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NYSEG Auburn Green Street MGP Site

Final Feasibility Study Supplement - Evaluation of Anaerobic and Aerobic Technologies within Former Gas Holder

NYSEG Auburn Green Street MGP Site,
City of Auburn, Cayuga County, New York
NYSDEC Site No. 7-06-009

Project number: 60543583

February 10, 2020

Prepared for:

New York State Electric and Gas

Prepared by:

AECOM
257 West Genesee Street
Buffalo, NY 14202
aecom.com

Table of Contents

Figures

Tables

1. Introduction

This memorandum is a Supplement to the Final Feasibility Study Report (FSR) (April 2019) for the NYSEG Auburn Green Street MGP Site (NYSDEC Site No. 7-06-009) to provide additional analysis of in situ bioremediation alternatives in response to review comments from NYSDEC dated November 15, 2019. NYSDEC review comments and requests included:

- "The treatment of groundwater outside the former holder structure outlined in Alternative 3 does not address the ongoing source of groundwater contamination or the highly concentrated groundwater contamination inside the holder which appears to be a source to the groundwater contaminant plume outside of the holder."
- "The Department requests that the FS be modified to include a remedial alternative that includes treatment inside the former holder structure to reduce contaminant migration from the holder."
- "The Department recognizes that the portion of the holder potentially accessible for treatment may be limited to the area of the former holder structure to the north of the substation where borings and wells have been previously completed."
- "The Department recommends that when screening technologies for treatment within the holder structure that anaerobic treatment using nitrates and/or sulfates be included among the technologies considered."

In a teleconference on December 17, 2019, NYSDEC provided clarification on the review comments to NYSEG and AECOM. In summary, NYSEG and AECOM discussed the challenges of implementing in situ bioremediation within the footprint of the former gas holder and the high voltage transformer area. Potential aerobic and anaerobic in situ bioremediation approaches were discussed including the more feasible approach of aerobic in situ bioremediation using biosparging versus an anaerobic bioremediation approach. At the conclusion of the teleconference, NYSDEC requested this supplement to the Feasibility Study to evaluate in situ bioremediation as a remedial alternative for the Site.

2. Site Conditions

The following summarizes the Site conditions for the former holder area that are relevant for evaluating in situ bioremediation of groundwater.

2.1 Site Geology/Hydrogeology

Fill material covers the majority of the Site in a layer of varying thickness generally ranging from 5 to 7 feet, but up to 22 feet in the area of the former holder. The fill consists primarily of sand, gravel, and bricks and sporadically contains varying amounts of wood, coal slag, cinders, and ash. Beneath the fill is a sandy silt unit that is composed of brown fine sand and silt with some gravel. Where present, the thickness of the sandy silt unit ranges from approximately 3 to 8 ft. A red-brown silty clay/clayey silt unit has been identified beneath the sandy silt and consists of likely native silty clay and clayey silt that grades to a till-like material including some gravel. The boundary between the overlying sandy silt unit and the silty clay/clayey silt unit varies across the Site. The top of the silty clay/clayey silt unit ranges from approximately 9 to 18 ft bgs.

Groundwater is observed at depths which range from approximately 5 to 14 feet below ground surface (bgs) across the Site. Lithology and groundwater elevation observations indicate a shallow groundwater zone (i.e., ~5 to 8 feet bgs) and a deeper groundwater zone (~14 feet bgs). Shallow groundwater flow direction varies across the Site but is generally from the southwest to the northeast.

2.2 Groundwater

Within the former holder structure area (MW-4), groundwater concentrations of benzene, toluene, ethylbenzene, xylene, naphthalene, and cyanide exceeded groundwater standard or guidance values during the 2013 and 2014 groundwater monitoring events. In 2014, concentrations in groundwater at MW-4 were 1,400 micrograms per liter (µg/L) of benzene, 410 µg/L of toluene, 20 µg/L of ethylbenzene, 220 µg/L of total xylenes, 120 µg/L of naphthalene, and 1,300 µg/L of cyanide. Outside the former holder area, benzene exceeded groundwater standards at concentrations less than at MW-4 that ranged from 10 to 59 µg/L in 2013 and 2014.

