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Geotechnical
Environmental and
Water Resources
Engineering

Alternatives Analysis

Operable Unit 2

Schenectady (Clinton Street)
Non-Owned Former MGP Site

Schenectady, New York

Order on Consent
Site No. V00474
Index No. D0-0001-0011

Submitted to:
National Grid
300 Erie Boulevard West
Syracuse, NY 13202

Submitted by:
GEI Consultants, Inc., P.C.
455 Winding Brook Drive, Suite 201
Glastonbury, CT 06033
860-368-5300

December 2013
Project 091990-2-1209

Jerry Zak
Project Manager

Reviewed by:

John T. Finn, P.E.
Senior Engineer

Engineer's Certification

In accordance with NYSDEC DER-10 Section 1.5 (b) 2,

I, John T. Finn, certify that I am currently a NYS registered professional engineer and that this 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.

STATE OF NEW YORK
JOHN T. FINN
073034
LICENSED PROFESSIONAL ENGINEER

December 2013 — 12/19/2013

Date

John Finn, PE
QEP
GEI Consultants, Inc., P.C.

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Abbreviations and Acronyms

AA	Alternatives Analysis
AOC	Administrative Order on Consent
AWQS	Ambient Water Quality Standards, Guidance Values, and Groundwater Effluent Limitations
COCs	Constituents of Concern
COPCs	Contaminant Of Primary Concern
CY	Cubic Yard
CP-51 Soil Cleanup Guidance	Soil Cleanup Guidance, NYSDEC Policy, October 21, 2010
DER-10	NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation, May, 2010
EPA	United States Environmental Protection Agency
ft/ft	feet per foot
GEI	GEI Consultants, Inc.
GRA	General Response Action
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	High-density Polyethylene
IRM	Interim Remedial Measure
IC/EC	Institutional Controls/Engineering Controls
ISS	In-Situ Solidification
MGP	Manufactured Gas Plant
mg/kg	Milligrams per kilogram (equivalent to ppm in soil)
MNA	Monitored Natural Attenuation
NAPL	Non-Aqueous Phase Liquid
NYCRR	New York Codes Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORC	Oxygen Releasing Compounds
OM&M	Operation, Maintenance and Monitoring
OSHA	Occupational Safety & Health Administration
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PDI	Pre-design Investigation
POTW	Publicly Owned Treatment Works
ppm	Parts Per Million (equivalent to mg/kg in soil)
RAO	Remedial Action Objective
RI	Remedial Investigation
RIR	Remedial Investigation Report
ROW	Right-of-way
Sanborn	Sanborn Fire Insurance maps
SCG	Standards, Criteria, and Guidance

Abbreviations and Acronyms (cont.)

SCO	Soil Cleanup Objective
SMHA	Schenectady Municipal Housing Authority
SMP	Site Management Plan
TAGM	Technical and Administrative Guidance Memorandum
TOGS	Technical and Operational Guidance Series
USDOT	United States Department of Transportation
VCO	Voluntary Consent Order
VOCs	Volatile Organic Compounds

Executive Summary

Introduction and Purpose

This report describes the Alternatives Analysis (AA) undertaken for the Operable Unit No. 2 (OU2) portion of the Schenectady (Clinton Street) Non-Owned Former Manufactured Gas Plant (MGP) site (the Site) located on Clinton Street, in Schenectady, New York. The location is shown in Figure 1. The purpose of the AA is to identify and evaluate a range of remedial alternatives and then recommend a remedy.

The Clinton Street former MGP Site has been divided into two operable units, Operable Unit No. 1 (OU1) and OU2, as shown in Figure 2. A separate AA report was prepared for OU1 in February 2012 and approved by NYSDEC on March 28, 2012. This AA report has been prepared for OU2.

The OU2 AA is based on a series of environmental studies performed by National Grid, culminating in the Remedial Investigation Report (RIR) of December 2012. The OU2 RIR was accepted by NYSDEC on December 14, 2012.

Remedial Alternative Development and Recommended Alternative

A range of alternatives were developed for OU2, based on the land use approaches, remedial action objectives (RAOs) and general response actions and the applicable technologies. A total of three alternatives were developed and retained for detailed analysis:

1. No Action (required for comparison purposes by DER-10).
2. Removal of MGP-residues at the Postage Stamp and associated area to 15 feet below ground surface that contain volatile organic compounds (VOCs) in excess of Part 375 Commercial Use Soil Cleanup Objectives (SCOs) and total polycyclic aromatic hydrocarbons (PAHs) at concentrations above 500 parts per million (ppm); introduction of oxygen release compound (ORC) prior to backfilling; enhancement of the existing non-aqueous phase liquid (NAPL) recovery program on the west side of Broadway; institutional controls.
3. Soil removal to Part 375 Unrestricted levels.

Based on the respective attributes and limitations of each alternative, Alternative 2, Removal of MGP-residues containing 500 ppm or greater of total PAHs at the Postage Stamp to 15 feet below ground surface, followed by introduction of ORC prior to backfilling; enhancement of the existing NAPL recovery program on the west side of Broadway, and institutional controls emerged as the recommended remedy for OU2. As summarized in the comparative analysis, Alternative 2 will substantially reduce the impacts and provide the equivalent effectiveness of Alternative 3, at less cost and with fewer negative impacts. This alternative is implementable with moderate short-term impacts, and meets the RAOs for the Site, to the extent practicable.

1. Introduction and Scope

This report describes an Alternatives Analysis (AA) for the Clinton Street (Non-Owned) former manufactured gas plant (MGP) Site located on Clinton Street and adjacent parcels in Schenectady, New York. The location is shown in Figure 1. The purpose of the AA is to identify and evaluate a range of remedial action alternatives to support the selection of a final remedy for Operable Unit No. 2 (OU2) (the Site).

The AA was developed consistent with the Voluntary Consent Order (VCO) dated July 3, 2001, Index number D0-0001-0011, and in accordance with the applicable guidance of the New York State Department of Environmental Conservation (NYSDEC) (DER-10 Technical Guidance for Site Investigation and Remediation, May, 2010 and 6 New York Codes, Rules and Regulations [NYCRR] Part 375) [(NYSDEC, 2010], the New York State Department of Health, the United States Environmental Protection Agency (EPA), and the National Contingency Plan.

The Clinton Street former MGP site consists of two operable units, OU1 and OU2, as shown in Figure 2. This AA report is for OU2, following NYSDEC's acceptance (12/14/12) of the final remedial investigation report (RIR) for OU2 (GEI, 2012). A separate AA report was prepared for OU1 and is dated February 2012.

This AA document summarizes the remedial investigation (RI) findings and potential human health and environmental impacts identified at the site. It defines remedial goals, remedial action objectives (RAOs) and Standards, Criteria and Guidance (SCGs). It develops and evaluates remedial alternatives, and presents a recommended remedy for OU2. The balance of the document is divided into the following sections:

Section 2 - Site History, Description, and Conceptual Site Model

Section 3 - Exposure Assessment and Remedial Action Objectives

Section 4 - General Response Actions and Estimated Volumes

Section 5 - Identification and Screening of Technologies

Section 6 - Development and Analysis of Alternatives

Section 7 - Recommended Remedy

Section 8 - References

2. Site History, Description, and Conceptual Site Model

This section describes the Site and summarizes the Site history. It is based on information presented in the OU2 RIR.

2.1 Site Description

The Clinton Street former MGP is located at the corner of Broadway and Clinton Street in the City of Schenectady, Schenectady County, New York.

The extent of OU2 is shown in Figure 2. OU2 is located on the west side of Broadway, across from the former MGP process area in OU1. It has been divided into OU2 North and OU2 South to support administrative requirements and facilitate reporting.

OU2 North is a paved parking area on the north side of the Clinton Street Extension. It is bounded by Broadway on the east, Hamilton Street to the north, the Delaware and Hudson railroad to the west, and the Clinton Street Extension on the south. OU2 North also contains a small gravel lot at the end of the Clinton Street Extension that is referred to as the “postage stamp”. All of the land in OU2 North is owned by the City of Schenectady.

OU2 South is bounded by the Clinton Street Extension to the north, Broadway to the east, Edison Avenue to the south and the Delaware and Hudson railroad to the west. The gravel area south of the postage stamp and west of Van Guysling is part of OU2 and is owned by the City. The remainder of OU2 South between Van Guysling Avenue and Broadway consists of privately owned commercial buildings, paved parking lots and some vacant gravel lots.

The boundary between OU1 and OU2 along Broadway is dominated by a utility corridor which includes water and sewer mains, gas mains, underground electric, and a fiber optic trunk line. The fiber optic trunk line continues northeast along Clinton Street.

2.2 Site History and Former Structures

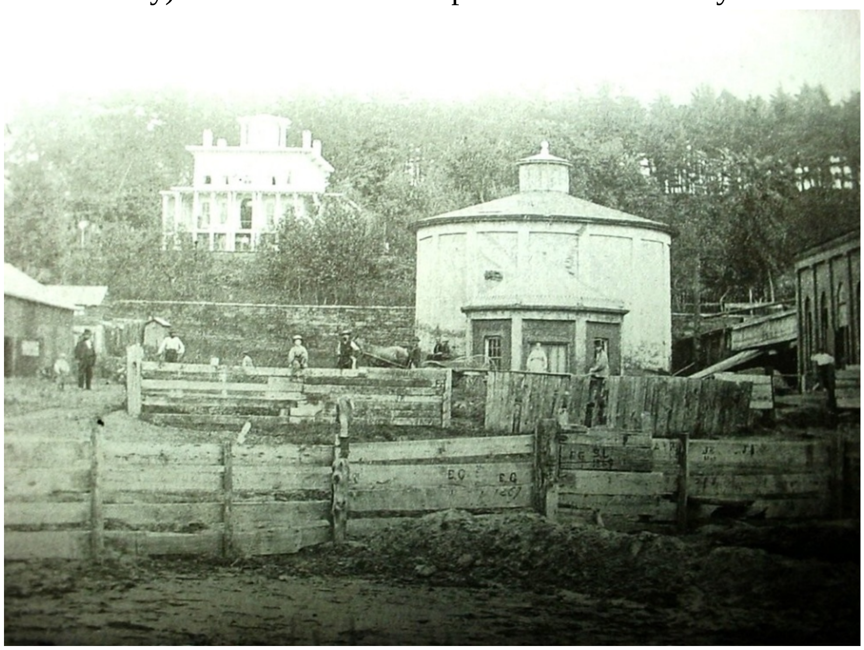
Historical land use information for the Site was developed using Sanborn Fire Insurance (Sanborn) maps, a historic Niagara Mohawk Power Company publication called *The Synchronizer*, the Phase 1A Literature Review and Archeological Assessment Report provided by Hartgen Archeological Associates, and digital photographs of other historic maps filed at the Schenectady Historical Society. These documents and more detail can be found in the OU2 RIR.

Sanborn maps were available for the areas of OU2 North and South for 1889, 1894, 1900, 1914, 1930, 1951, 1988, 1993-1995, and 1999. Additional OU2 North and South maps for 1866, 1880, 1884, 1889, 1892, 1894, and 1904 were reviewed at the Schenectady Historical Society office.

OU2 North and South were slowly developed for commercial uses between 1889 and 1930. None of the historical maps depicted MGP process buildings or structures in OU2 North or South. The former MGP structures were all located in OU1, shown in Figure 3.

2.2.1 The Gas Plant in OU1

According to *The Synchronizer* (1921) and A Guide for Historic Preservation (1978), the gas works was constructed in the early 1850s and began operation in 1851. The plant (Figure 3) was located on Center Street (now Broadway) and was the first to operate in Schenectady.



An 1870 view looking toward the Schenectady gas plant from Broadway.

