to provide an accurate vertical profile of the site as well as regional hydrogeology. However, regional information suggests the fill area only exists at the site, and therefore model layer 1 represents the fill area at the site. Regional data further indicate that the Rio Grande Creek is probably located in a transition zone between the sand-silt and the till units. Accordingly, model layers 1 and 2 represent the sand-silt unit on the south and till unit on the north of Rio Grande Creek, respectively. Model layer 3 represents the more conductive upper till zone, whereas, model layer 4 represents the highly dense, low permeability till zone.

Boundary Conditions

Boundary conditions must be imposed to define the spatial boundaries of the model on the top, bottom, and all sides of the model grid. In addition to these boundary conditions, sources and sinks of groundwater such as wells, drains, and rivers can be included within the model's external boundaries. A boundary condition can represent different types of physical boundaries, depending on the rules that govern groundwater flow across the boundary. This model includes five types of boundary conditions: constant head (head dependent flux), no-flow, river (head dependent flow), drains (head dependent flow), and recharge (constant flux). The location and type of boundary conditions at various model layers are shown in **Figures 5 and 6**.

The north-eastern boundary of the model has been represented using constant head cells with an assigned head of 430 feet MSL. These constant head boundaries represent the regional flux into the model domain. The initial stage elevations for the constant head cells were based on USGS regional information (Bugliosi et al, 1998) and then slightly adjusted during the calibration process. These constant head cells were located in all model layers. The active model domain covers an aerial extent of about 10,000 ft by 6,000 ft. Areas outside the active model domain have been defined as no flow cells in all 4 model layers.

River cells allow for the specification of a surface-water stage, a bottom elevation and a conductance term. Water can enter or exit the river cells based on the simulated aquifer heads. River cells were used to represent tributaries and channels to the north-west and south-east of the model domain. Variable elevations of both surface water bodies were derived from the USGS topographic maps. The conductance terms for the river cells were calculated from the grid-cell dimensions and estimates of the hydraulic conductivity of the aquifer material (estimated conductance values range from 1,000 to 10,000 feet squared per day).

Drain cells allow for the specification of a surface-water stage and a conductance term. If the simulated water level in the aquifer is below the drain elevation, the drain becomes inactive (dry). However, if the simulated water level in the aquifer rises above the specified drain elevation, groundwater flows from the aquifer and into the drain cell. Drain cells were used to represent the Rio Grande Creek extending from south-east to north-west of the model. The stage elevations of the drain cells were based on USGS topographic map. Similar to the river cells, the conductance terms for the drain cells were calculated from the grid-cell dimensions and estimates of the hydraulic conductivity of the aquifer material (estimated conductance values range from 750 to 2,500 feet squared per day).

Recharge flux was applied uniformly to the uppermost layer of the model. Annual recharge from precipitation was estimated during calibration to be approximately 2.35 inches per year (in/year).

Hydraulic Parameters

In constructing the model for the site, representative values for model parameters were selected based on regional information and site-specific data. These model parameters included aquifer recharge, and the horizontal and vertical hydraulic conductivity of various hydrogeologic units. The model was constructed with a uniform hydraulic conductivity and parameter values in each layer based on site slug test and specific capacity data as well as regional information. During the calibration of the model, various parameter values were adjusted within reason to minimize the difference between observed and simulated groundwater elevations.

The estimated conductivity zones and values for each model layer are presented in **Figures 8 to 9**.

Calibration Targets

Calibration targets are a set of field measurements, typically groundwater elevations, used to test the ability of a model to reproduce observed conditions within a groundwater flow system. For the calibration of a steady-state (time-invariant) model, the goal in selecting calibration targets is to define a set of water-level measurements that represent the average elevation of the water table or potentiometric surface at locations throughout the site.

Table 1 presents the monitoring wells and water-level elevations from the recent groundwater monitoring event that occurred in March 2009. These 23 water level elevations were utilized as calibration targets. There are 3 calibration targets in Model Layer 1, 11 in Model Layer 2, and 9 in Model Layer 3.

Groundwater Flow Model Calibration

Calibration of a groundwater flow model refers to the process of adjusting model parameters to obtain a reasonable match between observed and simulated water levels. In general, model calibration is an iterative procedure that involves adjustment of hydraulic properties or boundary conditions to achieve the best match between observed and simulated water levels.

During model calibration, site-specific data, regional information, and relevant literature values were used as a guide to constrain estimates of hydraulic conductivity.

Calibration Procedure

For best results, the calibration of a model should rely on discrete measurements (water levels) to produce answers free of contouring interpretations. In the calibration of a groundwater flow model, use of point data eliminates the potential for interpretive bias that may result from attempting to match a contoured potentiometric surface (Konikow 1978; Anderson and Woessner 1992). The groundwater flow model for

the site was calibrated using 23 water-level calibration targets measured during March 2009 at monitoring locations distributed throughout the site (**Table 1**).

The primary criterion for evaluating the calibration of a groundwater flow model is the difference between simulated and observed water levels at a set of calibration targets. A residual or model error e_i, is defined as the difference between the simulated (h_i) and observed ($\hat{h}_i$) hydraulic head measured at a target location:

$$e_i = h_i - \hat{h}_i \quad (1)$$

The automatic parameter estimation procedure seeks to minimize an objective function defined by the residual sum of squares (RSS):

$$RSS = \sum_{i=1}^{n} \left(h_i - \hat{h}_i\right)^2 \quad (2)$$

where h_i is the simulated value at a specific target location and $\hat{h}_i$ is the measured value of hydraulic head. A residual with a negative sign indicates under-prediction by the model (i.e., the observed head is higher than the simulated value). Conversely, a positive residual indicates over-prediction.

$$RSTD = \sqrt{\frac{RSS}{n - p}} \quad (3)$$

The residual standard deviation (RSTD) is useful for comparing model calibrations with different numbers of calibration targets and estimated parameters. Another calibration measure is the mean of all residuals ($\bar{e}$):

$$\bar{e} = \frac{1}{n} \sum_{i=1}^{n} e_i \quad (4)$$

A mean residual significantly different from zero indicates model bias. The Gauss-Newton parameter estimation procedure produces a near zero mean residual at the minimum RSS.

Calibration of the groundwater flow model required numerous individual computer simulations. The values and shapes of the various parameter zones in the model were gradually varied until a reasonable solution was achieved in agreement with the conceptual model. This primary calibration was achieved using both trial-and-error and parameter estimation techniques designed for use with MODFLOW. The statistical goals of model calibration included the following:

- *RSTD* less than 10 percent of the total head change observed across the model domain. The total observed head change for the monitoring wells in the model domain is approximately 10.5 ft; and

- The residual mean is close to zero (indicating little or no bias) and the majority of calculated residuals are less than 10 percent of the range of observed changes in water-level elevations.

Calibration Results

The 21 water-level calibration targets measured during June 2010 were used to evaluate the model calibration by analyzing the following: 1) simulated hydraulic head distributions across the Site and surrounding properties, 2) residual statistics, and 3) sensitivity of estimated hydraulic parameters.

The 23 water-level targets selected were used to evaluate the model calibration by analyzing the following: 1) simulated hydraulic head distributions across the site and surrounding properties and 2) residual statistics.

Simulated Hydraulic Head Distributions

As a part of evaluating the model calibration, simulated potentiometric surface maps were prepared for the entire modeled region to ensure that simulated groundwater flow patterns were reasonable relative to observed conditions. Simulated local potentiometric surface maps were prepared to depict groundwater flow conditions in the site vicinity (**Figures 10 to 13**). As shown in these figures, the simulated flow patterns match reasonably well with the observed conditions that depict general groundwater flow to the north towards Rio Grande Creek.

Residual Statistics

The model calibration sought to minimize the residual sum of squares (Equation 2) computed for the 23 water-level calibration targets. **Table 1** lists the simulated water elevations and model residuals for each of the calibration targets. The local maps of simulated hydraulic heads (**Figures 11 to 13**) show the spatial distribution of the residuals across the site. Overall, the model shows a good match to the measured water levels at the site. **Figure 14** shows the agreement between observed and simulated water levels graphically for the calibration targets.

Residual statistics for the calibrated groundwater flow model also indicate good agreement between simulated and measured groundwater elevations (**Table 1**). More than 80% of the targets have residuals less than 1.5 ft, which is 10% of the range of observed changes in water-level elevations. The residual standard deviation is calculated to be 1.32 ft, and the mean is very close to zero (-0.057 ft) as well.

The distribution of simulated heads and corresponding residual statistics indicate that a high degree of calibration has been achieved in this modeling effort.

Groundwater Flow Analysis

The calibrated groundwater flow model was utilized to evaluate the hydraulic impacts of Alternative 3 of the FS Report (i.e., ISS). **Figure 15** shows the extent of the proposed ISS monolith footprint (as presented in the FS Report), which extends vertically from approximately 425 ft MSL to the top of the till unit. The purpose of the flow analysis was to evaluate the increase in water levels resulting from the ISS remedial option, particularly at the Meter House area of the service center building. The floor of the Meter House portion of the building has the lowest elevation and could potentially become flooded if water levels were to rise significantly in this area.

To evaluate the water level rise at the site, a shallow layer was added to the numerical model at site vicinity to represent the fill area above the top of ISS monolith surface. A low hydraulic conductivity zone was delineated to represent the ISS monolith footprint area (**Figure 16**). The hydraulic conductivity for the ISS monolith was assumed to be 1.0E-6 cm/sec (which is equivalent to 2.83E-3 ft/day). Since the ISS monolith extends down to the till, the low conductivity zone representing the ISS monolith was assigned in model layers 2 and 3 of the refined 5-layer model.

The backfill material above the ISS monolith footprint was initially assumed to have a conductivity value of 100 ft/day. However, two additional sensitivity simulations were performed by lowering the conductivity value of the backfill material to 10 ft/day and 4 ft/day. Simulations were performed to evaluate the net increases in hydraulic head due to the ISS monolith under the stated conductivity conditions. The net head increase was calculated in the model by subtracting the calibrated head value from the simulated head value in the presence of ISS monolith. As shown on **Figures 17, 18 and 19**, modeling results suggest that the net increase in hydraulic head will likely remain between 0.2 and 0.4 ft below the Meter House portion of the building, assuming a reasonably conductive backfill material was emplaced above the ISS monolith. Modeling evaluation further suggests that the net head increase will probably become more than 1 ft below the Meter House portion of the building if the hydraulic conductivity of the backfill material is less than 1 ft/day.

Summary of Modeling Activities

Historic and recent hydrogeologic data collected at the site and additional regional information obtained from the literature were used to construct and calibrate a three-dimensional groundwater flow model for the site. The calibrated groundwater model was used to improve our understanding of the groundwater movement in the subsurface and serves as a tool to evaluate the hydraulic response of the groundwater flow system should Alternative 3 (i.e., ISS) of the FS Report be chosen as the remedial alternative for the site.