2.3 Treatment Volume

Higher concentrations of groundwater contaminants at MW-4 indicate that groundwater under the former gas holder structure is the source of benzene in groundwater observed outside the former holder structure (MW-1, MW-2, MW-3, MW-5, and MW-7). Thus, treatment of groundwater under the former holder structure is expected to decrease source mass, mitigate migration of contaminants from the former holder area, and decrease the concentration of benzene in groundwater outside of the holder area.

Within the former holder area, impacted shallow groundwater is expected to be in the sandy silt unit near MW-4 from approximately 7 to 15 feet below land surface (bls). South of MW-4 towards the center of the former holder area, observations from soil boring SB02 indicates the shallow groundwater is within fill material consisting of mostly sand to a depth of at least 22 feet bls. The lateral extent of groundwater with higher concentrations and the extent of the deeper fill material is uncertain under the former holder structure within the footprint of the high-voltage transformer area because of access limitations during investigations.

This supplement to the FSR evaluates in situ bioremediation as a remedial alternative to treat groundwater under the former holder structure and meet the following groundwater remedial action objectives (RAOs) as also presented in Section 3.3 of the FSR:

<u>Public Health Protection:</u>

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

<u>Environmental Protection:</u>

- Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to the surface water.
- Remove the source of groundwater contamination to the extent practicable.

3. Identification and Screening of In Situ Bioremediation Technologies

For groundwater at the Site, the FSR evaluated several general response actions including no action, institutional and engineering controls, removal, treatment, and containment. For the groundwater treatment general response action, the process option of in situ bioremediation was evaluated. This supplement to the FSR revises the screening of the aerobic in situ aerobic bioremediation process option and adds anaerobic in situ bioremediation.

3.1 Aerobic In Situ Bioremediation

As described in the FSR, aerobic in situ bioremediation enhances biooxidation of hydrocarbon contaminants by aerobic microbial consortiums that gain energy and mass by oxidizing the hydrocarbon contaminants while respiring on oxygen dissolved in groundwater. Thus, the conditions required to support this process are aerobic and oxidizing conditions that are created by the addition of oxygen to groundwater, which is typically oxygen deficient. Several methods are used to increase dissolved oxygen concentrations in situ and include air sparging also known as biosparging, oxygen sparging, dissolved oxygen injection, and injection of oxygen-releasing compounds.

To treat large volumes of groundwater and contaminant mass, biosparging is the most common and cost-effective approach. Biosparging remediation systems are typically optimized to provide air and oxygen at a rate that exceeds the respiration rate of the microbial consortium oxidizing the hydrocarbon contaminants. Vertical and horizontal (or directional) wells are the most common methods for delivering air to the treatment volume. For smaller treatment volumes, an oxygen generator can be used to separate oxygen from air that can be injected by sparge wells, diffused into groundwater using standard wells, or used to create high dissolved oxygen water (~35 milligrams per liter) in an ex situ treatment system that is delivered through a series of injection wells. The use of oxygen release compounds (ORC) can be applicable at sites where the slow-release of oxygen from the solid matrix meets a limited oxygen demand of the groundwater and microbial community.

For biosparge and air sparge systems, field-scale treatability studies are typically required to evaluate the oxygen demand of the groundwater and design specifications for a full-scale system. Design specifications include sparge well design, air sparge depth, the radius of influence for air sparge wells at various flow rates within the site lithology, required compressor size, and optimal system operation.

3.1.1 Effectiveness

Aerobic in-situ bioremediation is effective at treating many petroleum hydrocarbons including the volatile and semi-volatile contaminants observed in groundwater at the Site. Recent work at creosote and manufactured gas plant sites has shown that aerobic biosparging can also treat non-aqueous phase liquid (NAPL) creosote and tars over longer time periods by enhancing the removal via dissolution of groundwater contaminants from the NAPLs. At sites where limited source material such as NAPL and sorbed mass is present, aerobic in situ bioremediation can achieve groundwater RAOs in a short time (less than 10 years). If significant NAPL mass is present, access to the treatment volume is limited, or hydrogeologic conditions are difficult, longer time (more than 10 years) may be required to effectively remove groundwater contaminants from the NAPL.