An 1870 photograph (courtesy of Hartgen Archeological Associates, Inc.) taken from Broadway looking southeast, shows the office in front of a white gas holder. In 1882, according to the Burleigh map, a second gas holder was added to the plant close to Center Street. A pedestrian tunnel passing beneath the railroad is apparent in the 1892 map. The tunnel was blocked up (and used for storage by the City of Schenectady) at an unknown time and is not depicted on Sanborn maps.

The 1892 map depicts a right-of-way (ROW) attributed to the Schenectady Gas Light Company roughly in the same location as the current Clinton Street Extension.

The 1904 map indicates the plant was called the Mohawk Gas Company. The ROW first attributed to the Schenectady Gas Light Company (in 1892) is labeled Mohawk Gas Company in 1894.

Gas production ceased by 1906 when it the plant was "moved" to the second Schenectady MGP on Lower Broadway. Most of the remaining gas plant buildings, including the gas holder in the southeast portion of the Site, are depicted as storage and non-MGP use buildings on the 1910 map. These non-MGP uses remain apparent in the 1930 and 1951 Sanborn maps. No gas plant structures are apparent in the 1988 Sanborn map.

2.2.2 OU2 Land Development

In 1866 the land west of the gas works was open space with the Schermerhorn Creek and its tributaries draining the area. By 1880 a railroad ROW labeled as the "D&H Canal Co. (lessee)", was depicted running north and south. Also, in 1880 there appears to be a street or ROW between Center Street and the railroad that is labeled "Gas Co.". The 1882 oblique Burleigh map shows this ROW with two fence lines separating it from the open fields surrounding it. The current Clinton Street Extension occupies the former ROW.

By 1889, Brougham and Co. (a maker of horse drawn carriages) was established on the corner of Center Street and the unlabeled street leading toward the railroad. The land of OU2 North is shown as the Campbell Estate. Most of OU2 South is described as the Robert Furman Plat. In 1889, Van Guysling Avenue was marked out and building lots were established along it.

The 1894 map shows additional development with a photo shop and a "burnt out" building in OU2 North and further development along Center Street. There are a couple of homes shown near the Postage Stamp west of Van Guysling. By 1900 the area along the railroad on the west side of OU2 North had a builder's supply, a coal depot, a blacksmith shop and an ice house. The photo shop still existed at that time. The gas plant in OU1 ceased operating in 1906.

By 1914 there was significant commercial development in the area of OU2. OU2 North is identified as the City Pipe Yard (to be a public market). The Schenectady County Coal Company "Coal Pocket" building is depicted in the south west portion of OU2 North. A retaining wall separated a railroad spur that ran parallel to the building. A section of the spur appears to be a loading dock and there also appears to be a ramp into the building. The spur continued to the south and was built above a beverage depot before it ended in the OU2 South parcel. These structures remain in the 1930 and 1951 Sanborn maps; however, the Pipe Yard is now described as a public market. In the southeast corner of the Pipe Yard is a wagon painting building. A two story scale house is also depicted. The scale house currently remains in OU2 North.

Further south along Van Guysling was a hide and tallow company, a lubricating oil company, a wholesale grocery store, a beer company, and horse sales and stables.

By 1930 the buildings housing the beverage companies under the railroad spur were vacant, scattered piles of lumber and pipe are described on the south side of the Postage Stamp; junk storage and a junk yard were found on Van Guysling and a "filling station" was located in the middle of what is now the Clinton Street Extension. The 2007 C.T. Male Report (discussed below) describes the presence of an underground gasoline storage tank (1930) in OU2 North.

By 1951 another junk yard was shown where the lumber and pipe were in 1930 and across the street was a meat packing house.

In summary, OU2 had a number of mixed uses starting in 1889 which became fully developed by 1914, after the gas plant in OU1 had been decommissioned. The area of the Postage Stamp had coal storage, a wagon shed, beverage companies, a railroad spur, lumber and pipe storage, and a junk yard. Other potentially relevant businesses included a manufacturer of lubricating oil and a "filling station" just south of the Clinton Street Extension. By 1930 the lubricating oil manufacturer's site was occupied by a junk shop and attendant yard. Based on the Sanborn maps the junk shop remained through 1951 and up until to 1988, expanding further south and to the west of Van Guysling, encroaching (roughly) on the current location of 336 Broadway and the southwestern portion of OU2 South.

2.3 Physical Setting and Local Land and Water Use

2.3.1 Climate

The Schenectady area of Upstate New York is a temperate area with average summer temperatures of 83 degrees Fahrenheit and average winter temperatures of 13 degrees Fahrenheit. The annual average precipitation at Schenectady is 36.81 inches. Rainfall is fairly evenly distributed throughout the year. The wettest month of the year is June, with an average rainfall of 3.81 inches.

2.3.2 Topography

The ground surface in OU2 North and OU2 South is relatively flat with a slight gradient to the west. In general, the elevation on Broadway is about 226 feet. The elevation on Van Guysling Street is about 225 feet. Topographic contours are shown in Figure 2.

Surface water discharges to catch basins in Broadway and Van Guysling Avenue, the parking lots, and Schermerhorn Creek, which is partially culverted. Surface water ultimately drains to the Mohawk River approximately 3,500 feet northwest of the Site.

2.3.3 Land Use

OU2 is located in an urban area. Land use is predominantly commercial, and includes business offices, a Union Hall, and paved parking areas. To the east in OU1 is the Schenectady Municipal Housing Authority (SMHA) building with outdoor benches.

2.3.4 Zoning

The City of Schenectady has zoned the entire area within OU2 as C-4, Downtown Commercial District. This zoning is broadly described as non-residential and is meant to encourage mixed commercial use with easy pedestrian access. The City nonetheless has designated “Permitted and Special Permit Uses” which allow for residential use. Currently there is no known residential use in OU2.

2.3.5 Utilities and Infrastructure

OU2 is characterized by a predominance of critical underground utilities, as shown in Figure 3. The boundary between OU1 and OU2 along Broadway is dominated by a utility corridor which includes water and sewer mains, gas mains, underground electric, and a fiber optic trunk line. Van Guysling Avenue is lined with sanitary sewer, water, gas and overhead electric.

2.3.6 Water Supply in the Area

Water in the area of OU2 is publicly supplied from the Great Flats aquifer, also known as the Schenectady aquifer. The City’s Environmental Health department has reported that any private wells in the vicinity of the Site have been abandoned and there are no known private wells in the area. The site lies within the Schenectady Aquifer, which is a designated sole source aquifer area under Section 1427 of the Safe Drinking Water Act. The Schenectady public water supply is provided by wells located at the treatment plant on Rice Road in the Town of Rotterdam, approximately 2.3 miles from the site.

2.4 Site Geology

The geology of the Site was described in cross sections and on the test pit and soil boring logs included in the OU2 RI Report (GEI, 2012). Five subsurface soil units were identified during the investigation activities. Note: Refer to Figure 4 for the location of specific borings and monitoring wells:

- **Fill**: Fill material was observed in all borings. The minimum thickness was 1.1 feet (at SB-65/MW-18S(09) and the maximum thickness was 23 feet, at SB-155(11). The fill consisted of sand, gravel, wood fragments, brick, ash, and cinders.
- **Sand and silt:** Beneath the fill was a unit comprised of highly variable amounts of silt and sand. This is the same geologic formation described as the alluvium unit in the OU1 RI Report (AECOMa, 2009). The thickness of the sand/silt unit in OU2 South ranged from 2 feet at SB-42(08)/MW-14(08) to 73 feet at SB-81(09).
- **Lean clay:** A lean clay layer was identified during the pre-design investigation (PDI) in OU2 North at many of the PDI borings. Lean clay was identified at relatively shallow depths in OU2 South (SB-60/MW-17S(09), SB-76/MW-21S(09), SB-81(09), SB-125/MW-27S(10), and SB-127(10), in the Postage Stamp). The lean clay is not contiguous throughout

OU2; where present over a large area it is assumed to have confining properties.

- **Peat**: A peat layer was observed in eighteen borings at a depth that varied from approximately 12 to 22 feet below ground surface. The peat unit is not contiguous and its thickness ranged from less than six inches at SB-162(11) to 12.5 feet at SB-71(09).
- **Till**: A glacial till unit was identified at approximately 90 feet below ground surface in OU1. In OU2 South it was encountered at approximately 70 to 80 feet below ground surface at seven boring locations: SB-61/MW-17D(09), SB-63(09), SB-64(09), SB-66/MW-18D(09), SB-71(09), SB-92(09), and SB-95/MW-26D(09). The till consists of lean clay with gravel, is non-plastic, and is assumed to have confining properties. It is assumed to be a contiguous unit and at SB-63(09), it was at least 10 feet thick. The total maximum thickness is not known.

2.5 Surface Water Hydrology

Surface water flow direction across OU2 roughly follows the slope of the ground surface from southeast to northwest, with discharge to a series of catch basins in Clinton Street, Broadway, and Van Guysling Avenue. Most storm water is ultimately channeled into Schermerhorn Creek via a storm sewer beneath Van Guysling Avenue.

2.6 Site Hydrogeology

The water table in OU2 is found at depths generally ranging from approximately 5 to 11 feet below ground surface. The groundwater flow direction in OU2 North and South (2009 data) for shallow wells (less than 40 feet deep) screened across the water table is shown in Figure 5. Shallow groundwater flow is from the northeast to southwest across OU2 North and OU2 South, with Schermerhorn Creek as the apparent discharge point. The hydraulic gradient for the 2009 shallow groundwater flow is approximately 0.0047 feet per foot (ft/ft). Figure 5 also includes the groundwater flow direction for the select wells sampled in 2011. While there is some variance in contour lines, the shallow groundwater flow is apparently influenced by Schermerhorn Creek – where shallow groundwater discharge occurs. The hydraulic gradient for the 2011 shallow groundwater flow at and near the Postage Stamp is approximately 0.008 ft/ft.

The groundwater flow direction for deep wells (40 to 90 feet deep), shown in Figure 6, is from the east-northeast to the west-southwest in OU2 North and OU2 South. The hydraulic gradient for the deeper groundwater is 0.0008 to 0.002 ft/ft.

A slight downward gradient is apparent at the well pairs closest to Broadway. Farther to the west, the gradient shifts upward. The variance may be a function of the permeability of the soil the wells were screened in and/or discharge of groundwater to Schermerhorn Creek. Regardless of cause, the variances do not affect groundwater flow findings described above.

2.7 Extent of Impacts and Conceptual Site Model

2.7.1 Potential Sources of MGP Residuals

Former site operations in OU1 are the primary source of MGP-impacts in OU2. Tar migrated from OU1 beneath Broadway and to the west into OU2. Impacts in OU2 north were deposited there or migrated via a steel pipe found and removed during the Interim Remedial Measure (IRM). The pipe appeared to originate at former gas holder B. MGP impacts beneath the Postage Stamp migrated in the subsurface from OU2 North, via the steel pipe, or both. No evidence of the steel pipe was found at the Postage Stamp in April 2013 when test pits were excavated to search for it.

MGP-residuals in OU2 act as source areas, as follows:

- Deep soils (40 to 45 feet) along the west side of Broadway in OU2 have tar saturated intervals (with intervals ranging from 2 to 5.5 feet thick). Recovery wells have been installed and non-aqueous phase liquid (NAPL) is being recovered. The downgradient extent of subsurface tar saturation was identified during the OU2 RI. Tar is present in the subsurface below the water table and does have an effect on groundwater to the west/southwest.

- The IRM completed in OU2 North removed MGP residuals that were acting as source material to groundwater impacts. As a result of the IRM, OU2 North (on the north side of the Clinton Street Extension) is no longer regarded as a source area.