The calibrated model was used to evaluate the net increases in hydraulic head due to a potential ISS monolith at the site extending from approximately 425 ft MSL down to the top of the till unit. Model simulation results suggest that the net increase in hydraulic head will likely remain between 0.2 and 0.4 ft

below the Meter House portion of the building if reasonably conducive backfill material is emplaced above the ISS monolith.

References

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Konikow, L., 1978. *Calibration of Groundwater Models, in Proceedings of the Specialty Conferences on Verification of Mathematical and Physical Models in Hydraulic Engineering*, College Park, Maryland, August 9-11, 1978.

McDonald, M. G., and A. W. Harbaugh, 1988. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, Techniques of Water-Resources Investigations, Book 6, Chapter A1*. U. S. Geological Survey. Reston, Virginia.

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Table

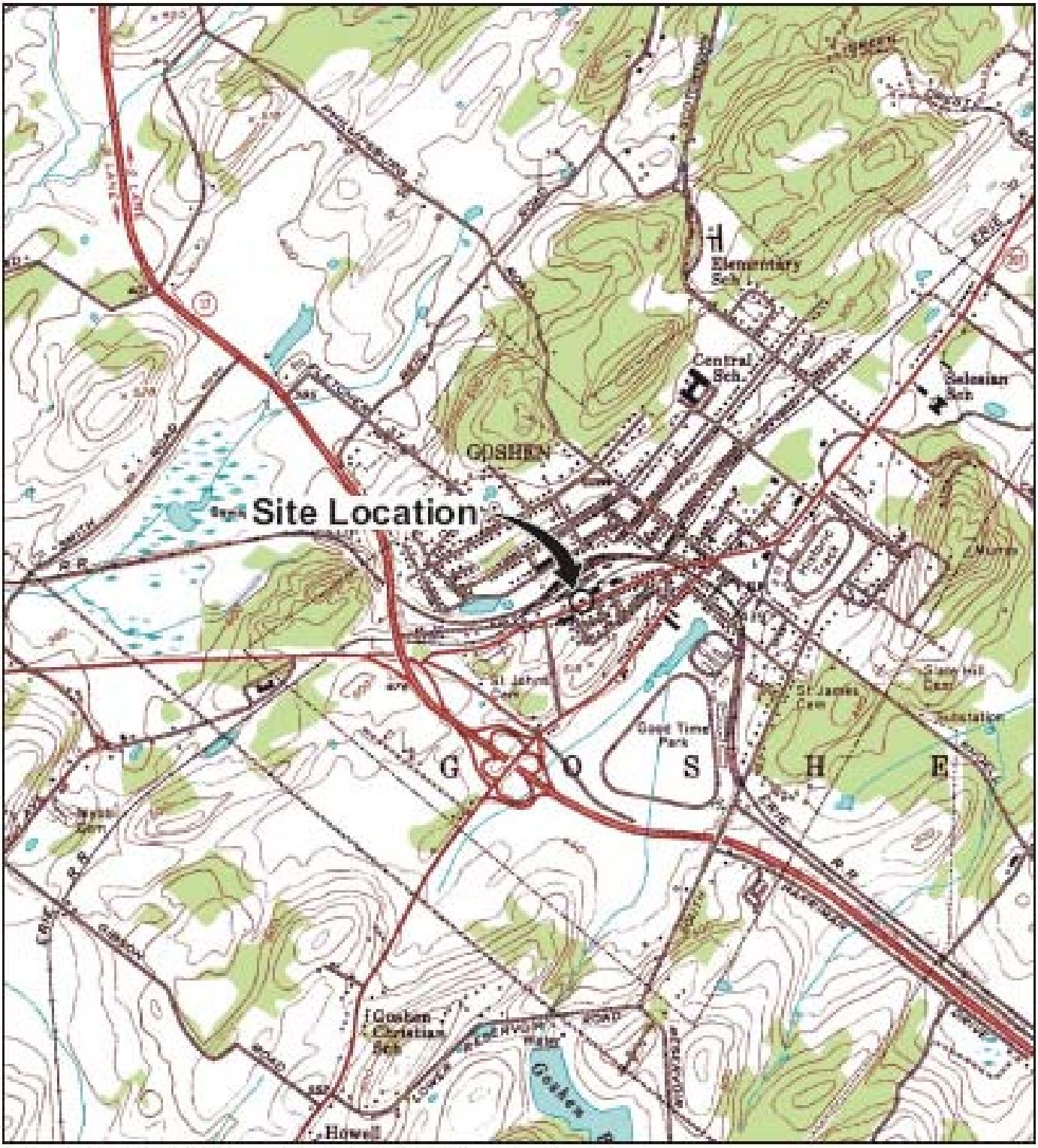
Table 1. Calibration Targets and Calculated Residuals
New York State Electric and Gas Corporation, Goshen, New York.

Well ID	Model Layer	Model Row	Model Column	Simulated Heads (ft MSL)	Observed Heads (ft MSL)	Residual (ft)
PZ08-01	1	130	143	426.006	426.98	-0.974
PZ08-02	1	133	147	427.877	428.5	-0.623
PZ08-03	1	131	144	426.565	427.02	-0.455
MW93-01S	2	138	145	427.094	428.37	-1.276
MW93-02S	2	126	138	421.515	421.43	0.085
MW93-03S	2	128	145	422.475	422.73	-0.256
MW08-04S	2	124	127	421.36	421.09	0.27
MW08-05S	2	127	136	422.16	422.23	-0.07
MW08-06S	2	125	142	420.803	420.83	-0.027
MW08-07S	2	137	138	426.649	430.32	-3.671
MW08-08S	2	132	134	424.705	425.59	-0.885
MW08-09S	2	130	148	423.637	423.74	-0.103
NMW08-01	2	132	142	424.527	424.3	0.227
NMW08-02	2	133	139	425	427.14	-2.14
MW93-01D	3	139	145	425.723	424.33	1.393
MW93-02D	3	125	138	421.821	421.71	0.111
MW93-03D	3	127	145	422.512	422.16	0.352
MW08-04D	3	124	126	421.861	421.69	0.171
MW08-05D	3	127	136	422.423	421.64	0.783
MW08-06D	3	125	142	421.843	421.99	-0.147
MW08-07D	3	137	138	425.115	422.51	2.605
MW08-08D	3	133	134	424.094	421.71	2.384
MW08-09D	3	130	148	423.492	422.55	0.942

Total Targets Used =	**23**
Mean =	**-0.057**
Variance =	**1.738**
Standard Deviation =	**1.318**
Residual Sum of Squares =	**38.315**

ARCADIS

Figures



REFERENCE: BASE MAP USGS 7.5 MIN. QUAD., GOSHEN, NY, 1957.

2000' 0 2000'

Approximate Scale: 1" = 2000'

PROJECT NAME -

NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK

GROUNDWATER FLOW MODEL

SITE LOCATION MAP

ARCADIS

FIGURE
1

LEGEND:

- MONITORING WELL LOCATION
- NAPL MONITORING WELL LOCATION
- SOIL BORING LOCATION
- PIEZOMETER LOCATION
- STAFF GAUGE LOCATION
- SURFACE SOIL SAMPLING LOCATION
- TEST PIT
- PREVIOUS TEST BORING LOCATION
- PREVIOUS TEST PIT LOCATION
- PREVIOUS SURFACE SOIL SAMPLE LOCATION
- FORMER STRUCTURE (1889–1945)
- NYSEG PROPERTY LINE (SITE)
- GAS LINE
- WATER LINE
- SEWER LINE
- ELECTRIC LINE
- STORM LINE
- PROPERTY LINE
- FENCE LINE
- A — A' LINE OF CROSS SECTION

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'
GRAPHIC SCALE

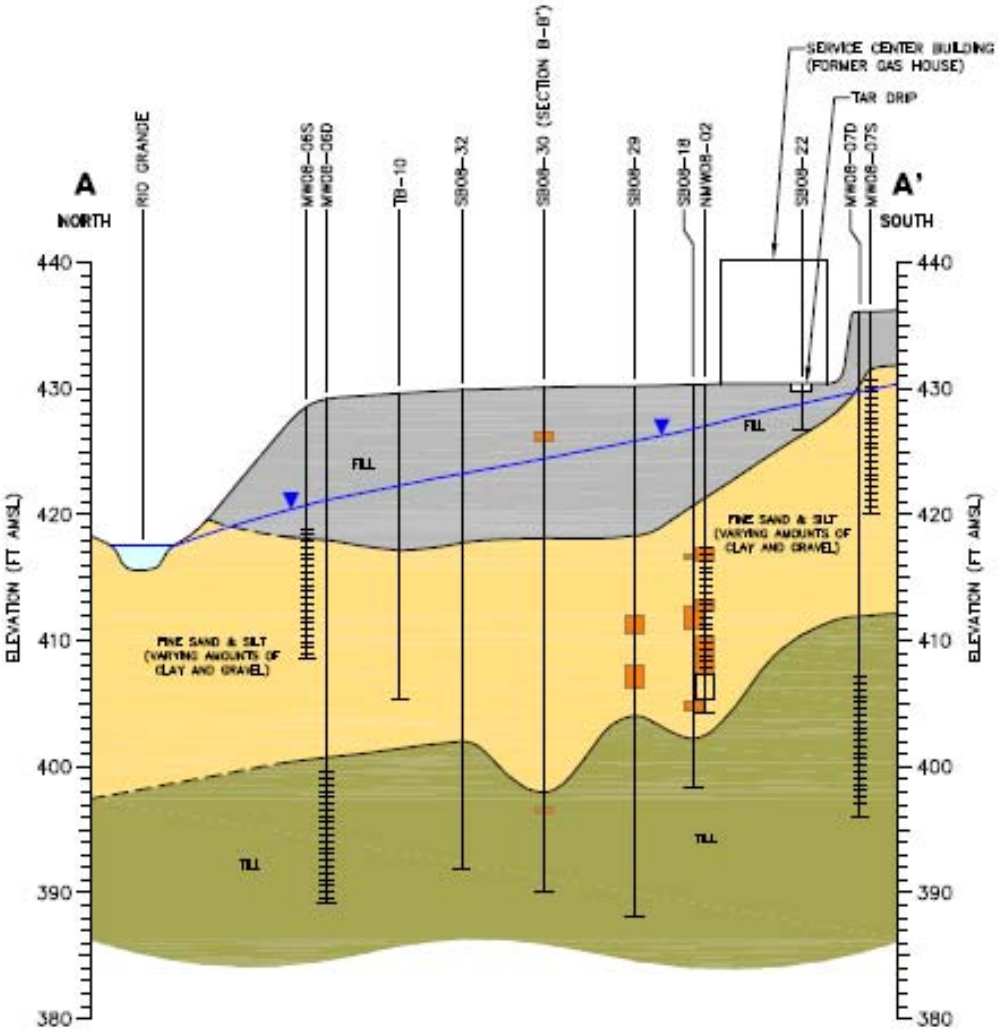
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

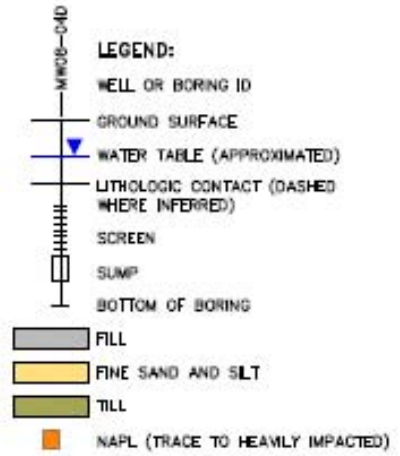
SITE MAP WITH CROSS SECTION LOCATIONS

ARCADIS

FIGURE
2

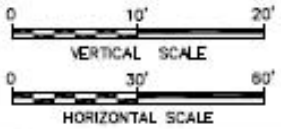
PROJECT NAME:





NOTE:

ELEVATIONS REFERENCED TO NAVD 1988.



NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK

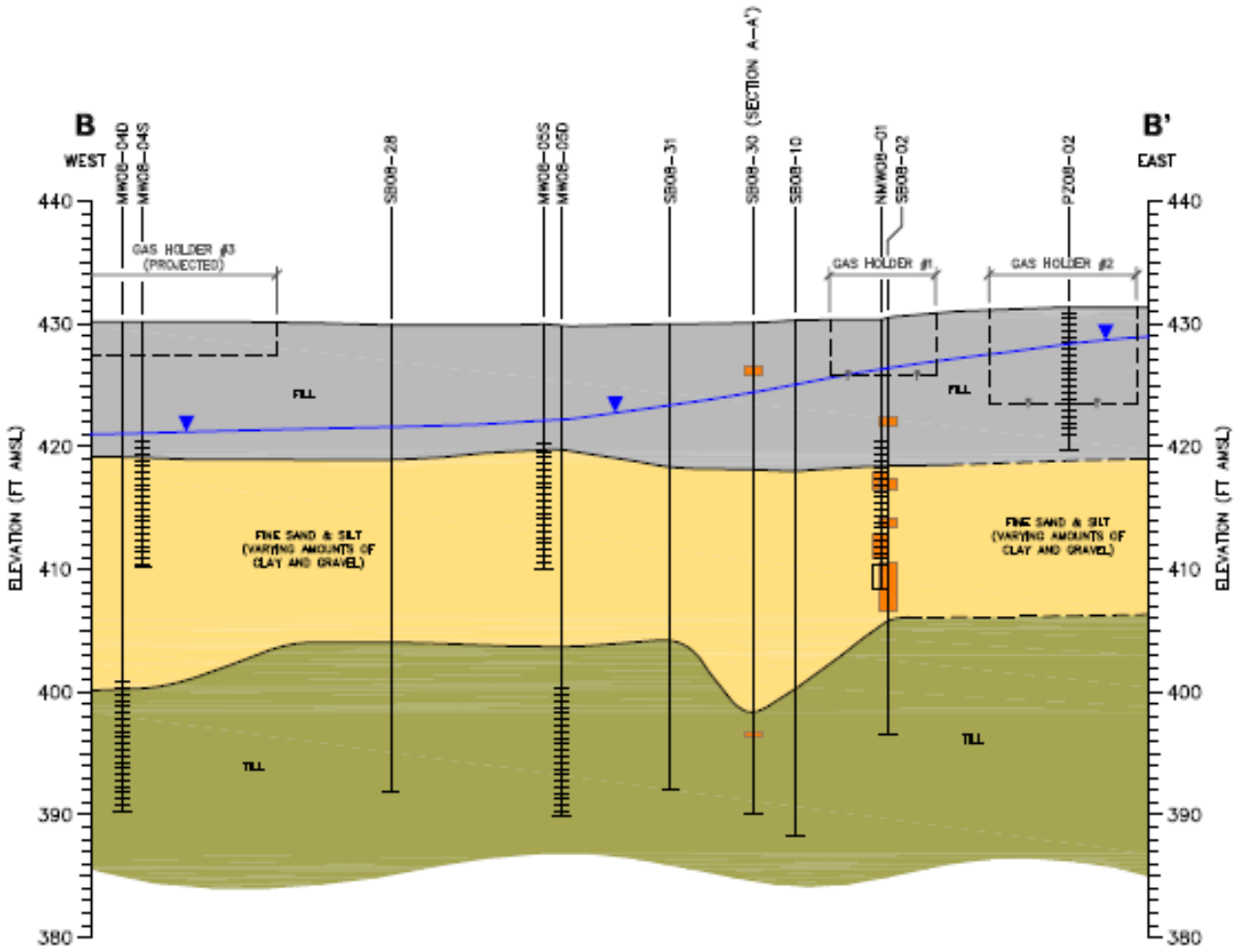
GROUNDWATER FLOW MODEL

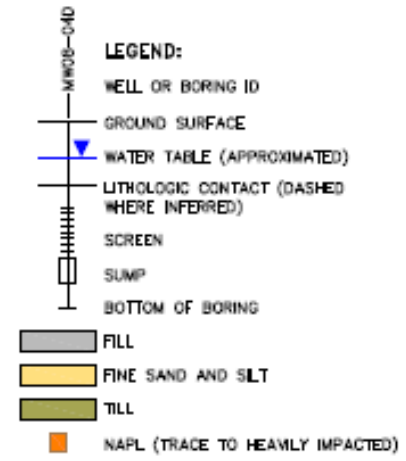
CROSS SECTION A-A'

ARCADIS

FIGURE
3

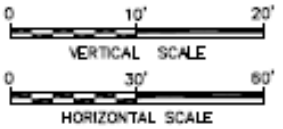
PROJECT NAME:





NOTE:

ELEVATIONS REFERENCED TO NAVD 1988.



PROJECT NAME:

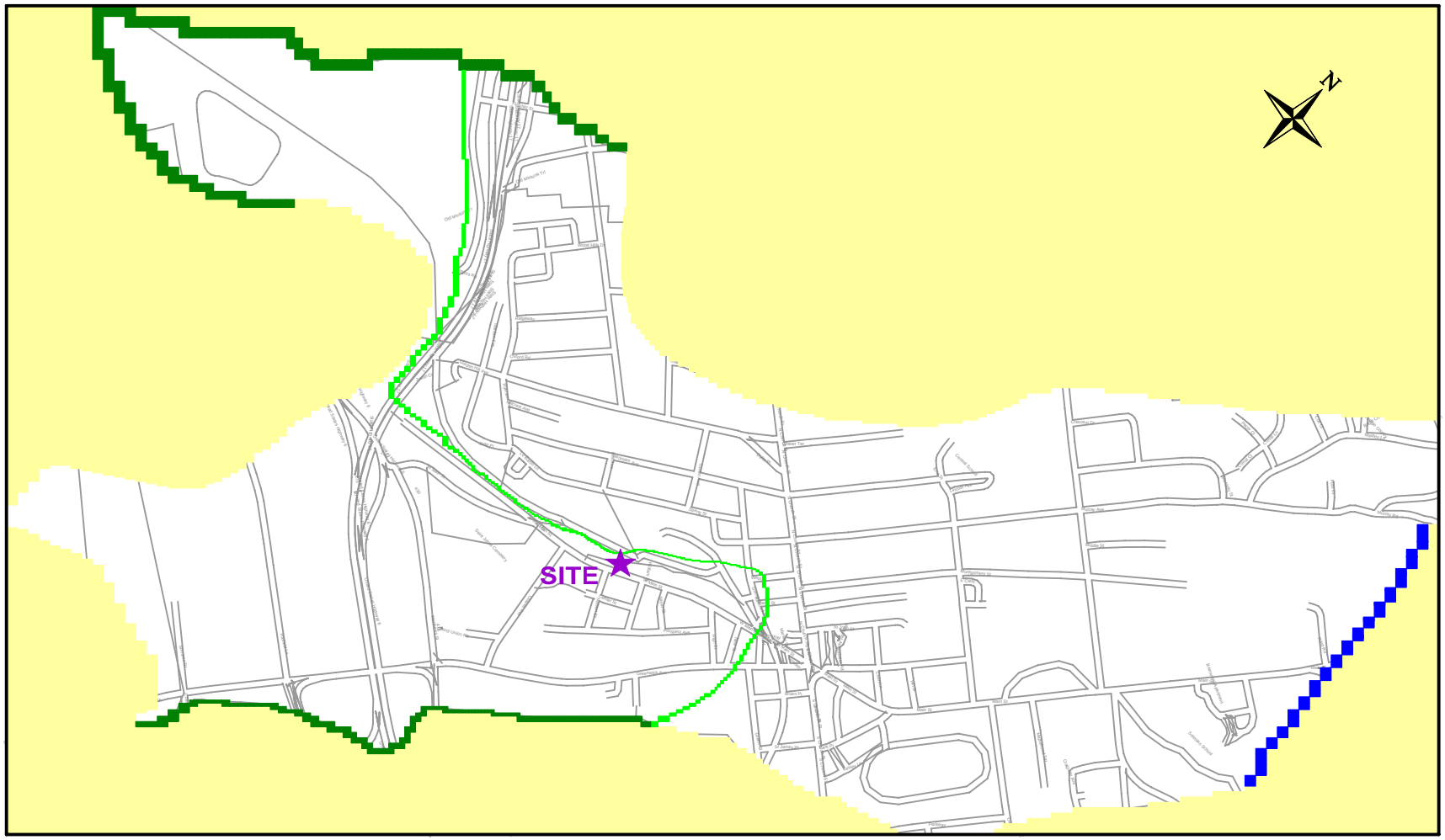
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK

GROUNDWATER FLOW MODEL

CROSS SECTION B-B'

ARCADIS

FIGURE
4



Scale in Feet

0 1000 2000

- Constant Head cells representing regional flow
- River Cells along Channels and Tributaries
- Drain Cells along Rio Grande Creek
- Inactive Area
- Active Model Area