3.1.2 Implementability

Implementation of aerobic in-situ bioremediation is typically achieved using biosparging to deliver the required air and dissolved oxygen to the treatment volume. Vertical or directional sparge wells are typically used to deliver air to groundwater in the treatment volume; thus, access to the treatment volume to install wells is required. Advances in horizontal sparge well design has increased the effective delivery of air along the horizontal well screen and improves access to treatment volumes that cannot be accessed with vertical sparge wells. Implementability is also affected by the permeability and heterogeneity of soil, which should allow the injection of air.

At the Site, vertical sparge wells are implementable to treat groundwater under the former holder outside the transformer area. The use of horizontal sparge wells to access the treatment area under the transformer area is potentially implementable but may require additional evaluation and field-scale testing. The low concentration benzene plume outside of the former holder area would likely be treated by implementation under the former holder area; however, biosparging or other low energy delivery of dissolved oxygen at existing wells can be implemented.

3.1.3 Evaluation

Aerobic in situ bioremediation is expected to be an effective and implementable technology for meeting groundwater RAOs at the Site where dissolved oxygen can be delivered. The technology is applicable for the contaminant types and observed concentrations under and outside the former gas holder area. This technology is retained for further evaluation at the Site. Further evaluation of aerobic in situ bioremediation will focus on the feasibility of delivering oxygen to the treatment volume.

3.2 Anaerobic In Situ Bioremediation

Like aerobic, anaerobic in situ bioremediation enhances biooxidation of hydrocarbon contaminants by anaerobic microbial consortiums that gain energy and mass by oxidizing the hydrocarbon contaminants. Unlike aerobic, the anaerobic microbial consortium respires on alternative electron acceptors dissolved in groundwater such as nitrate and sulfate instead of oxygen. Thus, the conditions required to support this process are anaerobic and reducing conditions that are typically present in groundwater impacted by dissolved hydrocarbons. At sites where anaerobic conditions are present in groundwater impacted by hydrocarbon contaminants, the alternative electron acceptors (nitrate and sulfate) are typically depleted and anaerobic bioremediation can be enhanced by addition of nitrate and/or sulfate.

Since nitrate has relatively low secondary standards in groundwater, sulfate is the electron acceptor most commonly used to enhance in situ anaerobic bioremediation. To treat groundwater and contaminant mass, sulfate solutions created with sodium or potassium sulfate salts (e.g., Epsom salt) are injected into the treatment volume. The use of groundwater recirculation systems with a series of injection and extraction wells can also be used to target delivery of sulfate to the treatment volume.

Field-scale treatability studies are typically required to evaluate the ability and appropriate design to effectively deliver sulfate solutions to the treatment volume. Microbial analysis can also be used to evaluate changes to populations of sulfate reducing microbes as well as confirm the presence of sulfate reducing bacteria that have the genes required to biodegrade benzene and naphthalene.

3.2.1 Effectiveness

Anaerobic in-situ bioremediation is effective at treating many petroleum hydrocarbons including the volatile and semi-volatile contaminants observed in groundwater at the Site. In comparison to oxygen, the solubility of sulfate in groundwater is very high and allows large doses of sulfate to be delivered. However, the rate of biodegradation for Site contaminants is typically much slower for sulfate reducing microbes than aerobes. Thus, remediation time for anaerobic in situ bioremediation is typically longer than aerobic in situ bioremediation when adequate oxygen is provided.

3.2.2 Implementability

Implementation of anaerobic in-situ bioremediation of groundwater is typically achieved using injection wells to deliver the sulfate solution to the treatment volume. Vertical wells are the primary means for delivering the sulfate solution to groundwater in the treatment volume; thus, access to the treatment volume to install vertical wells is required. For larger areas with access limitations, a series of injection and extraction wells can be used to increase hydraulic gradients and direct sulfate delivery to the treatment volume. However, uncertainty in the lithology and hydraulic conductivity variability under the former holder area could limit the ability to control groundwater flow and deliver sulfate to the to the treatment volume at the Site.