- MGP impacts are present beneath Clinton Street Extension and sidewalks to the south of the extension. They are also present in the subsurface at the Postage Stamp. At both locations, groundwater quality has been affected at concentrations above the SCGs. However, liquid tar has not been observed in these areas and the continued migration of tar is unlikely.

- All OU2 analytical data were compared to observations of physical impacts in the sampled interval. All samples with only an MGP odor and/or MGP staining had less than 500 milligrams per kilogram (mg/kg) of total polycyclic aromatic hydrocarbons (PAHs) and individual volatile organic compounds (VOC) compounds less than the Commercial SCOs for that individual VOC. All samples with sheen, blebs, or tar exceeded either the 500 mg/kg total PAHs or at least one of the VOC Commercial SCOs.

2.7.2 Nature and Extent of Contamination

Subsurface soil physical impacts in OU2 North and OU2 South are present along both sides of the Clinton Street Extension, the western side of Broadway across from the OU1 source area, and at the Postage Stamp and associated area.

2.7.2.1 OU2 North

The 312 Broadway impacts in OU2 North were addressed during the IRM in 2012. The IRM Completion Report is in review with NYSDEC.

2.7.2.2 OU2 South, Northern Portion

The shallowest MGP-related impact was a slight tar-like odor encountered at approximately 9 feet below ground surface at SB-110(10), between 318 and 330 Broadway. No evidence of sheen, blebs, or NAPL was present at this location. Other MGP physical impacts (odors, staining, sheen, blebs, globs, coatings, and lenses of saturation) were observed at depths generally ranging from 10 to 14 feet deep in the area between the Clinton Street Extension and the property at 336 Broadway (Figure 2). Aside from SB-110(10), the impacts located in this area are covered with at least 10 feet of un-impacted soil or by buildings, pavement, and sidewalks.

Soil vapor impacts are present at SV7(08). VOCs indicative of an MGP source and possibly other sources were detected, but are below a level of concern for soil vapor intrusion. This suggests that non-MGP petroleum products are the source of VOCs found in the soil vapor sample. Additional soil vapor sampling was conducted in February 2012. The results were provided separately to NYSDEC and they were consistent with those at SV7(08).

2.7.2.3 OU2 South, Southern Portion

In the southern portion of OU2 South, NAPL was observed at depths ranging from 39.5 to 45 feet below ground surface on the west side of Broadway. The soil impacts in OU2 South are terminated approximately 25 feet above the till unit that was encountered between approximately 70 to 77 feet below ground surface; subsurface soil physical impacts have been delineated. OU1 is the source of these impacts.

2.7.2.4 Postage Stamp and Associated Area

Impacts at the Postage Stamp are well documented. Polychlorinated Biphenyls (PCBs), unrelated to former gas-making, are present in the surface and shallow subsurface. The PCB impacts will be addressed by other parties.

MGP-impacted soil lies below the PCB impacts, with NAPL evidence present at about 10 feet below ground surface. The maximum depth of MGP visual impacts is 24 feet below ground surface.

2.7.2.5 OU2 Groundwater

Hydrocarbon impacts in shallow and deep overburden groundwater have been delineated. Based on groundwater that meets the SCGs at downgradient locations, the impacts are confined to OU2, except at shallow well SB-125/MW27S(10), south of the Postage Stamp. This well was installed in MGP-impacted soil. Otherwise, overburden groundwater impacts are reduced as they flow toward Schermerhorn Creek. Organic compounds are very low or non-detectable at wells SB-60/MW-17S(09), SB-61/MW-17D(09), SB-65/MW-18S(09), and SB-66/MW-18D(09) to the south; SB-84/MW-24S(09), SB-86/MW-25S(09), SB-87/MW-25D(09), and SB-165/MW-29S(11) to the west; and SB-95/MW-26D(09) to the north. Additional information about the nature and extent of contamination can be found in the RIR.

2.7.3 Fate and Transport Mechanisms

Based on the borings and test pits performed during the OU2 RI, the majority of the source material in OU2 South lies at depths of 40 to 45 feet below ground surface on the west side of Broadway. Unimpacted subsurface soil was found downgradient of the area and tar recovery is on-going at wells along Broadway. As such, additional migration is unlikely.

The IRM completed in OU2 North removed potential source material that would have provided "head" to MGP residuals beneath the Clinton Street Extension and the Postage Stamp, where the shallowest evidence of tar was observed at 10 feet below ground surface. Observation of MGP residuals in that area did not suggest the presence of mobile NAPL.

2.7.4 NAPL Removal Program

As part of the NYSDEC-approved NAPL Removal Program, GEI Consultants, Inc. (GEI) gauges, monitors and recovers NAPL in wells SB-19/MW-8S(06) and SB-44/MW-8D(08) in OU1 and SB-30/MW-12D(08), SB-43/MW-14D(08), and SB-117/RW-1(10) in OU2 on a twice per month basis. This effort is being conducted to establish the feasibility and practicality of a more formal NAPL recovery program. GEI provides the NYSDEC with an annual report that summarizes this work. In the last year there has been little or no recovery from the wells in OU-1. Most recovery has occurred from SB-43/MW-14D(08).

2.7.5 Adjacent Site

During the OU2 RI field work, GEI learned that remedial efforts were underway at an adjacent site. According to EPA documents (http://www.epaosc.org/Schemerhorn - correct spelling is *Schermerhorn*), a metal scrap yard was operated by Buff and Buff, Inc. at 95 Van Guysling Avenue from 1953 to 1993. This is located down gradient of OU2 South. The location is identified in Figure 4.

PCB oils were discharged onto the ground surface at that Site. EPA oversaw removal of the upper 5 feet of soils and stabilization of deeper soils in 2009. The cleanup was completed in April 2010.

2.8 Conceptual Site Model

Source(s)

OU1 is the source of NAPL and PAHs in OU2.

PCBs are present in the shallow subsurface at the Postage Stamp and associated area. The former railroad tunnel (now the vault) was initially identified as a potential source for PCBs. However, the concentrations of PCBs at the Postage Stamp and associated area are higher. The former Buff and Buff scrapyard is a likely source, given the EPA PCB cleanup conducted there in 2009.

Total and free cyanide are present in both soil and groundwater in OU2 North and OU2 south. The cyanide source is uncertain. It may be related to road salt stored in both OU2 North and OU2 South. Cyanide can be related to MGP purifier waste, but none has been observed at the Site.

Migration Pathways

A steel pipe containing MGP-residues was found in the subsurface during the IRM at 312 Broadway. The directional trend of the pipe suggested its origin was Gas Holder C, in OU1.

Most tar recently observed in OU2 North is very viscous or hardened and was removed during the IRM. The locations and elevations of former MGP impacts at 312 Broadway are consistent with south/southwest migration (and groundwater flow direction) beneath the Clinton Street Extension and towards the Postage Stamp and associated area. The steel pipe found during the IRM was further investigated to determine if it was a NAPL pathway to the Postage Stamp. No steel pipe was found and it is not possible to conclude that it was a tar conduit to the Postage Stamp.

A lean clay unit was observed in a number of borings in OU2 North and the northern portion of OU2 South. This unit may have influenced active NAPL movement in the past.

The depth of most former MGP impacts in OU2 North ranged from about 6 to 15 feet below ground surface. These depths suggest it was the source of subsurface soil and groundwater impacts between 10 and 24 feet below ground surface on the south side of the Clinton Street Extension.

Subsurface soil has been a migration pathway for NAPL from OU1 west into the eastern portion of OU2 South beneath Broadway. The migration appears to be on-going because coal tar dense non-aqueous phase liquid is periodically removed from recovery wells in OU2 South on the west side of Broadway and they continue to recharge with coal tar. The coal tar in this part of OU2 South is a source of dissolved constituents in groundwater in OU2 South, though acceptable groundwater quality is present at the downgradient site boundaries.

No evidence of coal tar has been found in the OU2 South subsurface more than 150 feet west of Broadway. The depth to coal tar on the west side of Broadway ranges from approximately 29 to 45 feet below ground surface. Downgradient physical impacts (to the west) are consistent with these depths – to almost 43 feet below ground surface at SB-112(10).

Based on analytical results, the extent of soil and groundwater physical and chemical impacts is limited to within the boundaries of OU2 North and South, except just south of the Postage Stamp, where impacted subsurface soil and groundwater is present near the railroad at well SB-125/MW-27S(10).

Ecological Receptors

There is little or no habitat for flora or fauna at or near OU2, given the urban environment. There are no significant ecological receptors.

Human Receptors

As discussed in Section 6, there are several potential human receptors for compounds detected in surface soil, subsurface soil, groundwater, and soil vapor. The potential receptors for surface soil include adults and trespassers. The potential receptors for subsurface soils, groundwater, and soil vapor are construction and utility workers – those with reason to perform intrusive activities such as excavation that might expose impacted soils or groundwater.

3. Exposure Assessment and Remedial Action Objectives

This section presents the RAOs that apply to this Site, based on an understanding of the exposure pathways provided in the OU2 RIR and the applicable regulatory SCGs for the Site.

3.1 Exposure Pathways

Complete exposure pathways do not exist in OU2 North on the north side of the Clinton Street Extension, unless intrusive excavation and construction were to occur. An IRM was completed there to remove source material in the fall of 2012. The entire area has been repaved and currently meets the NYSDEC Commercial use standards. Future site management will not allow intrusive work without appropriate controls, which are actively maintained now and will be into the future. In addition, deed restrictions, a Site Management Plan, and periodic inspections will be implemented by National Grid to further protect against exposure concerns. This is further discussed in Sections 6 and 7 of this document.

Only potentially complete pathways exist beneath the Clinton Street Extension and OU2 South between Broadway and Van Guysling Avenue. The pathways would be complete only if intrusive excavation or construction were to penetrate deep enough. However, along Broadway, the impacts are too deep to expose during any typical excavation. Beneath the Clinton Street Extension and between Broadway and Van Guysling, the impacts are generally covered with buildings and parking areas.

At the Postage Stamp, however, complete pathways are currently present for direct contact, inhalation, or ingestion of PCBs and total cyanide, which are present above the Commercial SCOs in surface soil and shallow subsurface soil. These impacts are not related to the former MGP and National Grid is not responsible for them, even though MGP impacts are present below them.

Section 6.1 of the RIR presents an assessment of the exposure pathways at the various properties that comprise the Site study area. The following summary is provided to form the basis for the Site RAOs.

3.1.1 Exposure Pathways

- **"Near Surface" Soil:** Outside of the Postage Stamp, numerous episodes of redevelopment which have involved re-grading of the ground surface and the installation of parking lots, buildings, and modern landscaped areas have caused the risk of impacts to users of OU2 to be very low. The potential receptors include the Adult Commercial Worker, Adult Utility

Worker, Visitor, and Trespasser under current and future expected use in these areas. The potential pathways are ingestion, dermal contact, and inhalation. Potentially complete exposure pathways exist for these compounds.

- **Subsurface Soil:** OU2 has subsurface MGP-related impacts, primarily at the Postage Stamp and OU2 South. In the northern portion of OU2 South, most of these impacts are located under buildings or paved areas, and beneath at least 10 feet of non-impacted areas. Therefore, these impacts would only be encountered during invasive excavations. Potentially complete exposure pathways exist for these compounds. The potential pathways are ingestion, dermal contact, and inhalation. The potential receptors include the Adult Commercial Worker and Adult Utility Worker under current and future expected use in OU2 South. Adults, children, and trespassers are not expected to conduct excavations that would cause exposure.

  In the southern portion of OU2 South on the west side of Broadway, NAPL is present at depths greater than 35 feet below ground surface. These are inaccessible to all but the deepest excavations.