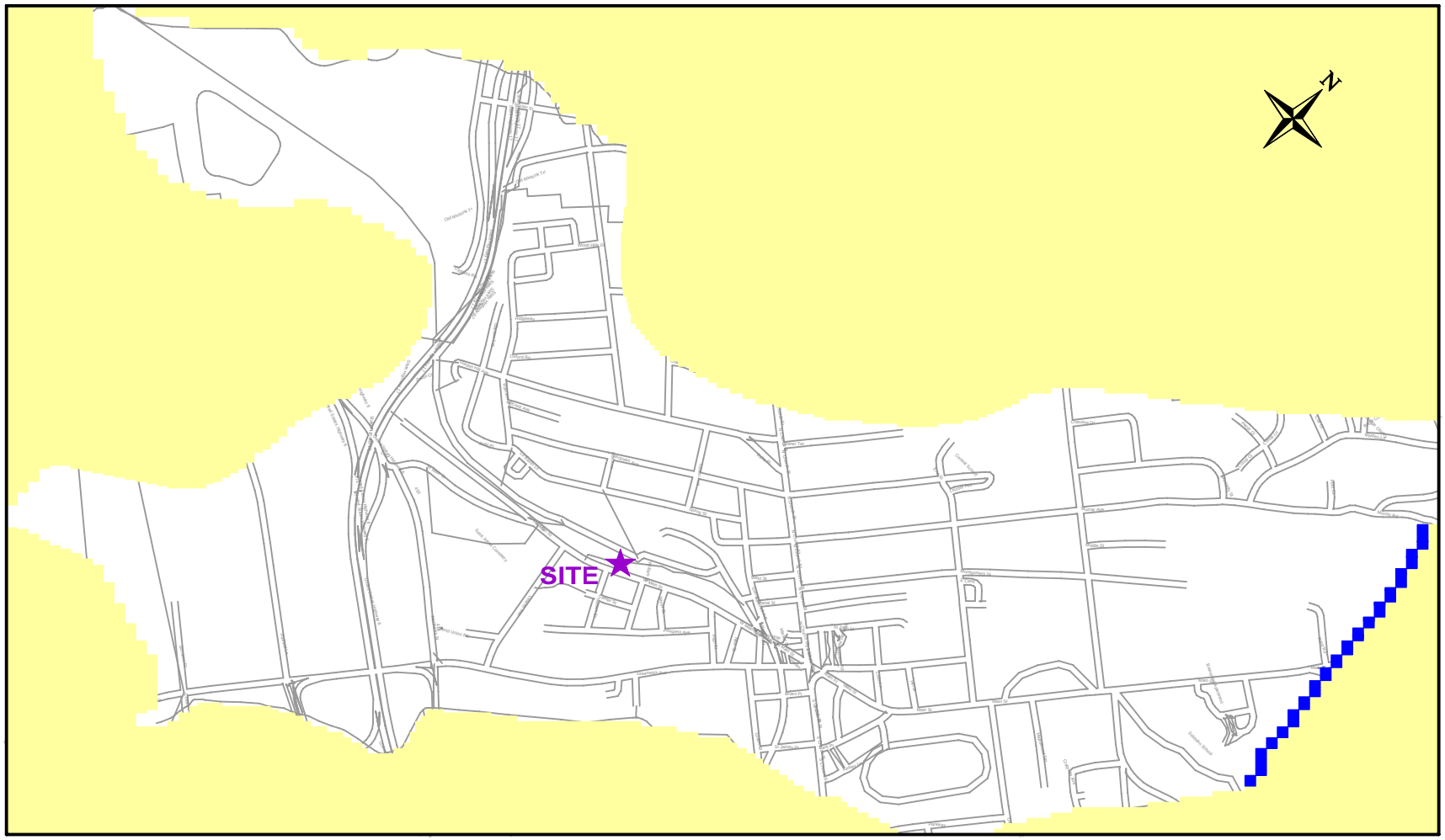
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

MODEL EXTENT AND BOUNDARY CONDITIONS: MODEL LAYER 1

ARCADIS

FIGURE
5

PROJECT NAME:



Scale in Feet

0 1000 2000

Constant Head cells representing regional flow

Inactive Area

Active Model Area

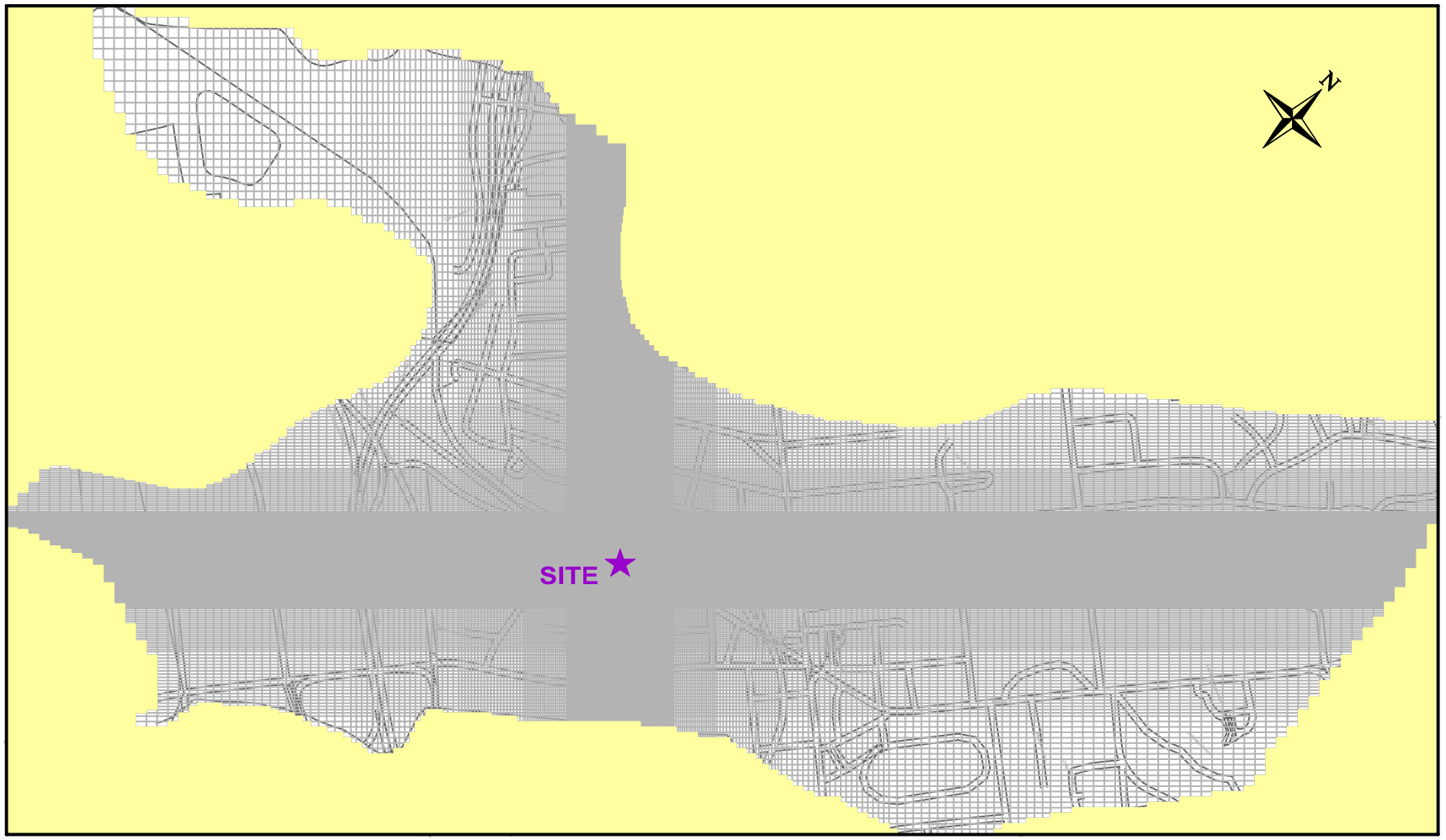
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

MODEL EXTENT AND BOUNDARY CONDITIONS: MODEL LAYERS 2 TO 4

ARCADIS

FIGURE
6

PROJECT NAME:



Scale in Feet

0 1000 2000

Grid Spacing of 10ft by 10ft at Site

Inactive Area

Active Model Area

NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK

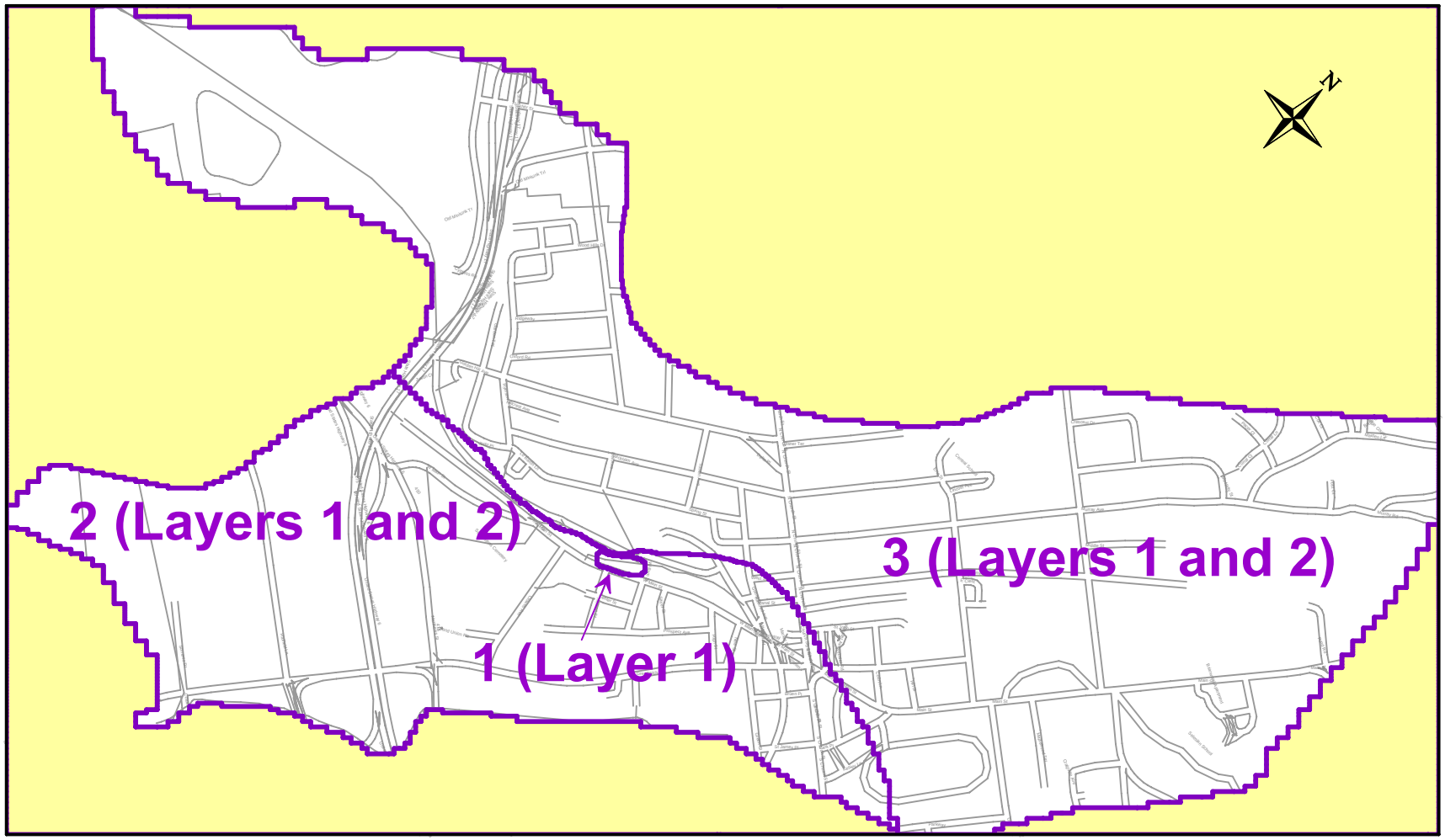
GROUNDWATER FLOW MODEL

FINITE DIFFERENCE GRID

ARCADIS

FIGURE
7

PROJECT NAME:



Scale in Feet

0 1000 2000

Conductivity Zone Boundary

Inactive Area

Active Model Area

Hydraulic Conductivity (K) Zones

Zone	K (feet/day)
1	0.2
2	0.15
3	4.0
4	0.1

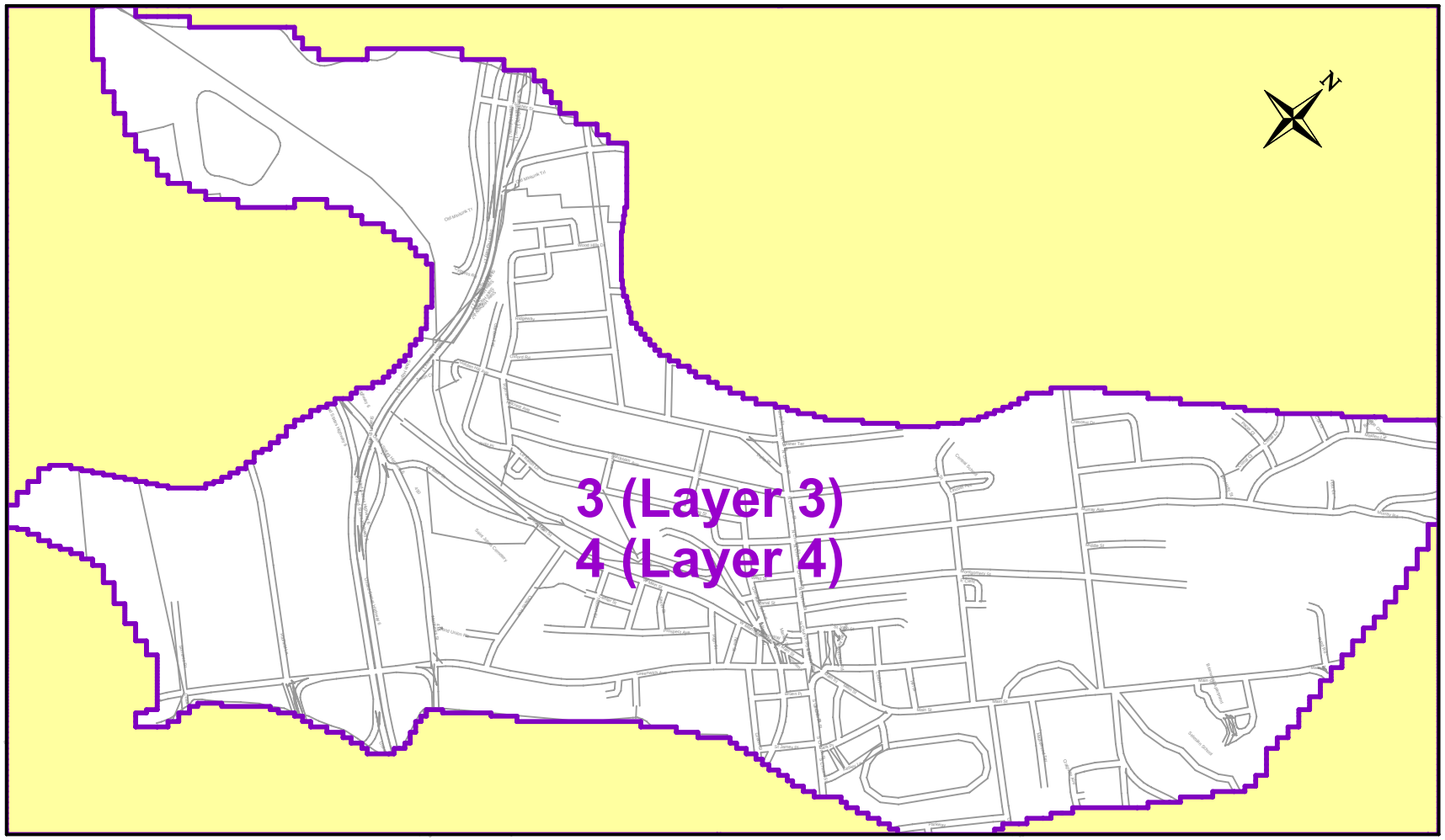
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

HYDRAULIC CONDUCTIVITY ZONES:
MODEL LAYERS 1 AND 2

ARCADIS

FIGURE
8

PROJECT NAME:



Scale in Feet

0 1000 2000

Conductivity Zone Boundary

Inactive Area

Active Model Area

Hydraulic Conductivity (K) Zones

Zone	K (feet/day)
1	0.2
2	0.15
3	4.0
4	0.1

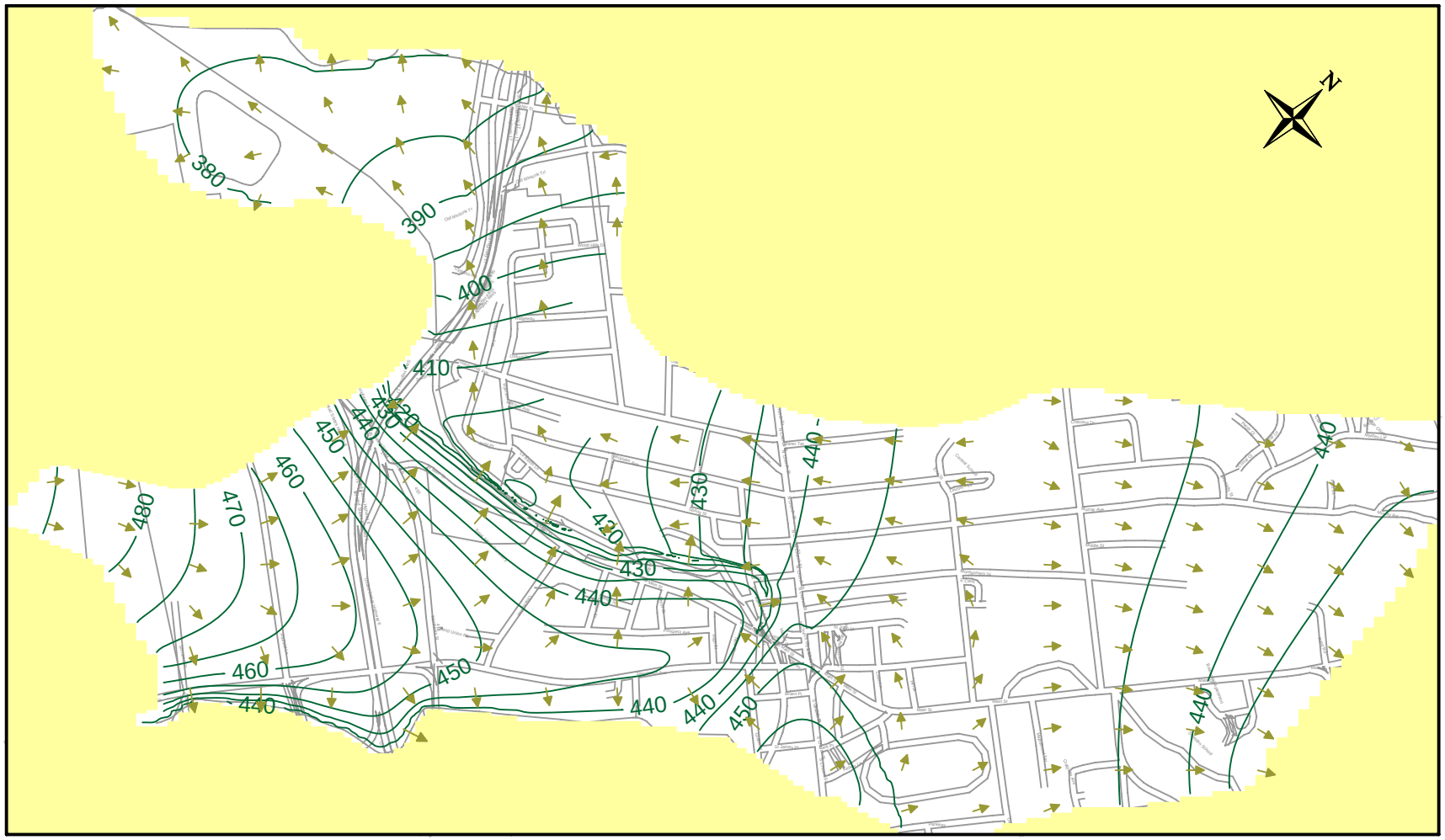
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

HYDRAULIC CONDUCTIVITY ZONES:
MODEL LAYERS 3 AND 4

ARCADIS

FIGURE
9

PROJECT NAME:



430 — Simulated Water Level Contour (ft MSL)

Simulated Groundwater Flow Vector

Inactive Area

Active Model Area

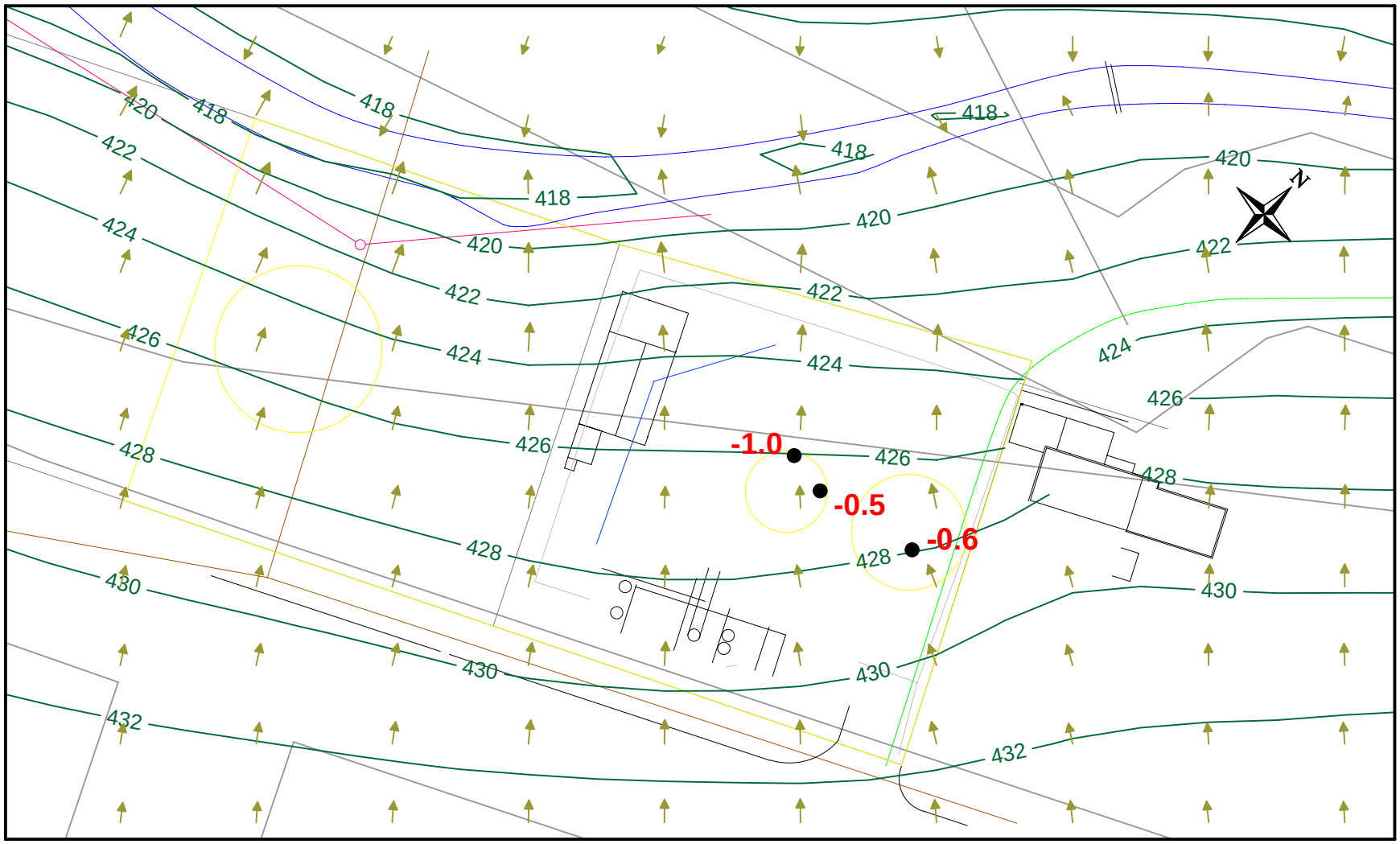
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