3.2.3 Evaluation

Although anaerobic in situ bioremediation is effective at treating the contaminants at the Site, implementation would be difficult because of limited access to the treatment volume to deliver sulfate using vertical injection wells. In comparison, biosparging is expected to be a more feasible in situ bioremediation technology for the treatment volume; thus, anaerobic in situ bioremediation is not retained.

4. Development and Detailed Analysis of In Situ Bioremediation Alternative

For the treatment volume under the former holder, aerobic in situ bioremediation is retained and evaluated as a supplemental remedial alternative, potentially capable of supporting progress toward achieving groundwater RAOs at the Site. The supplemental remedial alternative for the treatment volume under the former holder area includes the following:

- Biosparging with air is the selected technology to increase dissolved oxygen concentrations in the treatment volume and implement aerobic in situ bioremediation.
- Because of access limitations to the treatment volume under the transformer area, directional drilling equipment would be used to install up to two horizontal air sparge wells to treat impacted groundwater within the gas holder and under the transformer area (Figure 1). Alternatively, a mix of vertical and horizontal air sparge wells could be used to implement biosparging at the Site.
- The biosparge wells would be installed at the bottom of the sandy silt unit (15 feet bls) but may extend deeper to treat sand fill material observed to 22 feet bls.
- The design of the sparge wells, capacity of the biosparge equipment, and operation of the biosparge system would be developed following completion of a field-scale pre-design investigation treatability study.
- Using a single vertical biosparge well near MW-4 outside of the transformer area but within the former holder area, a field-scale pre-design investigation treatability study would evaluate the ability to deliver oxygen to groundwater, estimate the radius of influence at various air flow rates, and estimate the oxygen demand for groundwater in the treatment volume (Figure 1).
- Operation, maintenance, and monitoring (OM&M) of the biosparge system would occur monthly.
- Existing monitoring wells would be used to monitor remediation performance.
- Groundwater monitoring would be performed quarterly during the first year, semi-annually the second year, and annually thereafter.
- After two years the system would be evaluated based on the results of monitoring to determine performance and estimate remediation time. Groundwater in the treatment volume under the holder area is expected to achieve RAOs in less than 10 years.

4.1 Detailed Analysis of In Situ Bioremediation Alternative

Per the FSR, the following eight criteria were used to evaluate the in situ bioremediation alternative: overall protection of human health and the environment; compliance with groundwater standards; long-term effectiveness and permanence; reduction of toxicity, mobility, and/or volume; short-term effectiveness; implementability; cost effectiveness, and land use.

4.1.1 Protection of Human Health and the Environment

The Alternative would be protective of human health and the environment by addressing the RAOs for groundwater. The potential for contact with contaminants in groundwater would be eliminated through in situ destruction. Access to and use of groundwater would be controlled by ICs/ECs until monitoring indicates that RAOs have been achieved. COC in groundwater would be prevented from migrating off-site. There is no current or any anticipated future use of groundwater from the Site.

4.1.2 Compliance with Standards, Criteria and Guidance

Chemical-specific standards, criteria and guidance (SCGs) used to develop remedial criteria for groundwater will be addressed. Groundwater quality would improve through in situ bioremediation. Progress toward SCGs would be achieved as bioremediation of the contaminants is improved (less than 10 years).

4.1.3 Long-Term Effectiveness and Permanence

Contaminants in groundwater treatment zone under the former holder would be reduced and pose lesser risk of migration from the former holder area. Groundwater with low level contaminant concentrations outside of the holder would be prevented from migrating off-site. OM&M would be performed to verify the effectiveness of the remedy. ICs/ECs would provide guidance for handling and managing impacted groundwater encountered during future intrusive work until monitoring indicates that SCG concentrations of contaminants are achieved.