- **Groundwater:** The groundwater impacts would only be encountered during an invasive excavation below the groundwater table, which ranges from 5 to 11 feet below ground surface. Potential groundwater receptors include the Adult Commercial Worker and the Adult Utility Worker. There are potentially complete pathways via ingestion, dermal contact, and inhalation. An actual complete pathway would be triggered by intrusive subsurface activity, such as excavation. The depth to groundwater at the Site limits the potential for contact and the entire urban area of Schenectady is on a public water system.

- **Soil Vapor:** VOCs were found in soil vapor samples in OU2, in the vicinity of 318 Broadway. Shallower soil vapor compounds were at higher concentrations than the deeper samples, which are closer to MGP impacts. MGP-related soil vapor impacts that would cause vapor intrusion into OU2 buildings were not identified. The risk of indoor air quality issues from MGP-related impacts is low.

Based on the Unrestricted SCOs (for surface and subsurface soil), the Ambient Water Quality Standards, Guidance Values, and Groundwater Effluent Limitations (AWQS) for groundwater, and the presence of volatile compounds in soil vapor at concentrations above “background”, there are potentially complete exposure pathways for all three media.

3.2 Standards, Criteria, and Guidance

As defined in the DER-10, standards and criteria are the New York State regulations or statutes that dictate the cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations which are generally applicable, consistently applied, officially promulgated and are directly applicable to a remedial action.

The principal SCGs that are typically applicable are:

- *6 NYCRR § 375-1: General Remedial Program Requirements;*
- *6 NYCRR§ 375-2: Inactive Hazardous Waste Disposal Site Remedial Program;*
- *6 NYCRR§ 375-6: Remedial Program Soil Cleanup Objectives;*
- *Draft NYSDEC Policy Memorandum on Soil Cleanup Guidance (Soil Cleanup Memo), November 4, 2009;*
- *NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations;*
- *Guidance for Evaluating Soil Vapor Intrusion in New York;*
- *DER-10 Technical Guidance for Site Investigation and Remediation;*
- *NYSDEC* Soil Cleanup Guidance, NYSDEC Policy, October 21, 2010 *(CP-51) Soil Cleanup Guidance;*
- *DER-31 Green Remediation, and*
- Technical and Administrative Guidance Memorandum *(TAGM) 4030-Selection of Remedial Actions at Inactive Hazardous Waste Sites.*

However, the VCO allows some flexibility with application of SCGs, such that NYSDEC will consider site-specific approaches that are adequately protective of humans and ecology. As such, National Grid proposed a site-specific clean-up strategy that would be protective of humans and ecology in a letter dated April 1, 2013, to NYSDEC (Appendix A). NYSDEC confirmed the strategy was acceptable in an email dated April 5, 2013 (Appendix A).

Therefore, the site-specific cleanup levels for the MGP-related contaminants of concern in soil and groundwater are the SCGs that will be used to define the RAOs and to develop the remedial alternatives.

3.2.1 Soil Cleanup Levels for OU2

As stated in the CP-51 Soil Cleanup Guidance, Section 5, Paragraph A: *a soil cleanup level is the concentration of a given contaminant for a specific site that must be achieved under a remedial program for soil. The determination of soil cleanup levels is dependent on the following criteria* (The criteria are provided in *italics,* below):

1. *The applicable regulatory program*, which for this site is the Voluntary Cleanup Program;

2. *Whether the groundwater beneath or downgradient of the site is or may become contaminated with site related compounds.* Results from the RI indicate that groundwater

contamination is present but primarily limited to the Site.

3. *Whether ecological resources constitute an important component of the environment at or adjacent to the site, and which are, or may be, impacted by site-related contaminants.* Ecological resource considerations do not apply for this AA because OU2 and adjacent properties are characterized by landscaped and developed properties;

4. *Other impacted environmental media such as surface water, sediment, and soil vapor*. These considerations are not applicable for this Site, as described in Section 2, above. Contaminants in soil vapor within OU2 were not detected at a level of concern for SVI.

After evaluating the nature and extent of the soil impacts on OU2, this AA presents alternatives based on the removal of shallow soils that contain source material; total PAHs greater than 500 mg/kg, as described in the CP-51, Paragraph H; and/or individual VOC exceedances of Commercial Use SCOs. These criteria will be applied to the soil impacts at the Postage Stamp, in the gravel area on the west side of Van Guysling Avenue.

Impacted soils in the northern portion of OU2 South that are located below asphalt, concrete, or buildings and have at least 10 feet of non-impacted soil above them were not included in this approach. These will be addressed with institutional controls.

Recoverable NAPL located in the eastern portion of OU2 South on the west side of Broadway, where existing recovery operations are ongoing, will also be addressed. The development of these SCOs is described in more detail below.

Protection of Groundwater. The Site is located within the Great Flats aquifer, also known as the Schenectady aquifer, which is designated as a sole source aquifer area under section 1427 of the Safe Drinking Water Act. Protection of Groundwater SCOs (which are the Unrestricted SCOs for the organic and inorganic compounds at this Site) may be deemed not applicable by the DEC, allowing a Restricted Use approach, if the following conditions are met, as described in CP-51 Soil Cleanup Guidance, Section V, Paragraph D2 (the Guidance text is provided in *italics,* below):

- *The groundwater standard contravention is the result of an on-site source which is addressed by the remedial program.* In order for this condition to be met, the remedial alternatives in this AA that are based on the CP-51 approach include technologies that address the on-site source materials.

- *An environmental easement or other institutional control will be put in place which provides for a groundwater use restriction*. This provision is included in the alternatives in this AA that are based on the Unrestricted and Restricted Use approach.

- *DEC determines that contaminated groundwater at the site either:*

  - *Is not migrating or likely to migrate off site*. Impacted groundwater is migrating through OU2, but on-site monitoring wells downgradient of the deeper source material along Broadway are clean.

    or

  - *Is migrating or likely to migrate off site; however, the remedy includes active groundwater management to address off-site migration.* Potentially impacted shallow groundwater is migrating off-site from the Postage Stamp and Associated area (wells SB-125/MW-27S(10) and SB-165/MW-29S(11)) but an excavation to meet CP-51 criteria (total PAHs greater than 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs is planned for this area of the Site. These groundwater impacts were not caused by the deeper tar impacts on the west side of Broadway. This conclusion is based on groundwater contours and flow paths (Figures 5 and 6) and the shallow screen intervals of the impacted wells at the Postage Stamp and Associated Area.

- *DEC determines that groundwater quality will improve over time*. Groundwater quality improvements over time have been documented at a large number of MGP sites. A recent scientific report of a 14-year monitoring program at an MGP site in New York has demonstrated that monitored natural attenuation (MNA) is a viable remedial strategy for groundwater after the original source is removed, stabilized, or contained (Neuhauser, et al, 2009). While complete groundwater restoration will take many years, additional tar recovery along the west side of Broadway (as further discussed in Section 6), is expected to result in improved groundwater quality in the future. In addition, removal of subsurface impacts at the Postage Stamp will improve the quality of groundwater migrating off-site. Finally, post-excavation groundwater monitoring will be part of on-going site management and institutional controls.

Land Uses and SCOs. Using the CP-51 Criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs as the SCOs on the west side of Van Guysling Avenue will allow for commercial use which is both the current and future anticipated land use. Potential exposure to remaining contaminates will be mitigated by the use of institutional and engineering controls.

3.2.2 Groundwater Cleanup Levels for OU2

The SCGs for groundwater quality are the AWQS identified in "*NYSDEC Technical and Operational Guidance Series 1.1.1*" (TOGS).

3.3 Remedial Action Objectives

The RAOs are established as the overall goals for the site remediation to provide protection of human health and the environment.

Upon consideration of the SCGs, and the nature and extent of MGP impacts, as described in the RI, the following RAOs were developed for OU2. These RAOs are goals to be achieved to the extent practicable.

3.3.1 Soil

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of contaminants, including dust, from the soil.
- Prevent migration of contaminants that would result in groundwater or surface water contamination.

3.3.2 Groundwater

- Prevent contact with, or inhalation of volatiles from contaminated groundwater.
- Improve groundwater quality, to the extent practicable.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

4. General Response Actions and Estimated Volumes

In accordance with the guidance provided in DER-10 regarding the development and evaluation of remedial alternatives, this section describes the development of General Response Actions (GRAs) to address the RAOs identified in Section 3, and the estimated volumes of impacted media within OU2.

4.1 Range of GRAs

GRAs are not specific to any single technology, but represent categories or approaches which may be combined and further defined to create remedial alternatives. To meet the RAOs developed for the Site, the following GRAs were identified:

1. **No Action.** This response action is listed for compliance with AA guidance, but would not result in meeting the RAOs and is not contemplated for this Site.
2. **Administrative Actions Pertaining to Soil or Groundwater.** These actions involve restrictions of legal access to soil or groundwater. They are combined with other actions in the development of alternatives.
3. **Containment of Soil and Groundwater.** Containment actions involve little or no treatment, but provide physical barriers to exposure, or otherwise remove pathways of exposure. These actions include vertical barriers and surface caps.
4. **Removal and Off-site Treatment/Disposal of Soil and NAPL/Groundwater**. These actions include excavation of impacted soil and extraction of NAPL, and off-site treatment/disposal of these in properly permitted facilities.

4.2 General Extent of Impacts

The nature and extent of impacts at OU2 in surface soil, subsurface soil, NAPL, and groundwater were described in Section 2. Figure 7 shows the maximum depth of soil that exceeds CP-51 criteria (total PAHs greater than 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs and maximum depth of MGP-related visual impacts (tar sheens and greater).

In accordance with the guidance provided in DER-10, this section also presents the maximum extent of impacts in soil. The total maximum areal extent of soil impacts, defined as exceedances of Part 375 Unrestricted SCOs, are shown in Figure 8.

4.3 Volume Estimates

The volumes of impacted soil and NAPL present at OU2 were estimated for the purpose of providing a basis for the development and evaluation of remedial alternatives. The table below provides a summary of the volumes for each impacted medium. Volume calculation sheets and figures are provided in Appendix B.

Estimated Volumes of Impacted Media Exceeding Relevant SCOs or CP-51

Medium or Material in OU2	Estimated Volume [cubic yard (CY)]	Estimated Volume (gallons)
Unrestricted SCOs (accessible and inaccessible soils) in OU2	113,946	--
CP-51 (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs and Source Material in OU2	8,450	--
Potentially Recoverable NAPL (in OU2)	--	400 (5% porosity) 1,800 (24% porosity)

Some "clean" soil is included in the estimate because it must be removed to access deeper impacts. Soil borings lacking visual impacts and analytical data are assumed to be "clean", based on logging observations. Impacted soils at least 10 feet below asphalt, concrete, or buildings are not included. Soil borings with physical impacts but no associated analytical data are assumed to have an average concentration based on surrounding borings with similar impacts. Soils exhibiting sheens or greater are assumed for this site to exceed CP-51 and/or individual VOC exceedance of Commercial Use SCOs criteria, as described in section 2.7.1.

4.3.1 Surface Soils

MGP-impacted surface soils are not known to be present on OU2. PCBs were detected in surface soil samples at the Postage Stamp and associated area, but they are not MGP-related impacts. NYSDEC has concurred with this finding, and as such, surface soil is not addressed with this AA. At the Postage Stamp it will be addressed by others.

4.3.2 Subsurface Soils

Impacted soil volumes were estimated as the product of the impacted area and applicable impacted depths. Although non-impacted soils are present in the upper 4 to 6 feet of soil, these soils were included in the volume estimates because they would need to be excavated and managed to gain access to the deeper impacted soils in most remedial scenarios. Volume calculation sheets and associated figures are provided in Appendix B. All soil volumes were rounded to the nearest 10 cubic yards.