SIMULATED REGIONAL WATER LEVELS MODEL LAYER 1

ARCADIS

FIGURE
10

PROJECT NAME:



Scale in Feet

0 50 100

— 430 — Simulated Water Level Contour (ft MSL)

Simulated Groundwater Flow Vector

0.6 Difference Between Observed and Simulated Water Levels (ft)

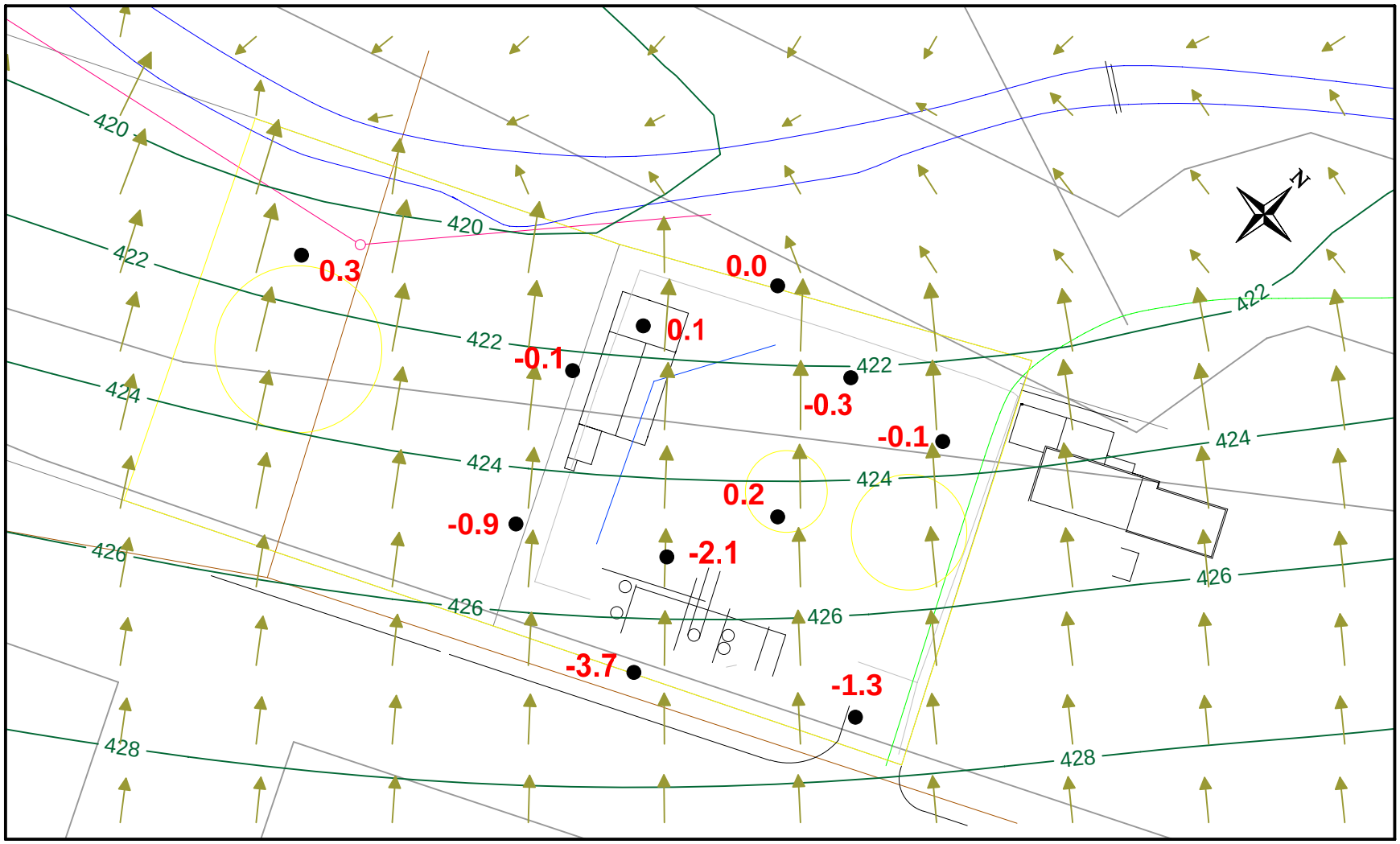
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

SIMULATED WATER LEVELS AND RESIDUALS: MODEL LAYER 1

ARCADIS

FIGURE
11

PROJECT NAME:



Scale in Feet

0 50 100

— 430 — Simulated Water Level Contour (ft MSL)

Simulated Groundwater Flow Vector

0.6 Difference Between Observed and Simulated Water Levels (ft)

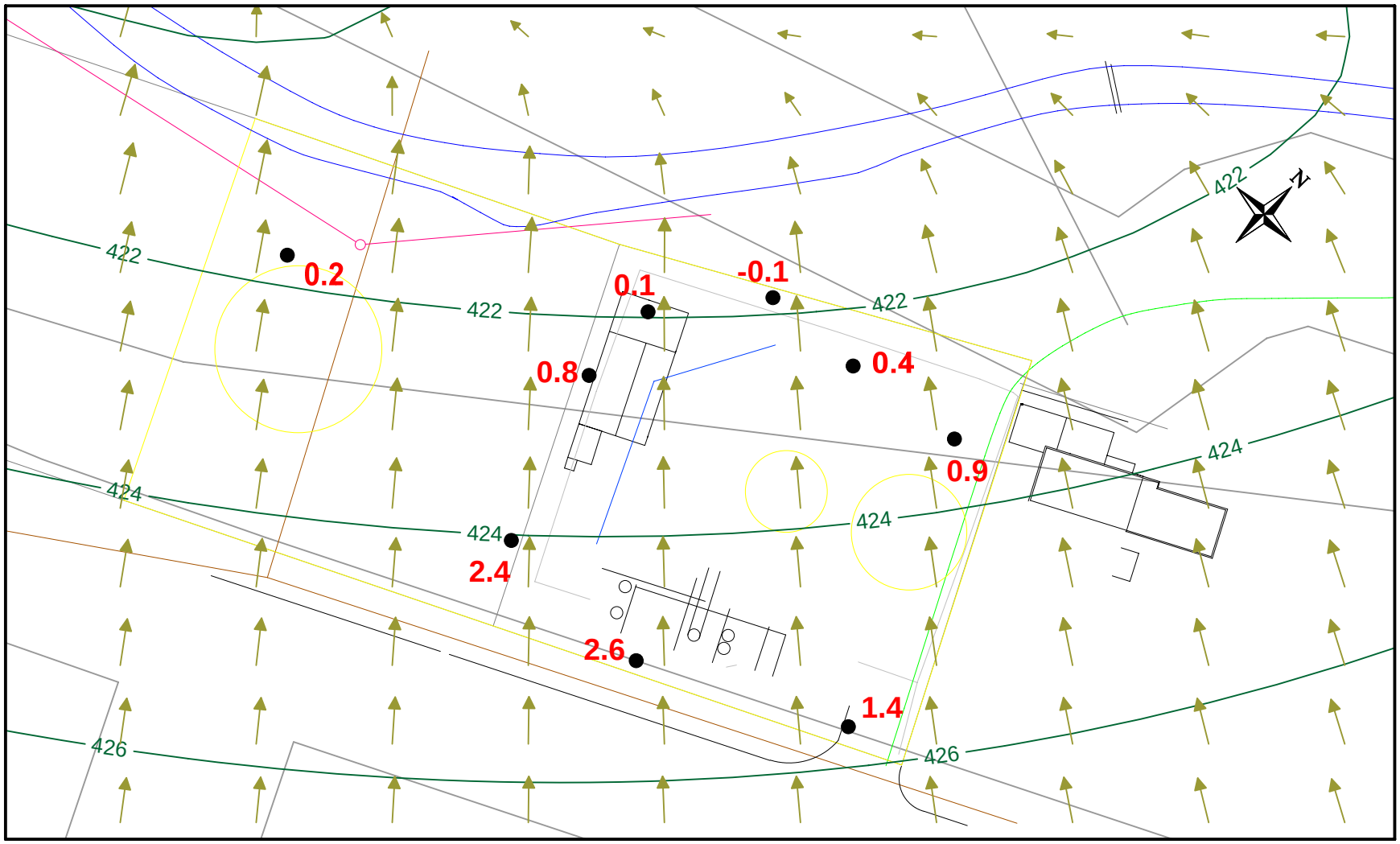
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

SIMULATED WATER LEVELS AND RESIDUALS: MODEL LAYER 2

ARCADIS

FIGURE
12

PROJECT NAME:



Scale in Feet

0 50 100

— 430 — Simulated Water Level Contour (ft MSL)