4.1.4 Reduction of Toxicity, Mobility, or Volume

This alternative would reduce the toxicity, mobility, and volume of contaminants in groundwater on Site. Waste generated as a result of drilling operations would be managed and transported off-site to a disposal facility.

4.1.5 Short-Term Effectiveness

Implementation of this alternative has minimal short-term risks associated with drilling injection wells, removal of spoil materials, injection of air, and monitoring. Under current use, exposures to contaminants in groundwater are limited and infrequent. Potential exposures to contaminants in groundwater at the Site are generally associated with future activities rather than those currently occurring. NYSEG has no plans to change current Site use.

<u>Protection of the Community</u> – A CAMP would be prepared in accordance with DER-10, Appendix 1A. Measures would be taken to monitor and reduce the potential impacts resulting from windblown particles, air emissions, dust, noise and traffic disturbance during drilling operations, biosparge system installation, and transport of spoil materials off-site for disposal.

<u>Protection of Workers</u> – Contractor employees would wear the appropriate PPE for various tasks as specified in the site-specific HASP.

<u>Environmental Impacts</u> – Short-term adverse environmental impacts associated with this alternative are low due to drilling operations, and operation of a biosparge system.

<u>Time Until Response Objectives are Achieved</u> – The groundwater monitoring program would be evaluated every two years. For costing purposes, assume that OM&M of the biosparge system for groundwater remediation would be 10 years.

<u>Green Remediation Considerations</u> – Fossil fuels and disposal facilities would be used for the drilling operations, and transport of materials to and off the Site.

4.1.6 Implementability

Technical Feasibility – It is technically feasible to implement this alternative. Biosparging is routinely used to promote aerobic biodegradation in groundwater and saturated soils for contaminants derived from MGP operations. Vertical and horizontal biosparge wells can be installed in readily accessible areas using conventional and directional drilling methods.

Administrative Feasibility - Injection of air and ICs/ECs can easily be implemented and are administratively feasible as NYSEG owns the properties.

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

4.1.7 Cost Effectiveness

The total estimated cost to implement a biosparge system in this alternative is $610,600. This cost includes $363,600 in capital costs and $247,000 in present value for OM&M costs for 10 years. The costs include a 20 percent contingency, engineering expenses and administrative fees. Details of the capital cost estimate are provided in Table 1.

The biosparge alternative is potentially a cost effective option as many of the RAOs may be addressed over a relatively short period. Contaminant reduction in the groundwater would be evaluated every two years by the NYSDEC. It is assumed that the groundwater monitoring period for this alternative would be 10 years.

4.1.8 Land Use

One of the two Site parcels currently operates as NYSEG's Auburn Green Street Substation, while the other parcel is currently grassed and undeveloped. NYSEG has no current plans to develop either parcel for different use. The properties are currently zoned for commercial use. This alternative would allow the current commercial land use as an electrical substation to continue.

5. Recommendations

Based on this detailed evaluation of in situ bioremediation for groundwater under the former holder, aerobic in situ bioremediation is a potentially feasible approach to achieve groundwater RAOs at the Site to the extent practicable. Biosparging with air injection wells is the recommended approach to implement aerobic in situ bioremediation at the Site, specifically for the treatment volume under the former holder. In order to aid in reduction of contaminant mass within and directly down-gradient of the former holder foundation, biosparging could be added to the remediation approach evaluated in Alternative 3 in the FSR. While this type of treatment was ruled out as a remedy for the site it may still be viable as an augmentation to the preferred remedy (FSR Alternative 3). Following a field-scale treatability study to determine design and operation parameters for the biosparge system under the former holder area, the remedial approach in Alternative 3 for the area outside of the holder (application of ORC at 10 injection wells) may be revised to implement aerobic in situ bioremediation using biosparging.