As discussed in Section 3, there is one land use approach applicable to OU2 for the foreseeable future. Single-family residential use was not considered in the AA due to the existing parking and commercial uses, which the City and NYSDEC expect to continue. Though the zoning can make special designations for residential use, these are generally not expected. Therefore, CP-51 criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs was used during the evaluation in accordance with NYS Part 375 and the NYS Soil Cleanup Policy

(CP-51) Memorandum. Evaluation of soil removal to Unrestricted SCO levels was considered only for comparison purposes in Section 6.

The soil volume exceeding the Unrestricted SCOs was estimated by referring to the RIR data tables for soils exceeding individual PAHs and the individual benzene, toluene, ethylbenzene, and xylene compounds, and including observed source materials, which will exceed the Unrestricted SCOs. This volume is 113,790 cubic yards. The soil volume exceeding the CP-51 criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs was estimated by referring to the RIR data tables for soils and also including observed source materials. The soil volume exceeding these criteria is 8,450 cubic yards.

Potentially recoverable NAPL exists at the site on the west side of Broadway in tar saturated soils at the following borings:

- SB-30/MW-12D(08), from 41.5 to 43.5 feet bgs;
- SB-35/MW-13D(08), from 40 to 41 feet bgs;
- SB-43/MW-14D(08), from 39.5 to 45 feet bgs;
- SB-117/RW-1(10), from 44.8 to 45.3 feet bgs.

Based on these data, it was assumed that the thickness of tar saturated soils is approximately 2 feet thick. (This assumption is for estimating purposes only, and will be refined during the design process). The total volume of potentially recoverable NAPL was estimated to range from approximately 400 to 1,800 gallons, depending on porosity. These volume calculations and the assumptions made to perform them can be found in Appendix B and in Figure 7.

5. Identification and Screening of Technologies

An initial screening process was used to determine the most applicable technologies for the Site, using literature sources and GEI's experience at similar sites (FRTR, 2002; GRI, 1997; ITRC, 2002; NYSDEC, 1992). Technologies corresponding to the General Response Actions were further refined and developed for this Site. Table 1 provides a summary of the effectiveness, implementability, and costs of each technology, and whether or not they were retained for use in the alternatives. The remainder of this section provides additional brief descriptions of the technologies.

5.1 Institutional and Engineering Site Controls

Site controls can effectively prevent exposures for potential receptors. They do not involve direct management of the impacted media, and therefore they are not effective in limiting subsurface migration of contaminants, or in volume reduction, or treatment. They consist of institutional controls and engineering controls (IC/ECs). Site controls are included in an alternative if the remedy does not immediately achieve RAOs, and use restrictions need to be applied.

The institutional controls that are applicable to alternatives for OU2 include a site use agreement between National Grid and the Site owners for groundwater use and Site use, a municipal ordinance restricting construction and use of groundwater wells, and a site management plan providing procedures to be implemented prior to disturbance of impacted soils, and periodic engineering inspections. The engineering controls that are applicable to OU2 include maintenance of Site pavement and signage to warn against excavation. Subsurface demarcation barriers, such as orange geo-fabrics, are important engineering controls which provide visual indications of impacted soil areas.

5.2 Containment Technologies

Containment technologies include surface caps, vertical barriers, and soil containment by In-Situ Solidification (ISS).

Caps include surface cover soil and impervious caps. These are effective for controlling exposure from surface soils. However, caps are not effective in preventing subsurface migration of NAPL, do not reduce the volume of source material, and require institutional controls. MGP impacted surface soils are not present on OU2. Therefore, capping is eliminated from further consideration as the primary component of remedial alternatives.

Low permeability barriers minimize infiltration of precipitation to source areas, reducing migration of dissolved contaminants. The purpose of vertical barrier containment technologies would be to reduce migration of impacted groundwater and NAPL by containment of these impacted media. There are four technologies commonly used to construct physical barriers for containment: 1) plastic liners used to minimize recontamination from adjacent impacted soils, 2) slurry walls, 3) grout curtains, and 4) sheet piling. All four technologies involve the construction of an impermeable wall capable of blocking groundwater and NAPL migration. Additional descriptions are provided in Section 5.4, below.

For permanent barriers as a primary component of a Site-wide remedy, the limitations of future Site use and continuing operation and maintenance of groundwater control or treatment systems are primary concerns. A confining layer is necessary for vertical barriers to be constructible and effective, and the confining layer needs to be a comprised of soils with low permeability. A contiguous till unit is present at the Site beginning at approximately 75 feet below ground surface. A vertical barrier of this depth would be expensive and unnecessary for the small layers of tar saturation that exist at the Site. These walls do not treat impacted soil to meet Unrestricted Use, Commercial Use, or CP-51 criteria and do not reduce the volume of source material. For this Site, these reasons eliminate barrier containment technologies from further consideration as the primary component of remedial alternatives. However, this technology is retained for use in detailed design of excavation alternatives and excavation support.

ISS technologies have aspects of containment and in-situ treatment. ISS of impacted soil involves the in-place mixing of cementitious reagents (such as Portland cement) with impacted soil to create a solid monolith that substantially decreases the ability of groundwater to come into contact with contaminants. An early use of the technology was for treatment of PCB-impacted soils (Stinson and Sawyer, 1988), metals-impacted soils, and oil-impacted soils (Conner, 1990). It is becoming an increasingly accepted means of remediation at MGP sites (EPA, 2000), including MGP sites in New York State (New York Construction, 2007), such as the Hiawatha Blvd., former MGP site in Syracuse. The ISS technology relies on the selection of the appropriate agents and proportions (the "mix design") as well as the successful delivery system to provide in-situ contact and encapsulation of the impacted soil. The three common delivery systems used for ISS are bucket mixing, auger mixing, and pressure/jet grouting.

ISS results in the formation of a solid monolith of relatively impermeable material in the saturated zone. Groundwater is forced around and under the ISS monolith, thus preventing contact of groundwater with the constituents of concern (COC) contained in the monolith. However, at some sites, the changed hydrogeologic regime can pose a risk for increased migration of NAPL and contaminant of primary concern (COPCs) from areas adjacent to the ISS monolith. This unintended consequence is the primary concern regarding the overall effectiveness of ISS at OU2.

Groundwater flow from OU1 into OU2 would encounter the ISS monolith, resulting in increased flow through the adjacent areas. Increased migration of COPCs and NAPL, or migration into areas not presently impacted, could result. Although subsurface drainage could be installed on either side of the ISS monolith, the effects at downgradient discharge points and the long-term effectiveness of the drainage systems would not be assured. These walls do not treat impacted soil to meet Unrestricted Use, Commercial Use, or CP-51 criteria and do not reduce the volume of source material. Therefore, use of ISS as a component of the remedy at OU2 is not recommended and this technology was not carried forward for development of alternatives at this Site.

5.3 On-site and In-situ Treatment

On-site and in-situ treatment technologies use chemical, thermal or biological processes to reduce the toxicity or volume of contaminants. The technologies evaluated for this alternatives analysis included on-site soil treatment and air sparging/soil vapor extraction.

On-site soil treatment processes conducted on excavated soil include biological, chemical or thermal treatment. The effectiveness of these processes is variable and each requires a site-specific demonstration to determine the degree of treatment, time, and land area required. One specific on-site soil treatment process is the application of oxygen release compound (ORC). ORC supplies "controlled-release molecular oxygen to the subsurface environment that will accelerate the rate of naturally occurring aerobic contaminant biodegradation in groundwater and [groundwater] saturated soils for periods of up to 12 months on a single application" (Regenesis, 2013). ORC is usually mixed with water to form a slurry and directly injected into the soil. ORC can also be applied to excavations in a dry powder form or as a slurry to exposed soils, and maximum treatment occurs when the ORC is mixed with the backfill material (Regenesis, 2013). In general, these processes require a location with an appropriate distance from surface features and existing structures. These considerations resulted in on-site treatment processes not being retained as the primary component of remedial alternatives; however, since excavation is a component of the remedy, ORC application is retained in, conjunction with the excavation alternative, as a "polishing" step to remove any remaining residual halo around the removed source area.

Air sparging/soil vapor extraction is the injection of pressurized air into the subsurface below the water table to induce volatilization of dissolved phase COPCs. The volatilized compounds are then removed by active vapor extraction wells. This technology is applicable to sites such as gasoline spills where VOCs are predominant. PAHs are the predominant COPCs at the Site, and these considerations resulted in this technology not being retained for alternative development.

5.4 Removal Technologies

5.4.1 Overview of Excavation and Related Technologies

Technologies for excavation include use of conventional trackhoe equipment for excavation to depths of 20 feet, extended arm trackhoe equipment for excavation to depths of 40 feet, and crane-mounted Kellybar/clam shell equipment for excavation to depths of 100 feet or more (Hayward Baker, 2005). At OU2, excavation for removal of impacted soils will extend to a depth of 15 feet. A combination of conventional trackhoe and extended arm trackhoe technologies, and staged, benched excavations, would be used to accomplish the excavation work. Most impacts at the Site exist in the shallow subsurface soils, from 5 to 17 feet below ground surface. Some impacts—including tar saturation—do extend to 45 feet below ground surface, but recovery wells are located at these locations. The Site is developed in the area of these deep impacts, with paved lots and buildings. An excavation to target these deep impacts would cause significant impact to the community including building and pavement demolition, construction dewatering, and significant increase of the number of truck movements transporting impacted soil off-site. Therefore, deep excavation is not retained for the development of the alternatives.

However, shallow excavation to target soils that exceed CP-51 criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs in the top 15 feet is retained for the alternative at the Postage Stamp.

Control of odors and VOC emissions will be a critical aspect of all excavation scenarios at the Site. Excavation and loading activities will be conducted using odor-controlling foam, temporary plastic covering and direct load-out, as was effectively done for odor control during recent remedial actions at the former non-owned Saratoga Springs MGP site.

Excavation below the water table requires management of groundwater in the excavation. Because of the shallow depth to water, 5 to 11 feet below ground surface, excavation water management is a critically important aspect of excavations performed at the Site. Specific techniques for groundwater management will be selected during the design and construction phase of the remedy. Any design of dewatering at the Site would need to address the risk of potential subsidence of adjacent the railroad embankment and buildings on the east side of Van Guysling Avenue. The following general review was completed for the purposes of conceptual design and cost estimating for this AA.

Excavation dewatering technologies include area-wide dewatering or excavation pit dewatering. Area-wide dewatering depresses the water table over the entire Site by pumping from a series of manifolded well points (Nichols and Day, 1999).

Dewatering of the excavation pits is localized, dewatering a specific zone below an excavation. The localized dewatering is accomplished by advancing wells outside the construction area, and by sumps inside the construction area. Excavation pit dewatering produces water that needs to be treated prior to discharge to the local Publicly Owned Treatment Works (POTW). Based on actual conditions during the 312 Broadway IRM a dewatering system will need to handle as much as 50 gallons per minute.

These dewatering and water treatment and disposal methods were carried forward into the alternatives involving excavation.

Materials handling and treatment/disposal of soils, rock, and debris encountered in subsurface fill material will be an important aspect of excavation. Off-site transportation and treatment/disposal of solids is the technology carried forward for excavated materials. Prior to transport, wet soils excavated from below the water table will first require stabilization. Transportation of solids would be done by appropriately permitted trucks. Off-site disposal options include commercial thermal desorption and landfill disposal. While both of these disposal options were carried forward into the detailed description of excavation alternatives, thermal desorption will be given preference where it is technically feasible, because it destroys more contaminants than landfilling. Large rock and demolition debris are unacceptable materials at commercial thermal desorption facilities. They will require landfilling.