Simulated Groundwater Flow Vector

0.6 Difference Between Observed and Simulated Water Levels (ft)

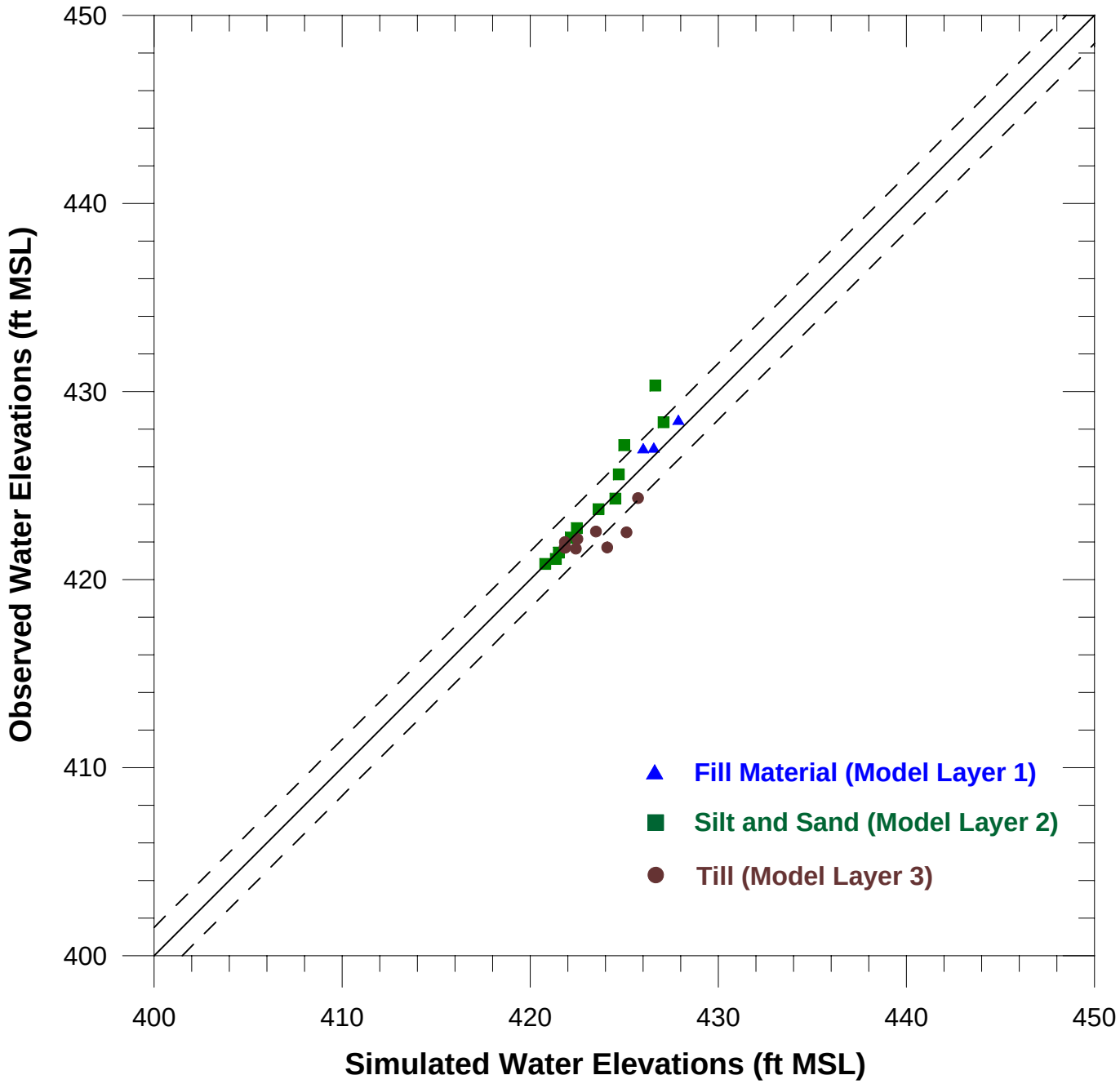
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

SIMULATED WATER LEVELS AND RESIDUALS: MODEL LAYER 3

ARCADIS

FIGURE 13

PROJECT NAME:



Project Name -

NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK

GROUNDWATER FLOW MODEL

OBSERVED VS SIMULATED
WATER LEVELS

ARCADIS

FIGURE
14

LEGEND:

- FORMER STRUCTURE (1889–1945)
- NYSEG PROPERTY LINE (SITE)
- GAS LINE
- WATER LINE
- SEWER LINE
- OVERHEAD ELECTRIC LINE
- STORM LINE
- PROPERTY LINE
- FENCE LINE
- APPROXIMATE EXTENT OF SOIL CONTAINING MGP-RELATED SOURCE MATERIAL (HATCHED WHERE INFERRED)
- (12) APPROXIMATE MAXIMUM DEPTH TO SOURCE MATERIAL
- APPROXIMATE EXTENT OF EXCAVATION OR ISS TREATMENT
- 12' APPROXIMATE DEPTH OF EXCAVATION OR ISS TREATMENT
- PROPOSED NAPL COLLECTION WELL

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. LOCATIONS OF FORMER STRUCTURES ARE BASED ON SANBORN FIRE INSURANCE MAPS FROM 1889 THROUGH 1939.

0 40' 80'
GRAPHIC SCALE

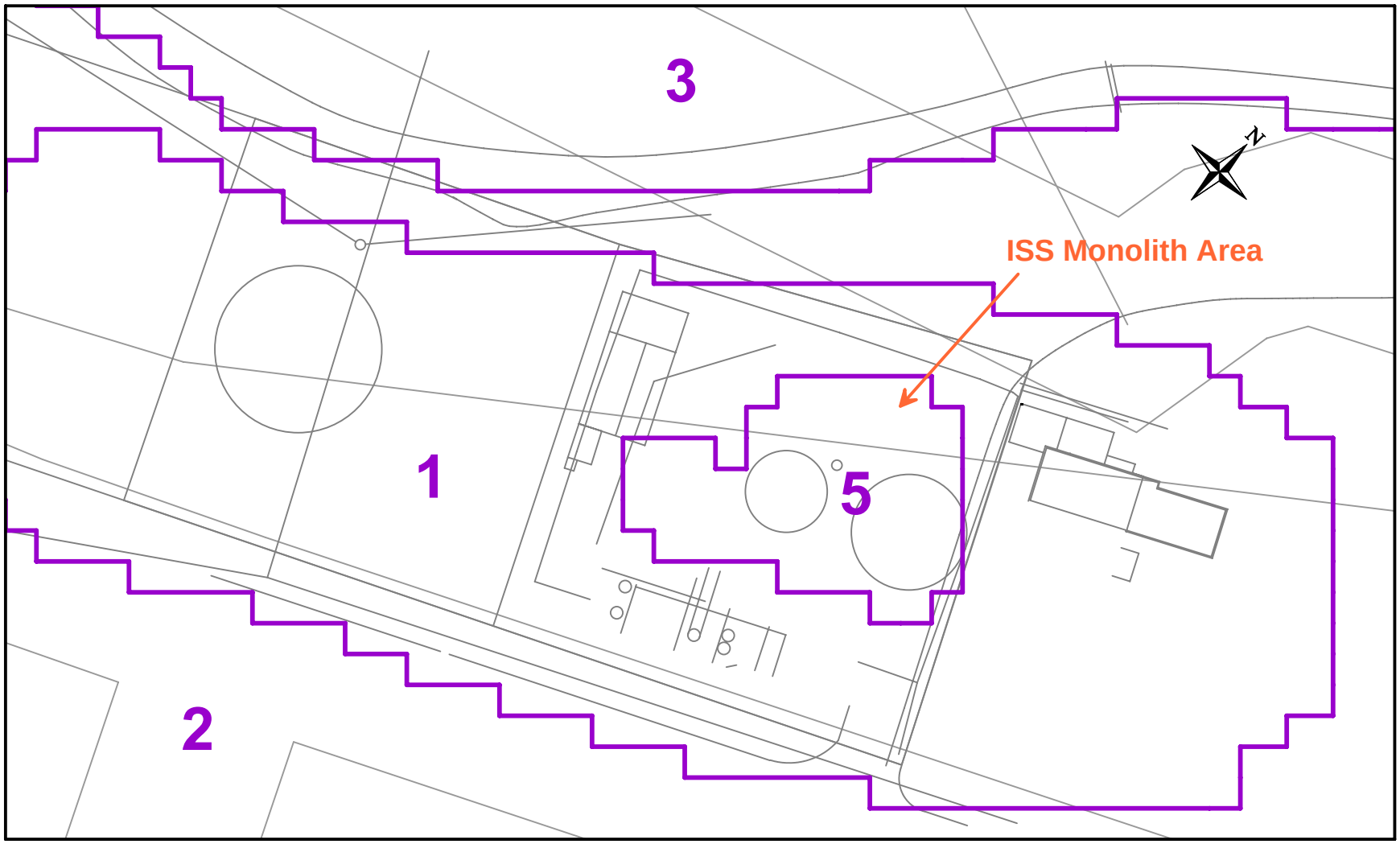
PROJECT NAME:

NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

PROPOSED EXTENT OF IN-SITU SOIL STABILIZATION (ISS)

ARCADIS

FIGURE
15



Scale in Feet

0 50 100

Conductivity Zone Boundary

Inactive Area

Active Model Area

Hydraulic Conductivity (K) Zones

Zone	K (feet/day)
1	0.2
2	0.15
3	4.0
5	100

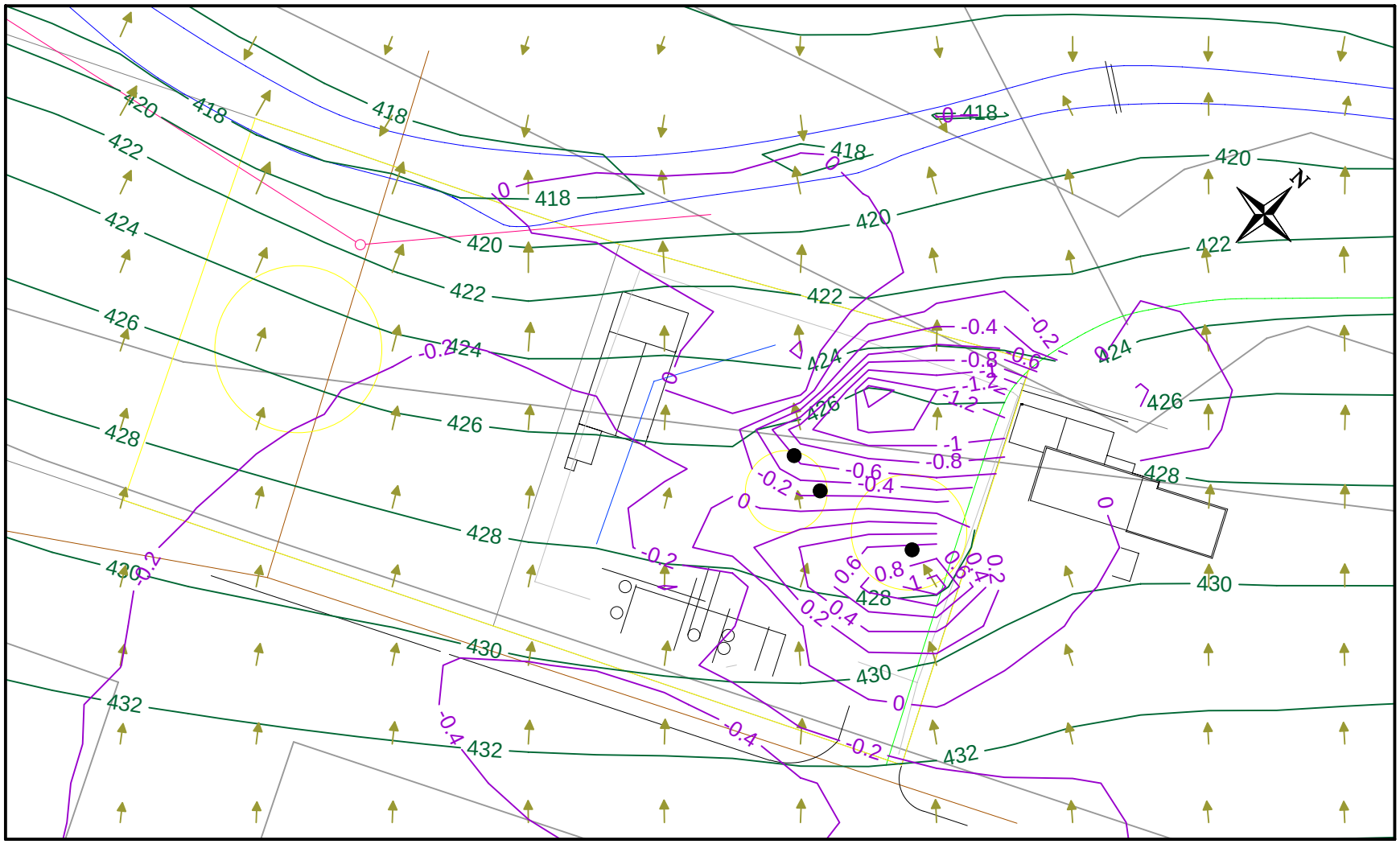
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