TABLE

AUBURN GREEN STREET MGP SITE
AUBURN, CAYUGA COUNTY, NEW YORK

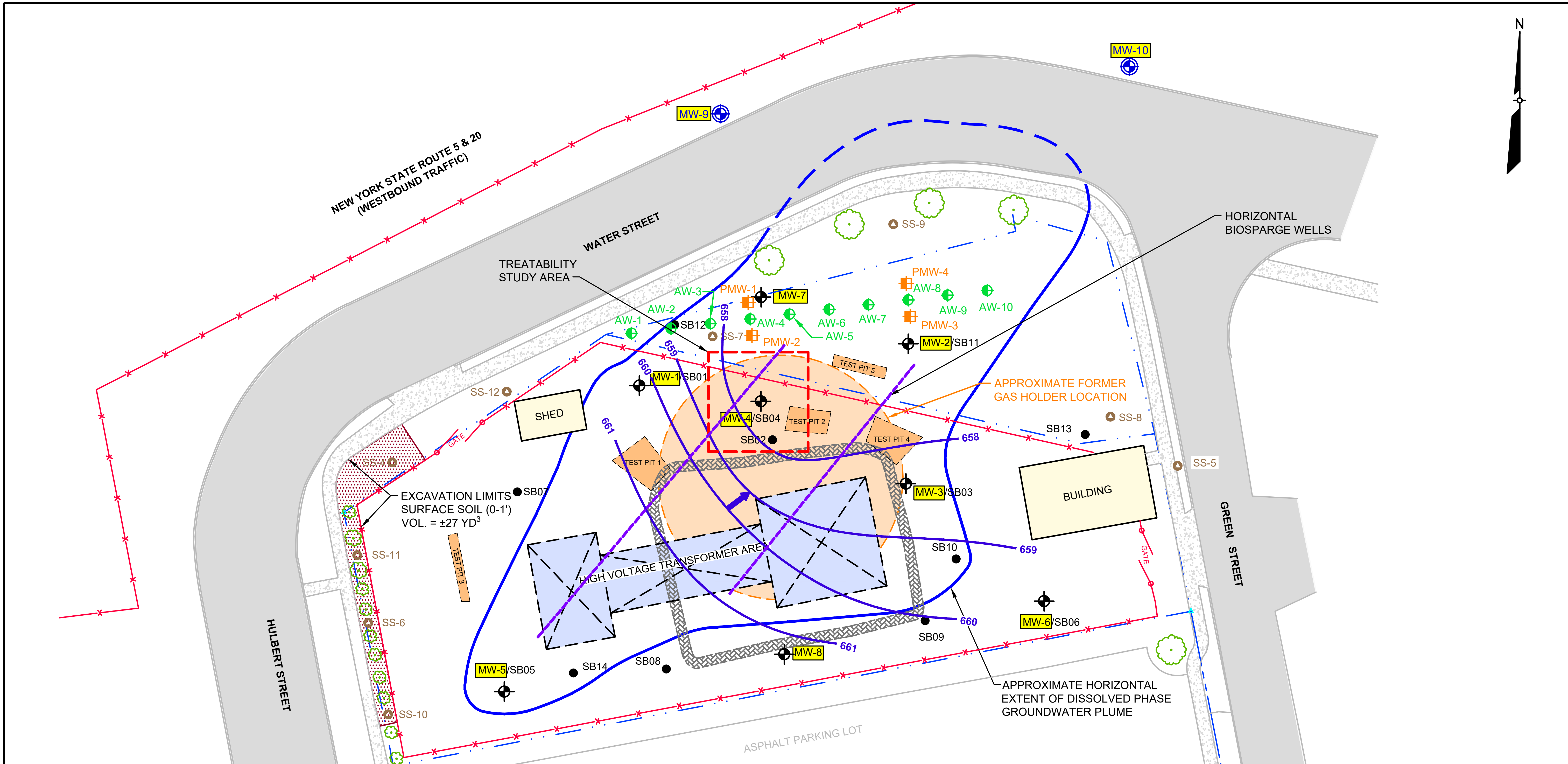
TABLE 1

Biosparging
Enhanced Aerobic Biodegradation

DESCRIPTION	QTY	UOM	UNIT COST	PROFIT ON SUB	TOTAL UNIT COST	TOTAL COST
CAPITAL COSTS - BIOSPARGING						
Pre-Design Investigation						**$ 68,000**
Pre-Design Investigation Work Plan	1	LS	$ 15,000		$ 15,000	$ 15,000
Vertical Well Drilling Mobilization	1	LS	$ 10,000	$ 1,000	$ 11,000	$ 11,000
Vertical Well Installation and Development	40	LF	$ 84	$ 8	$ 92	$ 3,678
Mobile Biosparge System Installation	1	LS	$ 10,000		$ 10,000	$ 10,000
Mobile Biosparge System Rental & Operation	1	mo	$ 15,000		$ 15,000	$ 15,000
Labor (2 laborers, 10-hr days; weighted average rate to account for overtime work)	90	HR	$ 107	$ 11	$ 117	$ 10,545
Pickup Truck with Storage Container	90	HR	$ 24	$ 2	$ 26	$ 2,352
Biosparge System						**$ 235,000**
Remedial Design & Implementation Work Plan	1	LS	$ 25,000		$ 25,000	$ 25,000
Horizontal Well Drilling Mobilization	1	LS	$ 12,000	$ 1,200	$ 13,200	$ 13,200
Horizontal Well Installation and Development	210	LF	$ 125	$ 13	$ 138	$ 28,875
Biosparge System Installation	1	LS	$ 40,000	$ 4,000	$ 44,000	$ 44,000
Biosparge System (Trailer)	1	LS	$ 100,000	$ 10,000	$ 110,000	$ 110,000
Labor (2 laborers, 10-hr days; weighted average rate to account for overtime work)	100	HR	$ 107	$ 11	$ 117	$ 11,717
Pickup Truck with Storage Container	100	HR	$ 24	$ 2	$ 26	$ 2,614
CAPITAL COSTS SUBTOTAL						**$ 303,000**
Contingency (20%)						**$ 60,600**
CAPITAL COSTS W/CONTINGENCY SUBTOTAL						**$ 363,600**

OPERATION AND MAINTENANCE	QTY	UOM	UNIT COST	PROFIT ON SUB	ANNUAL COST	PRESENT WORTH COST (5%)
Monthly OM&M (10 Years)						**$ 247,000**
1-Day Site Visit per month (1 Laborer and 1 pickup for 12 total hours)	10	yr	$ 10,000	$ 1,000	$ 11,000	$84,939
Materials and Supplies	10	yr	$ 10,000	$ 1,000	$ 11,000	$84,939
Reporting	10	yr	$ 10,000		$ 10,000	$ 77,217
O&M SUBTOTAL						**$ 247,000**
TOTAL CAPITAL AND O&M (PW) COST						**$ 610,600**

FIGURE



LEGEND

- EXISTING MONITORING WELL LOCATION
- SURFACE SOIL SAMPLE LOCATION
- SOIL BORING
- BUILDING
- ASPHALT PAVEMENT
- SIDEWALK
- BERM
- APPROXIMATE PROPERTY BOUNDARY
- CHAIN LINK FENCE
- APPROXIMATE FORMER GAS HOLDER LOCATION
- MW-4 MONITORING WELLS SAMPLED QUARTERLY YEAR 1; SEMI-ANNUALLY YEAR 2; ANNUALLY THEREAFTER
- PROPOSED MONITORING WELL
- EXCAVATION LIMITS SURFACE SOIL (0-1')
- O_2 PERFORMANCE MONITORING WELLS
- O_2 APPLICATION WELL

0 15 30 60
SCALE IN FEET

SOURCE: BASEMAP CREATED USING *T.G. MILLER P.C. ENGINEERS AND SURVEYORS* TOPOGRAPHIC MAP; JUNE 20, 2013.

AECOM
257 West Genesee Street, Suite 400
Buffalo, NY 14202
P: 716.856.5636

Figure 1 - Supplement to Auburn Green Street FS
Supplement to FS Alternative 3
Enhanced In situ Aerobic Treatment Option

Former Auburn Green Street MGP Site
Green Street
Auburn, Cayuga County, New York

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C:\60543583\FIGURE 1-ALTERNATIVE 3.dwg, 2/10/20 -1-RAL