The remaining challenges for excavation at the Site are sidewall support and water management. These are addressed below.

5.4.2 Sidewall Support

Due to the depth of the excavations, the shallow groundwater table and the constrained areas at the Site, simple sloping and benching of the excavations is not feasible and engineered sidewall support systems will be required. Seven technologies have typically been used for sidewall support of such excavations: 1) Pre-engineered shoring systems, 2) soldier beam and lagging walls, 3) sheet piling, 4) slurry walls, 5) grout curtains 6) freeze walls, and 7) slurry-supported wet excavation. Technologies 4 through 7 will not be evaluated due to their high cost and usual application to deep excavations only. One or more of the others are applicable to the excavations at OU2, and selection of specific shoring techniques will be conducted in the design and construction phase of the remedy. The following selection criteria are important in the consideration of these technologies for use at this Site:

- Safety during installation;
- Confidence in the success of implementation;
- Protection against sidewall failure;
- Protection against creating vertical migration pathways;
- Protection of the structural integrity of all buildings on and near the Site;
- Minimization of groundwater seepage into the excavation; and
- Minimization of water content of excavated soils.

5.4.3 Pre-engineered Shoring Systems

These “trench box” and other modular systems include slide rails, trench shields and hydraulic shoring (American Shoring, Inc., 2007). Rail systems that have steel posts and sidewall panels (slide rails) are assembled on-site. The panels are advanced into the excavation as the work proceeds. They are appropriate for shallow to moderate depths up to 20 feet. Advantages include low design costs, rapid installation and re-use. This technology is retained for alternative development and as a basis for cost estimation.

5.4.4 Soldier Beam and Lagging Walls

This is the most commonly used shoring technology for deep excavations. Soldier beams (vertical steel pilings) are first driven or drilled in from the ground surface to the final design depth, which is a specified depth below the final depth of the wall. They are placed at regular spacings of approximately 5 to 10 feet. After installation of the soldier beams, the soil in front of the wall is excavated in lifts, followed by installation of the first course of lagging. The lagging (usually wood beams) is placed horizontally between the flanges of the beam. Ground anchors (tie-backs) are then drilled through the side of the wall at a specified downward angle and length to support the wall. The top-down sequence of excavation followed by lagging placement and ground anchor installation continues until the design depth of the wall is reached (United States Department of Transportation [USDOT], 1999).

Safety and implementability of this technology are well established for a wide range of Site conditions. Properly designed, the technology provides adequate protection against sidewall failure and is protective of nearby buildings. One drawback of these systems is the large volume of groundwater that can seep from between the lagging (even with lagging seals). This can be overcome by the appropriate design and implementation of construction dewatering system. This technology is retained for alternative development and as a basis for cost estimation.

5.4.5 Sheet Piling

Sheet piling, as applied in the environmental industry, typically involves driving lengths of inter-connectable steel sheeting using a vibratory hammer into the ground to form an impermeable barrier. The same materials are used for construction of a temporary sheet pile wall for excavation shoring. The steel sheeting is available in a wide variety of configurations and strengths. The sidewall support is provided by driving the sheeting deeper than the excavation in a cantilevered application. Greater support for deep excavations are provided by ground anchors (tie-backs) which are drilled through the side of the wall at a specified downward angle and length to support the wall. Walers, rakers, and deadman anchors can be used to brace the sheetpile and are performed in stages to achieve the required excavation depths. Dewatering outboard of the sheetpile may be required to minimize groundwater pressure, especially during rain events. Cross-lot bracing between walls or other internal bracing can be used (Ratay, 1996; Deep Excavation, 2005).

The safety and implementability of this technology are well established for a wide range of Site conditions. Sheet piling could be advanced below the bottom of the excavation to allow for more effective dewatering than a soldier beam and lagging wall. One disadvantage of sheet piling is the potential for damage to nearby structures due to vibration. In addition, the installation of sheet piling can be difficult or ineffective in conditions where large rock or wood obstructions are present. Considering these advantages and limitations, this technology is applicable for portions of the excavation sidewall supports.

5.4.6 NAPL Recovery Technologies

NAPL recovery can reduce the mass of NAPL in the subsurface and by recovering the flowable fraction, reducing the mobility of residual NAPL. Typical recovery systems include specially constructed wells and recovery trenches. Collection can be passive or require an active pumping system. Several NAPL pumping systems are available, including low-flow NAPL only pumps which for many systems allow for the greatest NAPL recovery (EPRI, 2000). Effectiveness of pumping systems is highly dependent on the viscosity of the NAPL present.

NAPL on the site is located approximately 40 to 45 feet below ground surface in the vicinity of Broadway, and a recovery program at the Site is ongoing. NAPL has been recovered with some success, and the existing program may benefit from the addition of more recovery wells. Spacing, recovery rates, and selected equipment would be defined using data from the current recovery program and a PDI. As such, NAPL recovery methods were carried forward into the alternatives analysis.

6. Development and Analysis of Alternatives

In this section, the remedial alternatives for OU2 are developed and evaluated. A comparison of alternatives is presented at the conclusion of this section. A summary and comparison of the remedial alternatives is provided in Table 1. The recommended alternative is presented in Section 7.

6.1 Development of Alternatives for OU2

One viable alternative was developed for OU2, based on the land use approaches, RAOs and GRAs identified in Sections 3 and 4, and the applicable technologies identified in Section 5. Two more alternatives were included for comparison purposes by DER-10—No Action and Soil removal to Unrestricted levels. The three alternatives are defined below:

1. No Action (required for comparison purposes by DER-10).
2. Removal of MGP-residues containing 500 parts per million or greater of total PAHs at the Postage Stamp to 15 feet below ground surface, followed by introduction of oxygen release compound (ORC) prior to backfilling; enhancement of the existing NAPL recovery program on the west side of Broadway, and institutional controls.
3. Soil removal to Part 375 Unrestricted levels (required for comparison purposes by DER-10).

6.2 Detailed Analysis of Alternatives

The following sections present descriptions of each of the remedial alternatives and the results of the evaluation of the alternatives with regard to the following eight criteria defined by DER-10:

1. Overall protection of human health and the environment
2. Conformance with SCGs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume of contamination through treatment
5. Short-term impacts and effectiveness of controls
6. Implementability
7. Cost effectiveness
8. Land Use

In accordance with the NYSDEC guidance document DER-31 – Green Remediation, aspects of environmental sustainability were evaluated as part of the detailed analysis of alternatives. These aspects were included in the considerations of the short-term impacts for each alternative.

6.2.1 Alternative 1 - No Action

The No Action alternative is used as a baseline condition for comparison to other alternatives. It involves no IC/ECs, monitoring, or active remediation. There is no cost associated with this baseline alternative. Because it would not address the subsurface impacts present on OU2, The No Action Alternative would not achieve the threshold criteria of 1) overall protection of human health and the environment, or 2) conformance with SCGs required by DER-10. It would have low long-term effectiveness and permanence, and would not reduce mobility, toxicity, or volume. While no action would have no negative short-term impacts and would be implementable and cost-effective, it might not support current or future anticipated land use allowed by current zoning of the OU2.

6.2.2 Alternative 2 - Removal of MGP-Residues at the Postage Stamp, Enhancement of the NAPL Recovery Program; Institutional Controls.

6.2.2.1 Description

Compared to Alternative 3, this alternative will adequately protect human and ecological health with reduced short-term impacts and a lower remedial action cost. The land use would remain the same, allowing for commercial use.

This remedial alternative is depicted in Figure 9 and includes the following actions:

- Removal of MGP-impacted soil at the Postage Stamp to 15 feet below ground surface, followed by introduction of ORC prior to backfilling. The southern portion of the Postage Stamp, shown on Figure 9, will be excavated to 13 feet below ground surface because analytical and visual impact data indicate no CP-51 exceedances deeper than that. ORC will be placed at the bottom of the excavation to accelerate the biodegradation of any remaining contamination after the top 15 feet of soils is removed. The excavation will then be backfilled with clean soil.

    - Odor, vapor, and dust control would primarily be accomplished by conducting all excavation of NAPL-containing soil with the use of odor suppressant spray and/or foam. Waste materials would be covered with plastic sheeting while being stockpiled and awaiting off-site transport.

    - The excavation sidewalls would be stabilized by engineered shoring. The excavation will extend to 15 feet below ground surface.

    - Dewatering will be required during excavation beneath the water table (5 to 11 feet below ground surface). Wastewater will be treated on-site and then discharged to the POTW via the sanitary sewer system. All excavated materials will be loaded into lined, covered trucks for transport to permitted off-site treatment/disposal facilities.

    - For the purposes of cost estimating for this AA, the primary treatment/disposal facilities were assumed to be thermal desorption facilities. It is possible that soils removed could be disposed of at landfills, pending acceptance. This will be explored and determined during the design process. Large debris will be disposed of at landfill facilities.

- Installation and operation of one or more additional NAPL recovery wells to enhance the existing recovery program and address deeper impacts and non-accessible areas that were not excavated on the west side of Broadway.

    - Installation and operation of NAPL recovery wells will address mobile source material in OU2. The three NAPL recovery wells (SB-30/MW-12D(08), SB-43/MW-14D(08), and SB-117/RW-1(10)) shown in Figure 9 represent the existing coverage area of the NAPL recovery action.

    - The number, depth, type, and spacing of additional recovery wells will be determined during the design phase of the remedy. The coverage area will include the areas where lenses of source material were observed during the RI (the red hatched area shown in Figure 9. The intent of these wells is to provide continuous or intermittent NAPL removal to maintain well sump capacity. The recovered NAPL would be temporarily stored on-site and then transported off site for treatment and disposal at a permitted facility.

- The existing paved parking lot, roadway, and buildings and at least 10 feet of non-impacted fill material provide a barrier to direct contact with soils exceeding CP-51 criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs. These would be maintained as Engineering Controls as they currently exist. Engineering Controls will also include signs posted on the Site providing information regarding who to contact prior to digging or drilling in the area.

- Groundwater quality is expected to improve over time after the removal of source material.

- Institutional Controls are implemented as part of this alternative. Institutional Controls will include property agreements, land use restrictions and groundwater use restrictions. A property agreement similar to an environmental easement will be established between National Grid and the owners of the properties on which OU2 lies:

    - City of Schenectady (312 Broadway and west of Van Guysling Avenue)
    - Integra Development, LLC (318 Broadway)
    - Highbridge Clinton, LLC, 461 Clinton Ave ext.
    - Highbridge Broadway, LLC, 388 Broadway

A site management plan (SMP) would be established such that any future excavation in the impacted areas would be conducted under a NYSDEC-approved work plan. The work would be conducted and reported in compliance with DER-10.

6.2.2.2 Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. The potential for contact with COCs in surface soil and subsurface soils would be greatly reduced by excavation at the Postage Stamp and with the NAPL recovery program. Removal of source material and impacted soil will substantially reduce the potential for ongoing groundwater impacts.

6.2.2.3 Conformance with SCGs

This alternative would comply with soil SCGs because removal of soil to CP-51 (total PAHs greater than 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs levels in conjunction with Institutional Controls and site management would meet soil RAOs. Groundwater RAOs would also be met to the extent practicable. Removal of NAPL along Broadway and source material at the Postage Stamp will result in groundwater quality improvements.

6.2.2.4 Long-term Effectiveness and Permanence

The removal of impacted soils and source material will mitigate potential soil exposure pathways and reduce leaching of soil-bound COCs into groundwater. While excavation and NAPL recovery will remove a portion of source material, continuing sources of contaminants contributing to the exceedances of the NYSDEC Ambient Groundwater Water Quality Standards will be present beneath Broadway, the Clinton Street Extension, Van Guysling Avenue and the land between Broadway and Van Guysling Avenue. Removing these soils is not proposed because the impacts are covered by at least 10 feet of clean material and downgradient monitoring wells show no impacts. In addition, the soils are generally overlain by buildings, asphalt pavement, or concrete sidewalks.

6.2.2.5 Reduction of Mobility, Toxicity, or Volume

This remedial alternative will result in a substantial reduction of the volume of COCs present at the Site by removal of NAPL, source material, and other impacted soil.

6.2.2.6 Short-term Impacts and Effectiveness of Controls

The primary short-term impacts of this alternative are associated with excavation and installation of the NAPL recovery wells. This alternative results in a total of approximately 1,690 truck trips (assuming trucks with a 35 ton capacity) to remove impacted soil and deliver backfill material. This estimate of trucks does not account for trucks required for other construction purposes (e.g. mobilization, demobilization, transport of excavation support supplies, transport of personnel, etc.). Greenhouse gas emissions and other green remediation considerations will be relatively high for this alternative.

Protection of Community. During the implementation of this alternative, measures will be taken to monitor and reduce the potential for air emissions during source removal actions. Odor, vapor, and dust control will be managed by conducting all excavation of NAPL-containing soil with the use of odor suppressant foam. Waste materials would be covered with plastic sheeting while being stockpiled. Truck traffic from the operations will be a significant impact. Truck traffic will include mobilization and demobilization of heavy construction equipment, trucking of impacted material from the Site, and trucking of backfill material onto the Site.

Protection of Workers. Workers will be protected during implementation of this alternative as direct contact with impacted material will be minimized by use of heavy equipment to perform the excavation and loading activities. Workers will be Occupational Safety & Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) trained and enrolled in a medical monitoring program. All workers will follow a Site-specific Health and Safety Plan (HASP) that will be developed during the design process.

Environmental Impacts. The potential for negative environmental impacts from this alternative is moderate. Impacts during the soil and NAPL removal will be addressed by use of spill prevention and control measures. Impacts from trucking and thermal desorption of soil include the generation of greenhouse gasses. This construction will release approximately 6,500 million tons of carbon dioxide (Michigan Technological University, Project Emission Estimator).

Time Until Response Objectives are Achieved. It is anticipated that mobilization, site preparation, excavation, and Site restoration work will take approximately four months to perform. This time is based on the assumption that disposal facilities can handle 700 tons of excavated material per day. This alternative provides for a reduction in the concentrations of COCs in groundwater, starting at least one year after the removal action. The response objectives for groundwater will be achieved to the extent practicable over time.

6.2.2.7 Implementability

Technical Feasibility. Removal of NAPL and impacted soils and the placement of backfill soils are technically feasible using conventional equipment and construction methods. Excavation, transportation, and disposal of impacted soils are conventional remedial techniques.

Administrative Feasibility. This alternative is administratively feasible to the extent that Site access agreements and property restriction agreements with the current owners can be secured because National Grid does not own the impacted properties. Approvals for discharge of water to the POTW and for transportation of materials on City of Schenectady streets will be required.

Availability of Services and Materials. The services and materials required for this alternative are readily available.

6.2.2.8 Cost Effectiveness

This alternative has a high cost effectiveness because the cost, is relatively low and results in a proportional increase in conformance with SCGs and achievement of RAOs. The long-term liability of the Site will be reduced, but not eliminated.

The projected costs for this alternative are as follows:

Design and Oversight Costs	$0.3 million	
Construction Cost	$2.8 million	
OM&M Cost	$1.0 million	(including present worth of groundwater management for 20 years)
Contingency	$0.8 million	(A 20% allowance for undefined costs and conditions)
Total	**$4.9 million**	

Details of the cost estimate are provided in Appendix B.

6.2.2.9 Land Use

The future land use for this alternative will remain as it is now.

6.2.3 Alternative 3 - Removal of Soil to Unrestricted Levels

6.2.3.1 Description

This alternative was developed and evaluated in accordance with the DER-10 guidance. It is not a practicable remedy and is provided in this report for comparative purposes only.

This remedial alternative is depicted in Figure 10 and includes the following actions:

This alternative provides for protection of human health and the environment, with the highest short-term impacts and highest remedial action cost. The land use would substantially increase, allowing for single family residences or active recreational use where there could be contact with Site soil. This alternative requires the buildings to first be purchased and demolished, and critical utilities to be re-routed, followed by excavation of all of the soil on OU2 to Part 375 Unrestricted levels. This alternative would, therefore, provide maximum protection, but is not currently implementable and would have very severe impacts to the community.

This remedial alternative consists of excavation of the impacted soil area shown in Figure 10, and includes the following actions:

- Demolition of buildings. It should be noted that there are no plans to purchase and demolish the buildings, and that this action is not implementable, but is included in this alternative to allow for complete removal of impacted soil for comparison purposes only.

- Re-routing of gas, electrical, and other utility lines along Broadway and Van Guysling Avenue. It should be noted that the re-routing or excavation around the fiber optic lines is not currently implementable but is included in this alternative to allow for complete removal of impacted soil for comparison purposes only.
- Excavation of source material, and soil exceeding Part 375 Unrestricted SCOs, an estimated total of 113,790 cubic yards.
- Replacement of excavated soil with clean soil.
- Surface landscaping and replacement of drainage and utilities.

Because of the completeness of the removal, no NAPL recovery, in-situ treatment and MNA, or IC/ECs would be applicable.

The following considerations would apply to these excavation activities:

- During the pre-design investigation phase, the excavation areas would be delineated and pre-characterized for disposal in accordance with the requirements of the proposed receiving facilities.
- Odor, vapor, and dust control would be accomplished by excavation of NAPL-containing soil in conjunction with the use of foam and plastic sheeting.
- The buildings along Broadway and Clinton Street would be demolished. Owners/tenants would have to be temporarily or permanently relocated.
- The water table is typically 5 to 11 feet below ground surface. A significant dewatering program would have to be implemented in order to perform this alternative. This dewatering program would include temporary well points, groundwater gauging, and large capacity pumping systems. Dewatering is further discussed in Section 5.
- The excavated materials will be loaded into sealed and covered trucks for transport to permitted off-site disposal facilities.

6.2.3.2 Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. A high level of overall protection would be achieved by the complete removal action defined by this alternative.

6.2.3.3 Conformance with SCGs

SCGs for soils will be achieved by the removal of source materials and soils exceeding Part 375 Unrestricted levels. It is anticipated that this complete removal action would also result in achieving groundwater RAOs within a short time period.

6.2.3.4 Long-term Effectiveness and Permanence

This remedy relies primarily on removal actions which will be effective and permanent, and will eliminate all exposure potential upon removal.

6.2.3.5 Reduction of Mobility, Toxicity, or Volume through Treatment

This remedial alternative will result in rapid substantial reduction of mobility, toxicity, and volume of COC through the removal action.

6.2.3.6 Short-term Impacts and Effectiveness

The primary short-term impacts of this alternative are associated with the excavation. The extensive and deep excavation and backfilling in the soil removal area would also have large negative short-term impacts. This alternative results in a total of approximately 22,790 truck trips (assuming trucks with a 35 ton capacity) to remove impacted soil and deliver backfill material. This estimate of trucks does not account for trucks required for other construction purposes (e.g., mobilization, demobilization, transport of excavation support supplies, transport of personnel, etc.). In order for this alternative to occur, properties will have to be purchased from local businesses and the businesses will have to relocate. Road closure would also be necessary. Greenhouse gas emissions and other green remediation considerations would be extremely high for this alternative. These “short-term impacts” will last at least four years.

Protection of Community. During the implementation of this alternative, measures would be taken to monitor and reduce the potential for air emissions during source removal actions and transportation off site. Multiple sprung structures will need to be used to contain odors and dust generated during excavation activities. Road closure will also need to occur to maintain the safety of the community.

Truck traffic from the operations would be a long-lasting and very significant impact. Truck traffic would include mobilization and demobilization of heavy construction equipment, trucking of impacted material from the Site, and trucking of backfill material onto the Site.

Protection of Workers. Workers will be protected during implementation of this alternative as direct contact with impacted material will be minimized by use of heavy equipment to perform the excavation and loading activities. Workers will be OSHA HAZWOPER trained and enrolled in a medical monitoring program. All workers will follow a Site-specific HASP that will be developed during the design process.

Road closures will need to be in effect during construction to make sure workers are protected from vehicular traffic. Due to the large size of this excavation, significant site controls will have to be implemented and maintained to ensure the protection of on-site workers.

Environmental Impacts. The potential for negative environmental impacts for this alternative will be high. Potential releases during the removal of MGP source material will be addressed by the use of spill prevention and air emission control measures. Substantial impacts from trucking and thermal desorption of soil will include the generation of greenhouse gasses. This construction will release at least 18,000 million tons of carbon dioxide (Michigan Technological University, Project Emission Calculator).

Time Until Response Objectives are Achieved. The SCOs would be met upon completion of the removal, which is estimated to take a total of at least four years to complete, including the demolition of buildings and the re-routing of the critical utilities. This time is based on the assumption that disposal facilities can handle 700 tons of excavated material per day. Groundwater objectives would be met after a final attenuation period, estimated to have a duration of five years.

6.2.3.7 Implementability

Technical Feasibility. Removal by excavation is technically feasible using standard excavation equipment. Excavation, transportation, and disposal of impacted soils are conventional remedial techniques. Due to the large amount of excavation for this option, the feasibility may be hindered by lack of capacity of the selected disposal facility or facilities and dewatering/groundwater treatment facilities. An excavation this large also requires a substantial excavation support system that may be difficult to implement in the field, and excavations upwards of 50 feet below ground surface will prove difficult.

Administrative Feasibility. This alternative has poor administrative feasibility because it requires the buildings on-site to be vacated, purchased, and/or demolished. The relocation of existing tenants will also take time and effort. The time period to execute the job (four years) is also quite long.

Availability of Services and Materials. The services and materials required for this alternative are readily available. Multiple facilities may need to be identified for both treatment of excavated soil and provision of clean backfill material, acceptable to NYSDEC, due to the significant quantities of material involved. Excavation uses specialized construction equipment (e.g., excavators that can extend to 50 feet bgs, clamshell buckets for slurry walls, etc.) that may not be readily available.

6.2.3.8 Cost Effectiveness

This remedy would not be cost effective, as the high costs would not have a commensurately high value in additional environmental protection or increase in actual land use additional to the current high value of land use.

The projected costs for this alternative are as follows:

Design and Oversight Costs	$3.5 million	
Relocations and Administrative Costs	$6.5 million	
Construction Cost	$38.0 million	
Confirmatory Monitoring Cost	$0.2 million	(groundwater monitoring for five years after remediation)
Contingency	$9.6 million	(A 20% allowance for undefined costs and conditions)
Total	**$57.8 million**	

Details of the cost estimate are provided in Appendix B.

6.2.3.9 Land Use

This alternative would remediate the properties to allow single family residences. Under this alternative, land use would be unrestricted, which would also allow for agricultural uses. However, agricultural uses would not be applicable for this location since it is an urban environment within the City of Schenectady.

6.3 Comparison of Alternatives

A comparative analysis of the alternatives for OU2 was conducted in which the alternatives were compared to one another with regard to each of the eight analysis criteria. The following discussion provides a comparison of the two substantive alternatives, without the No Action alternative, which is not considered a viable alternative.

6.3.1 Overall Protection of Human Health and the Environment

Both of the substantive alternatives include common elements that would result in overall protection of human health and the environment. Both alternatives would be protective of human health and the environment by eliminating potential exposure pathways or maintaining barriers to potential exposure pathways, either by removal or institutional and engineering controls.

For Alternative 2, SCGs for groundwater would only be met to the extent practicable because of the residual impacts remaining in areas not practicably accessible for excavation.

With respect to this criterion, the alternatives are ranked as follows:

1. Alternative 3 would be the most protective, because it would involve the most complete removal of impacted materials.
2. Alternative 2 would rank as the next most protective because it would achieve substantially similar protection at OU2.

6.3.2 Conformance with SCGs

Alternative 2 would provide conformance with the SCGs appropriate for the land uses for each alternative, to the extent practicable. Alternative 3 would provide additional conformance to SCGs, as it could result in meeting groundwater RAOs within a few years, if it were effective in removing all soils exceeding Unrestricted levels.

6.3.3 Long-term Effectiveness and Permanence

Both of the alternatives would result in some degree of permanent reduction of the source of impacts to groundwater. The ranking of the alternatives with respect to this criterion would be proportional to the amount of COCs removed and identical to the ranking indicated for Overall Protection of Human Health and Environment, above.

6.3.4 Reduction of Toxicity, Mobility, or Volume

Both of the removal alternatives would reduce the volume and mobility of MGP impacts at the Site. The ranking of the alternatives with respect to this criterion would be proportional to the amount of COCs removed and identical to the ranking indicated for Overall Protection of Human Health and Environment, above.

6.3.5 Short-term Impacts and Effectiveness

Both of the removal alternatives would have some degree of short-term impacts, as they all involve shoring, on-site water treatment, and heavy excavation and off-site trucking, treatment and disposal, and greenhouse gas emissions. The primary factor is the amount and depth of excavation involved in each. The principal short-term impacts to the community would be relocation of businesses, demolition of buildings, truck traffic, and additional excavation and backfill volume would result in additional truck traffic over a longer time period to complete the work. Greenhouse gases will also be generated through construction and disposal activities, with Alternative 3 generating approximately three times the greenhouse gases as Alternative 2. Their short-term effectiveness, as indicated by the time until response objectives are achieved, differs for each alternative. Only the alternative with removal to Unrestricted levels could possibly achieve short-term effectiveness with respect to the groundwater remedy. With respect to this criterion, the alternatives are ranked as follows:

1. Alternative 2 would be effective through a period of NAPL recovery and groundwater treatment and monitoring. It would also involve excavation, but with less short-term impact than Alternative 3 with regard to truck traffic and duration of work.
2. Alternative 3 involves the greatest excavation quantities and depths, resulting in the greatest negative short-term impacts, but would be the most effective at achieving RAOs.

6.3.6 Implementability

With respect to this criterion, the alternatives are ranked as follows:

1. Alternative 2 would rank as most implementable, because excavation to 15 feet is readily achievable and water management and risks to infrastructure would be reasonable. Also, recovery well installation and recovery well pumping are minimally invasive.
2. Alternative 3 is not implementable because of the depth of the excavation and the uncertainty with regard to achieving the Unrestricted SCOs at a depth of more than 50 feet in saturated soils. The larger excavation at that depth will require a greater level of staging and coordination. Dewatering will also be a concern at these greater depths and will add to the complexity and uncertainty associated with this Alternative.

6.3.7 Cost Effectiveness

The alternatives are ranked as follows with respect to cost effectiveness:

1. Alternative 2 is most cost effective, since it provides for more or less land use value and reduction in long-term liability for their estimated costs.
2. Alternative 3 is the least cost effective as its high costs of $57.8 million would not have a commensurately high value in additional environmental protection or increase in actual land use additional to the current high value of land use.

7. Recommended Remedy

Alternative 2 is recommended. This alternative includes enhancement of the existing NAPL recovery program along Broadway in OU2 South, cleanup of MGP impacts at the Postage Stamp and associated area to 15 feet (after the PCB cleanup is completed by others) followed by addition of ORC, and institutional controls for all of OU2. As summarized in the comparative analysis, Alternative 2 will achieve a substantial reduction in impacts, and with less cost and negative impact risk and equivalent actual effectiveness to Alternative 3, which involves deep excavation. Alternative 2 provides an emphasis on a balanced effectiveness and cost. This alternative is implementable with moderate short-term impacts, and meets the RAOs for the Site, to the extent practicable.

Alternative 2, Removal of Soil at the Postage Stamp and associated area that exceeds CP-51 criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs and source material, involves excavation of an estimated 8,450 cubic yards, followed by NAPL recovery and groundwater monitoring, for an estimated cost of $5.75 million.

This remedial alternative is depicted in Figure 9 and includes the following actions:

- Removal of MGP-impacted soil at the Postage Stamp to 15 feet below ground surface, followed by introduction of ORC prior to backfilling. The southern portion of the Postage Stamp, shown on Figure 9, will be excavated to 13 feet below ground surface because analytical and visual impact data indicate no CP-51 exceedances deeper than that. ORC will be placed at the bottom of the excavation to accelerate the biodegradation of any remaining contamination after the top 15 feet of soils is removed. The excavation will then be backfilled with clean soil.

- Installation and operation of one or more additional NAPL recovery wells to enhance the existing recovery program and address deeper impacts and non-accessible areas that were not excavated on the west side of Broadway.

    - Installation and operation of NAPL recovery wells will address mobile source material in OU2. The area of NAPL recovery is shown on Figure. The number, depth, type, and spacing of additional recovery wells will be determined during the design phase of the remedy. The coverage area will include the areas where lenses of source material were observed during the RI, and for this alternative includes the central parking lot area and the utility corridor along Broadway..

- The existing paved parking lot, roadway, and buildings and at least 10 feet of non-impacted fill material provide a barrier to direct contact with soils exceeding CP-51 criteria (total PAHs exceeding 500 mg/kg) and/or individual VOC exceedances of Commercial Use SCOs. These would be maintained as Engineering Controls as they currently exist. Engineering Controls will also include signs posted on the Site providing information regarding who to contact prior to digging or drilling in the area.

- Groundwater quality is expected to improve over time after the removal of source material. The conceptual groundwater monitoring plan is provided in Appendix C.

- Institutional Controls are implemented as part of this alternative. Institutional Controls will include property agreements, land use restrictions and groundwater use restrictions. A property agreement similar to an environmental easement will be established between National Grid and the owners of the properties on which OU2 lies. The land use restrictions would limit the use of the OU2 properties to commercial, which would include industrial uses. There are currently no water supply wells on the property, and future installation of wells and groundwater use on the properties would be restricted by the property agreements and deed attachments established under this alternative.

  A SMP would be established such that any future excavation in the impacted areas would be conducted under a NYSDEC-approved work plan. The work would be conducted and reported in compliance with DER-10.

The active Site work, including the excavation and restoration of the property would have a duration of approximately four months.

It is not possible to predict with certainty the duration of NAPL recovery operations or the duration of in-situ groundwater treatment/monitoring. Additional recovery wells will be added to those already in operation. After 1 year of monitoring/recovery, the program will be re-evaluated for modification/effectiveness. Similarly a 5-year initial groundwater monitoring program is recommended, after which time the program would be evaluated. The details of the NAPL recovery and groundwater monitoring programs will be developed in the design phase of the project.

In accordance with DER-31 Green Remediation, this alternative would have a moderate environmental footprint, primarily associated with the transport and disposal of impacted soil. During the course of the remedial activities, steps would be taken to mitigate the environmental footprint and provide for sustainable practices, energy usage and materials. The details of these provisions will be developed in the design phase of the remedy.

The recommended remedy for OU2 represents a consistent approach appropriate for its current and future land use and fitting with the local community.

8. References

AECOM, 2009. Remedial Investigation Report, Operable Unit 1, Schenectady (Clinton Street) Non-Owned Former MGP Site, Schenectady, NY, NYSDEC Site No.: V00474, Index #: D0-0001-0011, June 28, 2009.

American Shoring Inc., 2007. http://www.americanshoring.com/website/products.php

Conner, J.R., 1990. Chemical Fixation and Solidification of Hazardous Wastes. Van Nostrand Reinhold, New York.

Deep Excavation, 2005. Deep Excavation LLC, Website Information http://www.deepexcavation.com/deep.html

EPA, 1998. Evaluation of Subsurface Engineered Barriers at Waste Sites. Office of Solid Waste and Emergency Response. EPA 542-R-98-005, August 1998.

EPA, 2000. Solidification/Stabilization Use at Superfund Sites. September 2000.

EPRI, 2000. Technical and Economic Evaluation of Coal Tar Dense Non-Aqueous Phase Liquid (NAPL) Pumping Techniques. TR-113101. Final Report, March 2000 Cosponsor Baltimore Gas & Electric Co. (BGE), Suite 101, 609 Energy Parkway, Baltimore, Maryland 21226.

FRTR, 2002. Federal Remediation Technology Roundtable - Remediation Technologies Screening Matrix and Reference Guide, 4th Edition, January 2002. http://www.frtr.gov/matrix2/section4/4_9.html#app and http://www.frtr.gov/matrix2/section4/4_34.html#des.

GEI, 2010. Pre-Design Investigation Work Plan, 312 Broadway and NAPL Recovery Pilot, Schenectady OU2 Former MGP Site, NYSDEC Site #V00474, Index #: D0-0001-0011, July 28, 2010.

GEI, 2012. Final Remedial Investigation Report, Operable Unit 2, Schenectady (Clinton Street) Non-Owned Former MGP Site, Schenectady, NY, NYSDEC Site No.: V00474, Index #: D0-0001-0011, December 2012.

GRI, 1997. Environmentally Acceptable Endpoints in Soil. David G Linz and David V. Nakles, RETEC eds. Gas Research Institute. Academy of Environmental Engineers, USA.

Hayward Baker, 2005. Website information: http://www.haywardbaker.com/services/slurry_trench.htm.

ITRC, 2002. Remediation Technology Review resource of the Inter-State Technology Research Council. USA. Itrcweb.org, June 2002.

ITRC, 2004. Strategies for Monitoring the Performance of NAPL Source Zone Remedies, Inter-State Technology Research Council. USA. August 2004. P. 49.

Michigan Technological University. Website Information and Project Emission Estimator. http://www.construction.mtu.edu/cass_reports/webpage/estimator.html.

Neuhauser, E.F., et al, 2009. Monitored Natural Attenuation of Manufactured Gas Plant Tar Mono- and Polycyclic Aromatic Hydrocarbons in Ground Water: A 14-Year Field Study. E.F. Neuhauser, J.A. Ripp, N.A. Azzolina, E.L. Madsen, D.M. Mauro, T. Taylor. Ground Water Monitoring & Remediation, Vol 29 No 3 p 66-76, 2009.

New York Construction, 2007. "Nyack Manufactured Gas Plant Remediation" McGraw Hill 2007 Award Winning Design. December 2007.

NYSDEC, 1992. NYSDEC HWR TAGM#4042 Interim Remedial Measures, p. 2.

NYSDEC, 2010. DER-10 Technical Guidance for Site Investigation and Remediation, May 2010.

Nichols, H.L. and Day, D.A., 1999. Moving the Earth: The Workbook of Excavation. McGraw-Hill, New York.

Ratay, 1996. Handbook of Temporary Structures in Construction. McGraw Hill, New York.

Regenesis, 2013. Website information: http://regenesis.com.

Stinson, M.K., and S. Sawyer, 1988. In-Situ Treatment of PCB-Contaminated Soil. U.S. EPA Site Papers: 504-507.

USDOT, 1999. Geotechnical Engineering Circular No. 4: Ground Anchors and Anchored Systems, FHWA-IF-99-015. Office of Bridge Technology, Washington, DC. June 1999.

Table

Figures

Appendix A

Correspondence

Appendix B

Remedial Alternative Cost and Volume Estimates

Appendix C

Conceptual Groundwater Monitoring Plan