HYDRAULIC CONDUCTIVITY ZONATION
INCLUDING ISS MONOLITH AREA

ARCADIS

FIGURE
16

PROJECT NAME:



Scale in Feet

0 50 100

— 0.2 — Simulated Drawdown Contour (ft)
[Difference between Calibrated and ISS Simulated Water Levels]

— 430 — Simulated Water Level Contour (ft MSL)

↗ Simulated Groundwater Flow Vector

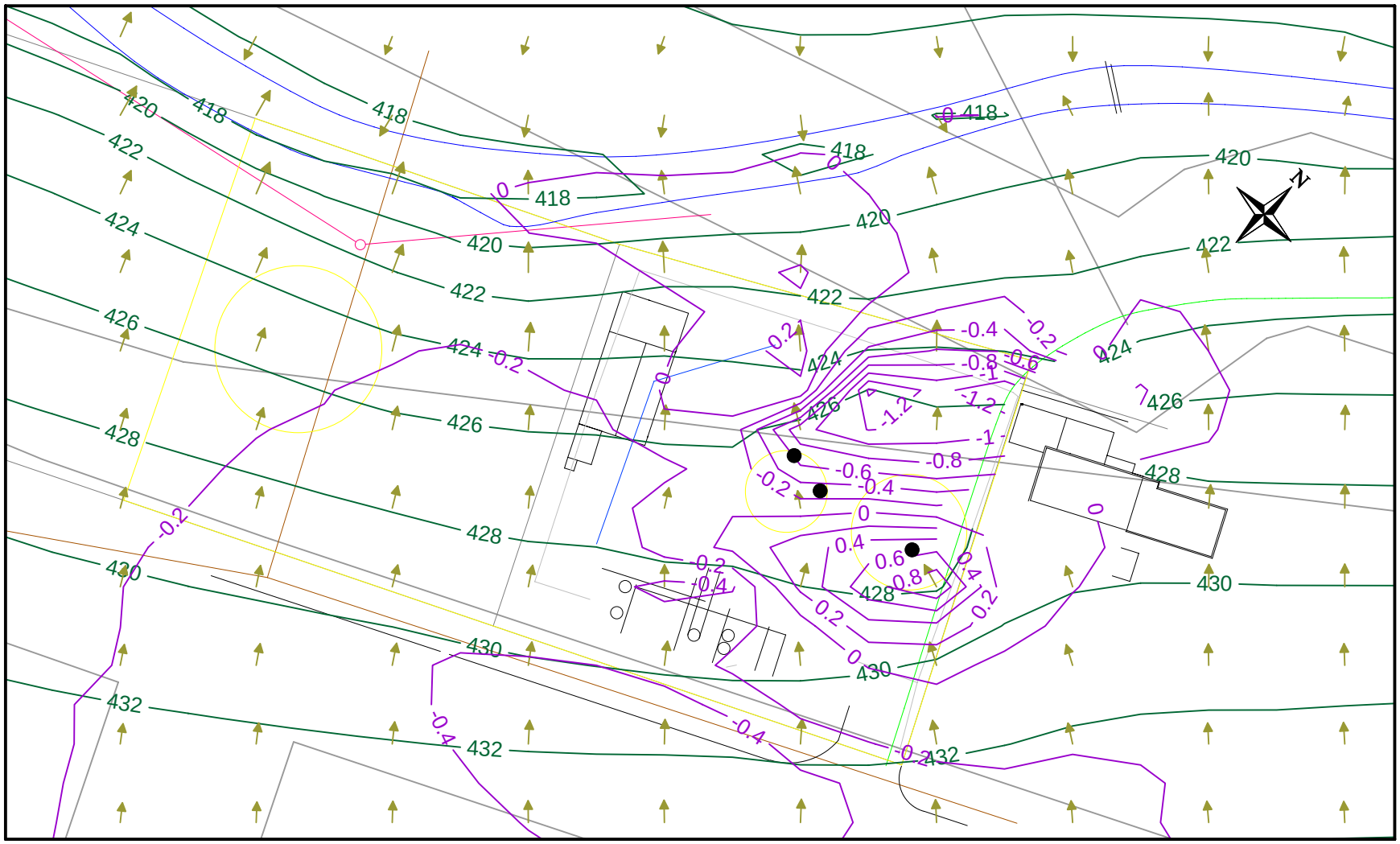
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

WATER LEVELS AND DRAWDOWNS WITH ISS FROM 425 FT MSL TO TILL: BACKFILL CONDUCTIVITY OF 100 FT/DAY

ARCADIS

FIGURE
17

PROJECT NAME:



Scale in Feet

0 50 100

— 0.2 — Simulated Drawdown Contour (ft)
[Difference between Calibrated and ISS Simulated Water Levels]

— 430 — Simulated Water Level Contour (ft MSL)

Simulated Groundwater Flow Vector

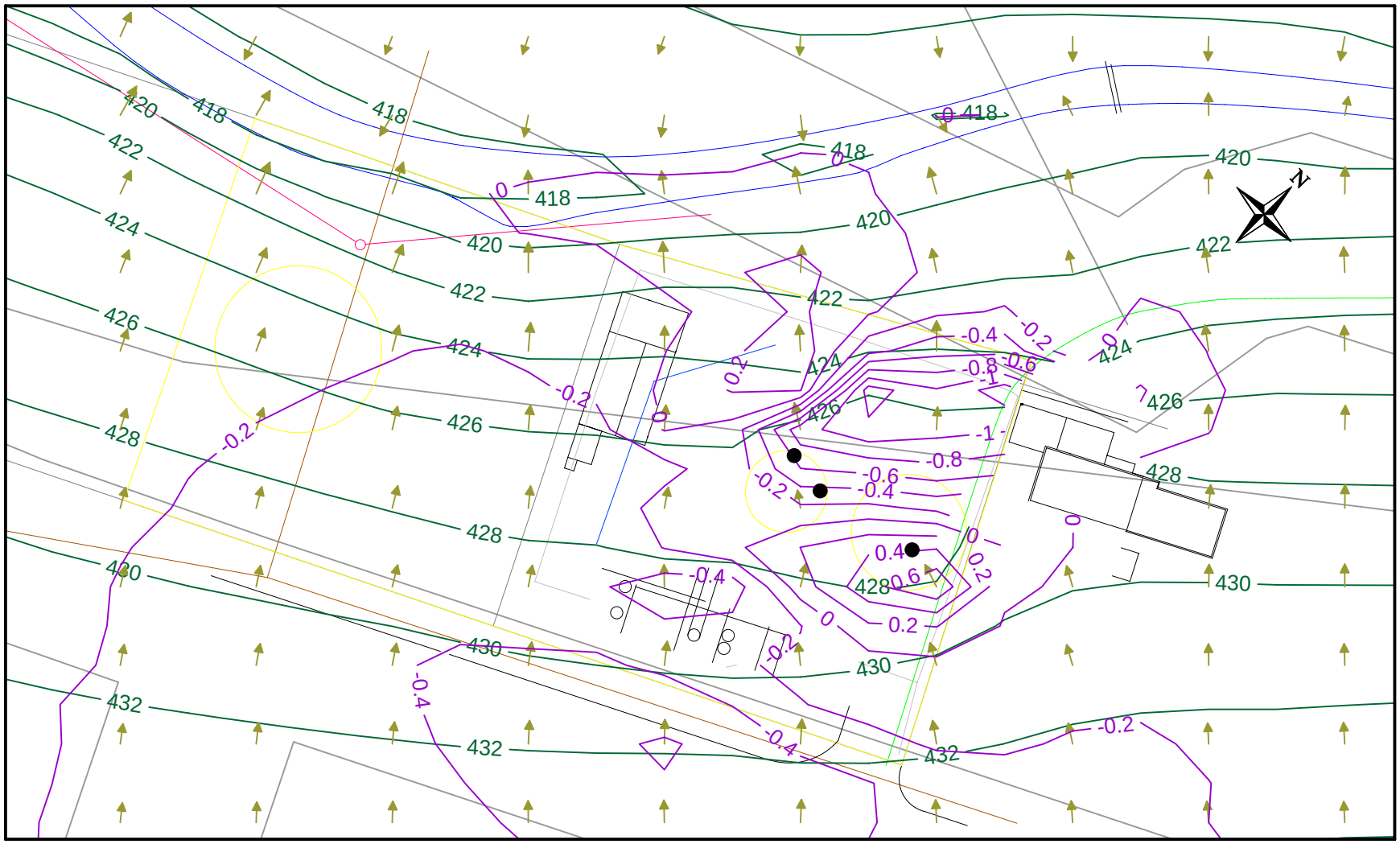
NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

WATER LEVELS AND DRAWDOWNS WITH ISS FROM 425 FT MSL TO TILL: BACKFILL CONDUCTIVITY OF 10 FT/DAY

ARCADIS

FIGURE
18

PROJECT NAME:



Scale in Feet

0 50 100

— 0.2 — Simulated Drawdown Contour (ft)
[Difference between Calibrated and ISS Simulated Water Levels]

— 430 — Simulated Water Level Contour (ft MSL)

Simulated Groundwater Flow Vector

NEW YORK STATE ELECTRIC AND GAS CORPORATION
GOSHEN, NEW YORK
GROUNDWATER FLOW MODEL

WATER LEVELS AND DRAWDOWNS WITH ISS FROM 425 FT MSL TO TILL: BACKFILL CONDUCTIVITY OF 4 FT/DAY

ARCADIS

FIGURE
19

PROJECT NAME: