Feasibility Study

Port Jervis MGP Site
Port Jervis, New York
NYSDEC Site No. 03-36-049P
Index # D03-0001-99-01

Prepared by:

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RETEC Project Number: ORAN2-18420-910

Prepared for:

Orange and Rockland Utilities, Inc.
390 West Route 59
Spring Valley, New York 10977

March 31, 2006

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Engineer's Certification

I certify that this Feasibility Study was prepared in accordance with the Order on Consent between New York State and Orange and Rockland Utilities, Inc., Index #D3-0001-99-01.

Work for this project was performed, and this report prepared, in accordance with generally accepted professional practices for the nature and condition of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Orange and Rockland Utilities, Inc. for specific application to the Port Jervis former manufactured gas plant site in Port Jervis, New York. No other warranty, express or implied, is made.

This report presents opinions of probable cost to aid in the evaluation of various remediation alternatives. Do not over rely on these opinions or apply them for purposes for which they were not intended. They have been based, in part, on approximate quantity evaluations that are not accurate enough to permit contractors to prepare bids. Such bids will be based in substantial part on the cost of labor and materials and the competitive bidding climate at the time the bids are formulated, the specific details of the design, and other factors over which RETEC has no control and of which RETEC in some instances has no knowledge. Accordingly, RETEC does not guarantee the accuracy of its opinions of probable cost as compared to contractors' bids or actual price to perform the work.

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JOHN T. FINN

3/30/06

Engineer's Seal — Date

RETEC Engineering, P.C.

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List of Acronyms and Abbreviations

bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980. Amended in the Superfund Amendments and Reauthorization Act (SARA) of 1986
COC	Constituents of Concern
DNAPL	Dense Non-aqueous Phase Liquid
ESS	Ex-situ Solidification
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
GRA	General Response Action
HDPE	High-density Polyethylene
ISCO	In-situ Chemical Oxidation
ISS	In-situ Solidification
LNAPL	Light Non-aqueous Phase Liquid
MGP	Manufactured Gas Plant
NAPL	Non-aqueous Phase Liquid
NCP	National Contingency Plan. 40CFR1J Part 300 – National Oil and Hazardous Substances Pollution Contingency Plan
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&R	Orange and Rockland Utilities, Inc.
ORC	Oxygen Releasing Compounds
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAHs	Polycyclic Aromatic Hydrocarbons
POTW	Publicly Owned Treatment Works
ppb	Parts Per Billion
PPE	Personal Protective Equipment
ppm	Parts Per Million
PRAP	Proposed Remedial Action Plan
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RETEC	The RETEC Group, Inc.
RI	Remedial Investigation
ROD	Record of Decision
ROW	Right-of-way
SCG	Standards, Criteria, and Guidance
SPDES	State Pollutant Discharge Elimination System
SVOCs	Semi-volatile Organic Compounds
TAGM	Technical and Administrative Guidance Memorandum
TBC	To Be Considered
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1 Introduction

This report describes the Feasibility Study (FS) undertaken for the former manufactured gas plant (MGP) site in the City of Port Jervis, New York. The purpose of the FS was to identify and evaluate a range of remedial action alternatives to support the selection of actions that will constitute the final remedy for the site. The FS was conducted in a manner consistent with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), the National Contingency Plan (NCP), and guidance by the New York State Department of Environmental Conservation (NYSDEC). NYSDEC guidance documents include the Technical and Administrative Guidance Memorandum (TAGM) #HWR-90-4030 "Selection of Remedial Actions at Inactive Hazardous Waste Sites" and other applicable NYSDEC guidance.

This FS was based on the Remedial Investigation (RI) Report, which was prepared for Orange and Rockland Utilities, Inc. (O&R) to present the findings of a comprehensive remedial investigation of environmental conditions at the site [RETEC, 2005]. The RI/FS process is being conducted in accordance with the Order on Consent (Order) #D3-0001-99-01 which O&R and NYSDEC executed on March 11, 1999 [NYSDEC, 1999].

1.1 Site Description

The Port Jervis MGP site is located at 16 Pike Street in the western portion of the City of Port Jervis, Orange County, New York. The location of the site is shown on Figure 1-1. The remedial alternatives presented in this FS address a single Operable Unit comprising the property controlled by O&R (referred to as On-site impacts) and impacts present on off-site properties. The site layout, Operable Unit boundary, and current features are shown on Figure 1-2.

1.1.1 On-site Property Description

The MGP site parcel is 1.2 acres in size, and covers most of a single city block of land. The parcel is currently owned and controlled by O&R. The City Tax Assessors office lists the property as Section 18, Block 16, Lot 2. The property is zoned for commercial and industrial purposes.

The site is roughly rectangular in shape, and is bounded by Pike Street to the southeast, King Street to the northeast, Brown Street to the northwest, and Water Street to the southwest. A vacant two-story apartment building is present on a lot at the southwest corner of the block which was purchased by O&R in 1999. A partial basement is present beneath the northeastern portion of the building. The balance of the block is an O&R operations center which consists of a business office and offices for gas, electric, and survey crews. The site building is a single story brick building and, in addition to the offices, includes a parts store room, an open garage bay area, and two loading docks. The building is constructed on-grade and does not have a basement. A second smaller brick building to the west of the operations center contains communications equipment and is also used for storage. A microwave tower is present immediately to the west of the communications building. A fenced gas regulator station is present in the west-central portion of the site.

The operations center parcel is enclosed by an 8-foot high, chain-link fence topped with barbed wire, and access is restricted to O&R employees. The majority of the area of the parcel enclosed by the fence that is not occupied by the buildings is used as a storage area for the gas and electric crews. Outside of the fenced area, two small grass-covered areas are present including an area to the southwest of the O&R apartment building, and an area between the operations building and the Pike Street right-of-way (ROW).

A large diameter (5-foot) storm sewer culvert is present 5 to 25 feet beneath the site which carries storm water from the majority of the City of Port Jervis east of the site, to an outfall pipe (Port Jervis Outfall) and seasonal pool located adjacent to the Delaware River to the west of the site.

1.1.2 Off-site Property Description

The following off-site properties are addressed in this FS:

- **28 Pike Street**. The only portion of Block 16 not owned by O&R is the property at 28 Pike Street, located in the northeast corner of the block. A three-story building is present at this location. The basement and first floor of the building is a restaurant. The second and third floors of the building are apartment units. This parcel was once part of the MGP site and was used for coal storage. It is now considered off site since it is no longer property owned by O&R.

- **The Pike, Brown, and Water Street roadways**. These streets are two lane and paved. Brown and Water Streets are residential. Pike Street, also known as NYS Route 209, has higher traffic from/to the adjacent Delaware River Bridge.

- **Off-site Properties Southwest of the Site.** Conditions at the commercial and residential properties in all directions surrounding the site were investigated during the RI. Other than 28 Pike Street, only off-site properties to the southwest of the site will be addressed in this FS since this was the only other area where impacts from the MGP were identified. These properties, all owned by the same owner, include the residence at 15/17 Pike Street, the residence at 13 Pike Street, the bookstore at 11 Pike Street, and the property at 9 Pike Street which includes a residence, a small school building, and an apartment building. The parcel at 9 Pike Street is immediately adjacent to the Delaware River.

- **The Delaware River.** The river is located approximately 160 feet to the southwest of the MGP site, on the opposite side of Water Street. It is a NYSDEC Class A river in the area adjacent to the site, and is prone to flooding.

1.2 FS Report Organization

The remainder of this FS Report is presented in the following sections:

Section 2. Lists the applicable Standards, Criteria, and Guidance (SCGs), and presents the Remedial Action Objectives (RAOs).

Section 3. Presents volume estimates of impacted media.

Section 4. Describes the formation of alternatives.

Section 5. Describes the analysis criteria, presents the detailed analysis of the alternatives, and presents the recommended alternative.

Section 6. Provides references cited in the report.

The appendices to the report provide volume and cost estimates, and summaries of the relevant analytical data.

2 SCGs and RAOs

This section describes the standards, criteria, and guidance values (SCGs) considered applicable to the site. Site-specific remedial action objectives (RAOs) are then developed based in part on the applicable SCGs. General Response Actions (GRAs) to address the RAOs are then identified.

2.1 Standards, Criteria, and Guidance Values

SCGs are grouped in the following three categories:

- Chemical-specific SCGs set health or risk-based concentration screening values, limits, or ranges in various environmental media for specific chemical constituents.
- Action-specific SCGs are those which would be in effect for the implementation of a particular remedial action.
- Location-specific SCGs are those which refer to local requirements or conditions that are specific to the location of the site.

The list of potential chemical, action, and location-specific SCGs is presented in Tables D-1, D-2, and D-3 in Appendix D. Notes regarding the applicability of the SCGs are also provided.

2.2 Remedial Action Objectives

The RAOs are site-specific goals that address media of concern, specific contaminants, and the active exposure pathways at the site. The RAOs are established as the overall goal for the site remediation to provide protection of human health and the environment.

The RI found no immediate potential threats to human or ecological receptors. The primary constituents of concern (COC) in soil and groundwater were found to be volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). Inorganic constituents were found to be below or only slightly above background ranges for eastern USA or New York State soils and/or groundwater.

Upon consideration of the SCGs, and the nature and extent of MGP impacts, as described in the RI, the following long-term RAOs for protection of human health and the environment at the Port Jervis site were developed:

1. **Prevent human contact with soil containing COCs at levels above NYSDEC TAGM 4046 Guidelines.**

2. **Prevent human exposure to impacted soil gas vapors.**

3. **Removal of source mass to the extent practicable.**

4. **Mitigation of groundwater impacts to the extent practicable.**

5. **Elimination of potential impacts to the river to the extent practicable.**

2.3 General Response Actions

To meet the RAOs developed for the site, the following GRAs were identified:

1. **No Action.** This response action is listed for compliance with FS guidance, but would not result in meeting the RAOs and is not contemplated for this site.

2. **Administrative Actions.** These actions involve restrictions of legal access to soil or groundwater.

3. **Containment.** Containment actions involve little or no treatment, but provide physical barriers to exposure, or otherwise remove pathways of exposure.

4. **Treatment/Disposal.** These actions include on-site or off-site reduction in the volume, toxicity, and/or mobility of the contaminants. Treatment/disposal actions include removal and off-site treatment/disposal of impacted media in properly permitted facilities.

3 Media of Concern

3.1 Exceedances of SCGs

The laboratory data presented in the RI [RETEC, 2005] were evaluated with regard to chemical-specific SCGs for surface soil, subsurface soil, sediment, and groundwater. These data are presented in Appendix C.

The areal extents of soil and groundwater impacts are shown on Figure 3-1. Cross sections showing the depths of impacts are presented in Figures 3-2 and 3-3.

3.2 Volume Estimates

The volumes or areas of media (soil, groundwater, and NAPL) to be addressed by remedial alternatives were estimated as follows. The calculations from which the estimates were made are included in Appendix A.

Surface Soils:

All surface soil samples collected on the site and at the off-site background locations in the City of Port Jervis had three or more individual PAH compounds present in concentrations exceeding individual TAGM guidance values. A total volume of surface soils in exceedance of the TAGM values has not been calculated.

On-site surface soil is present only in the lawn area around the apartment building and in front of the operations building along Pike Street. Other on-site areas are covered by pavement or structures.

The highest surface soil concentration of total PAHs (446 mg/Kg) was found in sample SS1 which was collected from behind the restaurant building at 28 Pike Street. The volume of the soil at this location is estimated to be 1 cubic yard and will be removed (see Section 5.2.2). Portions of other surface soil areas may also be removed, depending on which of the remedial alternatives discussed in this FS is ultimately selected.

Subsurface Soils:

NAPL or tar-like materials are present in subsurface structures and in subsurface soil both on and off site. The volume of NAPL-impacted soil is estimated to be between 2,500 and 10,600 cubic yards, over 75% of which is on site.

The volume of soil exhibiting a hydrocarbon sheen, including the NAPL-impacted soils, is estimated to be approximately 25,000 cubic yards on site, and 16,000 cubic yards off site. Except for two MGP structures, the on-site sheen and NAPL-impacted soils are located below 14 feet below ground surface (bgs) [below 30 feet bgs off site].

The volume of soil exceeding 500 mg/Kg total PAHs and/or 10 mg/Kg total BTEX is approximately 34,000 cubic yards. There were no off-site analytical detections greater than 500 mg/Kg total PAHs, or 10 mg/Kg total BTEX in soil.

The volume of on- and off-site subsurface soil exceeding TAGM 4046 values is approximately 80,000 cubic yards.

Groundwater:

Depth to groundwater varies from 15 to 18 feet bgs on site and 18 to 24 feet bgs in the off-site areas to the south.

The dissolved groundwater plume intersects the river in an approximate 180 foot length of shoreline. Due to upwelling at the river's edge, the impacted groundwater plume at this location tapers up to a thickness of approximately 20 feet (from approximately 20 to 40 feet bgs). Groundwater samples taken below this depth were not found to be impacted with COC greater than groundwater standards. Elsewhere at the site, groundwater impacts are deeper.

The area of the plume exceeding groundwater standards is approximately 130,000 square feet (3 acres). The total volume of impacted water, assuming a 25% soil porosity and an average impacted thickness of 60 feet, is approximately 14.5 million gallons. The flux (mass loading) of COC to the river is estimated to be less than 0.004 lbs/day of BTEX and less than 0.006 lbs/day of PAHs.

Soil Vapor:

Extensive soil vapor and indoor air sampling was performed during the RI. Based on the results of this sampling, soil vapor does not appear to have been impacted by site-related residuals. Therefore, an estimate of the extent of impacted soil vapor has not been included in the FS. Note that under each of the evaluated alternatives, source removal will be performed and the removal of this material is anticipated to further reduce the potential that soil vapor may be a concern for potential receptors in the on-site and off-site areas.

3.3 Delaware River Sediments

Extensive sampling and analyses were performed during the RI to determine whether site-related COCs are present in sediments in the Delaware River area adjacent to the site. Concentrations of PAHs were greatest (32 to 71 mg/Kg) in the soft sediments at the seasonal, localized embayment at the Port Jervis storm sewer outfall to the Delaware River. A localized pocket of non-MGP related petroleum NAPL was also noted at this location. Investigation, sampling, and analysis was performed to make this determination. The results of this analysis are discussed in the following paragraphs.

Test pits and borings were performed, and soil and groundwater samples were analyzed, to determine if bedding material for the storm sewer pipe may be acting as a migration pathway or conduit from the site to the outfall area. Test pits TP5, TP6, and TP9 straddled the former canal raceway (in which the sewer pipe is located), and assessed the potential for impacts in the raceway, along the raceway, and in the sewer pipe bedding. The test pits uncovered the storm drain but NAPL or significant soil impacts were not observed. No groundwater discharge was observed from the bedding below the pipe at the outfall during periods of low flow when the outfall pipe is several feet above the river water level.

Additional information regarding the soil conditions adjacent to the pipe or bedding material was obtained during the completion of the soil borings for wells MW2, MW9D, and TW1, located between the site and the river area. Impacted soil was not observed at or below the elevation of the pipe in any of these borings.

The conditions around the storm sewer pipe are shown in the cross section on Figure 3-3. It is important to note that the storm sewer pipe is located above the depth of the groundwater table, eliminating the potential of the pipe or bedding material acting as a conduit for impacted groundwater at the site. Furthermore, subsurface geologic units (lower confining layers) which could act to direct the flow of NAPL towards the pipe or bedding material, were not observed during the RI. If NAPL or tar were present in any area of the site, the NAPL is anticipated to migrate downward through the sand alluvial material to the water table, and then to the southwest.

Based on the groundwater sampling performed at monitoring wells TW1 and MW10S, located between the site and the outfall, groundwater in this area is not impacted with COCs in concentrations greater than groundwater standards. The site-related impacted groundwater plume is present further to the southwest of this location and it does not appear that the storm sewer bedding material is acting as a sink or conduit for site-related impacts.

Based on groundwater contours provided in the RI, the secondary storm sewer below Pike Street is not believed to be acting as a sink for groundwater, and possibly NAPL, from the site. Infiltration to the storm sewer system is highly unlikely because the inverts of the storm sewer system are above the water table. Several groundwater sampling and measurement events have confirmed that groundwater flow is to the southwest, away from the sewer outfall, without preferential pathways (the site-related groundwater plume is addressed later in this FS).

Sampling was performed during the RI to determine if sediments within the storm sewer pipe itself were impacted with PAHs in concentrations greater than screening criteria. A sediment sample collected from the storm sewer at a location upgradient of the MGP site contained 46 mg/Kg of PAHs. Based on this sampling it appears that sediment materials associated with the urban discharge from the northern portion of the City of Port Jervis can be expected to contain PAHs in concentrations exceeding sediment screening criteria.

PAHs are COCs associated with both MGP sites and other hydrocarbon sources, such as urban roadway runoff, so a sample of NAPL from the soft sediment in the outfall basin was analyzed for hydrocarbon fingerprinting. The hydrocarbon material was found to be a mixture of a "heavy" petroleum oil (such as lubrication oils), fatty acids and esters (plant matter extracts), and a silicone polymer. PAHs that may be present as a result of MGP operations were not identified in the sample.

During rainfall events in Port Jervis, hydrocarbon sheens were observed in water discharging from the storm sewer pipe, further indicating that the source of the hydrocarbon materials in the river area is likely due to urban storm water runoff, not the MGP site.

It does not appear that the sewer pipe or the pipe bedding materials are acting as a pathway for residuals to migrate from the areas of known impact at the site towards the Port Jervis outfall area. The impacts at the sewer outfall appear to be from non-MGP urban runoff sources.

A second (down stream) storm sewer outfall pipe that drains the southwestern portion of the City of Port Jervis was also sampled during the RI. This pipe is well outside of the area where MGP-site related impacts would be expected. The sediments in the area of this outfall also contain PAHs in concentrations ranging up to 4 mg/Kg, indicating that samples collected anywhere within the City of Port Jervis storm sewer system, including the sediment locations adjacent to the outfalls, can be expected to contain PAH compounds.

The groundwater plume that is related to the MGP site meets the river south of the primary outfall in a limited area of approximately 180 linear feet of shoreline. Sediment samples collected from the river adjacent to this area had total PAH concentrations significantly lower than those detected at the (upgradient) sewer outfall area. Visible evidence of MGP-related materials, such as sheen or NAPL, was not observed where impacted groundwater meets the river. For these reasons, it appears that the hydrocarbon impacts in this area of the river are likely due to the urban runoff from the storm sewer outfall, rather than COC related to the MGP site.

Discussions have been held with the NYSDEC regarding the need to perform cleanup of the sediments within the pool at the Port Jervis outfall. The volume of these sediments, assuming an average impact depth of 4 feet and an area of 10 feet x 20 feet, would be approximately 30 cubic yards.

Excavation, handling, and off-site disposal costs of MGP-impacted sediments could range from $300 to $600 per cubic yard, including dewatering, placement of armor stone, air monitoring, and project oversight. Based on the small volume of material at this site, an estimate of $600 per cubic yard, or $18,000 total, may be appropriate. Access to this work area, however, is difficult. Access from the river side (by barge) would be cost prohibitive, while access from the south or east is impossible due to existing structures. Access from the north would be via a steep embankment and then along the shore during low water season. The costs of providing safe access by this route could add $20,000 to the cost of the remedy. Permits would also need to be obtained from U.S. Army Corps of Engineers (USACE) and other regulatory bodies, resulting in additional time and costs. Ultimately, the task of removing 30 cubic yards of urban- runoff-impacted sediment from the outfall could cost $50,000. Approximately 300 feet of existing, vegetated shoreline would be disturbed by heavy equipment to provide access to the outfall pool. Restoration costs are not included in this estimate. Alternatively, sediments may be removed by a vac-truck parked above the embankment. There may be some cost savings associated with this method because of reduced access issues, though it may not be technically feasible due to the distance and vacuum required. It could also be more labor intensive (ultimately increasing the cost per cubic yard) and no armor stone could be placed to prevent erosion.

Under either remedial scenario, the outfall area would be expected to become re-impacted by urban runoff in the future.

As discussed above, the data obtained during the RI indicates that the hydrocarbon COC in the storm sewer outfalls and the river is likely due to urban runoff, not the MGP site. Since the impacts to the Delaware River sediments are not believed to be related to the MGP site, they are not included in any of the remedies in this FS.

4 Development of Alternatives

4.1 Technology Identification and Screening

An initial screening process was used during this FS to highlight the most promising technologies for implementation at the site [FRTR, 2002; GRI, 1997; ITRC, 2002; NYSDEC, 1992]. Table 4-1 summarizes the technologies screened.

The technologies are categorized according to their typical application to either groundwater/NAPL, or soil.

Brief explanatory notes for each of the technologies are provided in the tables and each technology is evaluated in terms of applicability to the on-site O&R property, the off-site public street areas, and the off-site residential/commercial areas.

4.1.1 Screening of NAPL Recovery Technologies

NAPL recovery can reduce the mass of NAPL in the subsurface and/or it can, by recovering the flowable fraction, reduce the mobility of residual NAPL.

Several of the Port Jervis monitoring wells have collected NAPL over time. Bail-down tests conducted during the RI, however, removed successively smaller quantities of NAPL from each well, indicating that the quantity of recoverable NAPL may be moderate.

Aggressive NAPL recovery technologies such as hot water flushing, steam flushing, and surfactant flushing are applicable to sites where a great amount of hydraulic control can be provided. There is no confining layer at the Port Jervis site, and the hydrogeologic conditions are characterized by high groundwater flow rates and a predominance of deep sand below the existing NAPL impacts. The mobilized NAPL would tend to migrate downward and downgradient, and sufficient hydraulic control and capture of mobilized NAPL would not be technically feasible. These aggressive NAPL recovery technologies were therefore not carried forward into the proposed NAPL recovery program.

The most effective type of NAPL recovery for the hydrogeology of this site would be intermittent low-flow pumping to induce NAPL migration towards recovery wells. As the volumes of NAPL diminished, recovery could continue on a more intermittent basis with hand balers or vacuum enhanced recovery.

4.1.2 Screening of In-situ Groundwater Treatment Technologies

In-situ groundwater remediation can be accomplished biologically, chemically, or physically, as indicated in Table 4-1. Physical treatment typically involves either air sparging to drive dissolved VOCs from the groundwater, or the inducement of controlled groundwater flow to a collection point for treatment or extraction. Chemical oxidation usually involves injections of oxidants that react directly with the contaminants. Due primarily to the proximity of occupied buildings, physical and chemical treatment technologies were deemed inappropriate and not applicable to the Port Jervis site and were not carried forward into the proposed in-situ groundwater treatment program.

Biological treatment enhances the natural degradation of contaminants. Long-term in-situ groundwater treatment of BTEX and PAH compounds is typically an aerobic biodegradation process. Engineered saturated zone bioremediation processes are designed to treat the dissolved constituents of the groundwater plume by insuring the existence of a bioactive zone which is sufficient to degrade the constituents before they reach an environmental receptor. The natural process of biodegradation can be slow and limited by the availability of oxygen or nutrients. Therefore, in-situ biodegradation is enhanced by the addition of oxygen, and/or nutrients to the aquifer, and one of the key features is the use of in-situ aquifer aeration.

The process will usually require the addition of oxygen (aeration) to enhance the rate of oxygen recharge above that already occurring in the aquifer.

Common methods of aquifer aeration include placement of oxygen releasing compounds (ORC) in the subsurface, injection of hydrogen peroxide or ozone, or air/oxygen aeration. Any aquifer aeration technology implemented at the Port Jervis site would require a high degree of hydraulic control. Injection of hydrogen peroxide or ozone would present difficulties and uncertainties with regard to hydraulic control and therefore may not be appropriate for this site. For bioremediation at Port Jervis, air or oxygen aeration would likely be most cost effective due to the anticipated scope and long duration of the work. The estimated remediation rate would still be measured in years or decades.

Sufficient air (or oxygen) would be added to the trench or wells to satisfy the biological oxygen demand for biodegradation of the dissolved phase constituents transported into the trench.

No groundwater pumping would be performed as part of this process.

In general, permeable soils, such as those found at Port Jervis, are necessary to provide pores that are large enough to allow effective aquifer aeration.

The treatment system can be engineered in several configurations, depending upon the site-specific requirements, but it should meet three primary design criteria:

1. The hydraulic design must be engineered to maximize mixing of any amendments with the groundwater, without forcing contaminated groundwater beyond the containment or treatment zones.

2. The levels of dissolved organics being degraded must be sufficiently small such that the length of time in the treatment zone and the quantity of cell mass produced are consistent with the long-term operation of the process.

3. The compounds of concern must be biodegradable and not create metabolites that are more toxic than the original compounds of concern.

A "microbial fence" approach might be used at the Port Jervis site to accelerate natural attenuation, while minimizing the types of aggressive treatment that typically are highly disruptive. This option would involve the installation of a row of aquifer aeration wells aligned perpendicular to the groundwater flow direction.

4.1.3 Screening of In-situ Solidification (ISS) Technologies

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]. 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. Both aspects of the ISS technologies are discussed below.

Mix Design

A large number of possible solidification reagents have been proposed, including polymers and waxes [Conner, 1990]. However, Portland cement and bentonite clay, which have become the reliable and effective standard for most ISS applications, would be well suited to the sandy soils at the Port Jervis MGP site. While a treatability study would be required to demonstrate effectiveness and determined to be the least-cost mix design, addition of approximately 5 to 10% Portland cement would be anticipated to be effective for this site to achieve typical criteria, such as permeability of less than 1 x 10^{-6} centimeters per second, and an unconfined compressive strength of at least 50 pounds per square inch.

Delivery Systems

The three common delivery systems used for ISS are bucket mixing, auger mixing, and pressure/jet grouting. Bucket mixing uses conventional excavation equipment to mix the ISS reagents with the soil. It may not be applicable to the Port Jervis site, where the depth of ISS will extend below the reach of excavation equipment.

Auger mixing is the most commonly used delivery system. A large vertical auger (5 to 12 feet in diameter) is used. The process involves a large drilling rig which is used to turn the auger into the soil. As the auger is lowered, the grout mixture is injected into the soil through holes in the auger blades. The auger creates a column of mixed material. Columns are placed side by side in an overlapping pattern to ensure that there is sufficient overlap of the mixed soil. Pressure/jet grouting uses high pressure grout to fill void spaces in the soil matrix and thereby solidify the soil. It can be used alone, or more commonly, as an adjunct to auger mixing whereby pressure is used to force grout between large subsurface obstructions or sensitive underground utilities. The end result of both processes is a large solidified mass of lower permeability in which contaminants are immobilized. Due to low permeability, groundwater flow is diverted around the solid mass.

Control of odors and VOC emissions will be a critical aspect of all remedial scenarios at the Port Jervis site. ISS activities would require crane-mounted excavation equipment that would not be feasible to enclose within a temporary fabric structure. Other engineering controls, such as plastic sheeting and odor control foam, would be used to prevent off-site odors and VOC emissions.

4.1.4 Screening of Excavation Technologies

Overview of Excavation 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 the Port Jervis site, excavation for removal of impacted soils could extend to depths of 50 feet. Depths greater than 100 feet would be required for slurry wall construction. A combination of these technologies would be used to accomplish the excavation work at Port Jervis and are therefore carried forward into the detailed description of excavation alternatives.

Control of odors and VOC emissions will be a critical aspect of all excavation scenarios at the Port Jervis site. Where feasible, excavation and on-site loading activities would be conducted within temporary fabric structures. Deep excavation activities may require crane-mounted excavation equipment that would not be feasible to enclose within a structure. During these activities, odor control foam and other engineering controls would be used to prevent off-site odors and VOC emissions.

Similarly, the handling of soils, rock, and demolition debris will be an important aspect of excavation at the Port Jervis site. On-site treatment or disposal of impacted solids will not be feasible at this site due to the lack of space and the inappropriate location for such activities. Off-site transportation and disposal of solids will first require stabilization of wet soils that would be excavated under alternatives that would involve removal of soils from below the water table. Transportation of solids would be done by appropriately permitted trucks, rather than by rail, since no rail siding exists at the site. Off-site disposal options would 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, such as for dry soils. Wet soils, large rock, and demolition debris would constitute materials that would not be acceptable to commercial thermal desorption facilities, and therefore would require landfilling.

The two remaining major challenges for excavation at the Port Jervis site are sidewall support and water management. The screening of technologies to address these aspects is discussed below.

Sidewall Support

Due to the depth of the excavations, the characteristics of the soils, and the constrained area at the site, simple sloping of the excavations would not be feasible and an engineered support system would be required for all but the most shallow excavations. Five technologies have been widely used for sidewall support of deep excavations: 1) soldier beam and lagging walls, 2) sheet piling, 3) slurry walls, 4) grout curtains, and 5) slurry-supported wet excavation. The following selection criteria were used in the consideration of these technologies for use at the Port Jervis site:

- Safety during installation;
- Confidence in the success of implementation;
- Protection against sidewall failure;
- 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.

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 [USDOT, 1999].

Safety and implementability of this technology are well established for a wide range of site conditions. Properly designed, the technology would provide adequate protection against sidewall failure and would be protective of nearby buildings. The major drawback would be the large flows of groundwater that would seep from the bottom of the excavation between the lagging (even with lagging seals). Unlike slurry walls, grout curtains, and sheet pile walls, soldier beam and lagging walls cannot be extended below the depth of excavation. Therefore, groundwater flow from the bottom would present a major problem which would render the technology infeasible. Dewatering of the excavation area is not practicable at this site, as discussed below under Water Management. The wet excavation would result in unacceptably wet soil being removed, with no on-site area available to stabilize the wet soil prior to transportation off site. Considering these limitations, this technology may be applicable to a limited portion of relatively shallow excavation sidewall supports, but would not be applicable for most of the deeper site excavation work.

Slurry Walls and Grout Curtains

A slurry wall is a low-permeability subsurface vertical barrier constructed by excavating a trench which is then backfilled with selected low-permeability materials, such as bentonite. The sides of the trench are kept stable during excavation by a slurry (a suspension of bentonite clay in water). Grout curtain installation involves injecting a liquid, slurry, or emulsion under pressure into the soil matrix. The use of slurry walls and grout curtains as shoring for excavation has been made possible augmented by various steel reinforcing frames, pilings, and/or other materials. 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 [Ratay, 1996].

The safety and implementability of this technology are well established for a wide range of site conditions. They could be advanced below the bottom of the excavation to allow for more effective groundwater cutoff than a soldier beam and lagging wall. The main drawback of these technologies is their requirement for additional strengthening to provide adequate protection against sidewall failure at depths greater than 30 feet. Specialized engineering and construction capabilities would be required. Considering this limitation, these technologies may be applicable to a limited portion of relatively shallow excavation sidewall supports, and could also be applicable for most of the deeper site excavation work, with substantial design and construction efforts.

Sheet Piling

Sheet piling, as applied in the environmental industry, typically involves driving lengths of inter-connectable steel sheeting 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 cantilvered 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 may be used to brace the sheetpile and 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 may 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. During driving of the sheet piling, it is possible for the sheets to come out of interlock and wander out of position. Obviously, if this occurs, the sheet piling will not be an effective barrier to groundwater flow. Reportedly, it is difficult to maintain full interlock at depths over 80 feet. In addition, the installation of sheet piling can be difficult or ineffective in conditions where large rock or wood obstructions are present. It is unknown at present whether or not such obstructions exist at the Port Jervis site. A layer of cobbles was encountered during the RI drilling program at a depth of approximately 18 feet bgs, and approximately 10 to 15 feet thick.

Considering these limitations, this technology may be applicable to portions of the excavation sidewall supports, and could also be applicable for most of the deeper site excavation work. However, substantial design and construction efforts would be required. Additional information would need to be provided in a pre-design investigation, including a sheet pile test that would indicate appropriate conditions for successful driving of steel sheet piling.

Slurry Supported Wet Excavation

Another approach to excavation sidewall support is to perform the excavation in a series of slurry-filled trenches. The bentonite clay slurry would act to support the sidewalls and to prevent groundwater infiltration. This process would alternate an excavated strip with an unexcavated strip, which allows for curing time for the slurry/clean fill mixture.

This is a relatively new application of slurry support technology and the safety and implementability of this technology are not well established. One of the main drawbacks of this technology is that some material could collapse from the sidewalls [Rumer and Ryan, 1995]. This would threaten the sidewall stability and result in impacted material falling to the bottom and not being removed. The second main drawback is that this technology would result in unacceptably wet soil being removed, with no on-site area available to stabilize the wet soil prior to transportation off site. Considering these limitations, this technology was not carried forward into the alternatives involving excavation.

Excavation Water Management

Excavation below the water table will require management of the groundwater seepage into the excavated area. Excavation dewatering technologies include area-wide dewatering or excavation pit dewatering. Area-wide dewatering involves depressing the water table over the entire site by pumping from a series of manifolded well points [Nichols and Day, 1999]. This would present a major difficulty at the Port Jervis site. The coarse sand and gravel soil conditions would require an infeasibly high rate of pumping to achieve area-wide dewatering.

Dewatering of the excavation pits would involve a localized dewatering of a specific zone below an excavation. The localized dewatering would be made possible by temporary vertical cutoff walls that are installed below the maximum depth of excavation. The walls would act to minimize the lateral and upward flow of groundwater. Excavation pit dewatering would produce water that would need to be treated prior to discharge to the City of Port Jervis Publicly Owned Treatment Works (POTW) or, alternatively, discharged to surface water under an agreement that would be technically equivalent to a State Pollution Discharge Elimination System (SPDES) permit. Water management by excavation pit dewatering was therefore carried forward into the FS alternatives involving excavation.

4.1.5 Screening of Containment Technologies

Overview of Barrier Technologies

The purpose of containment technologies would be to eliminate off-site migration of impacted groundwater and NAPL by containment of on-site sources. There are three technologies commonly used to construct physical barriers for containment: 1) slurry walls, 2) grout curtains, and 3) sheet piling. All three technologies involve the construction of an impermeable wall capable of blocking groundwater and NAPL migration. For permanent barriers, chemical compatibility between contaminants and the barrier materials is a prime consideration. While the main concern has been with highly acidic leachates from landfills and mine waste [Rumer and Ryan, 1995], the chemical compatibility of any containment system at the Port Jervis site would need to be determined by compatibility studies with actual groundwater and NAPL samples.

Slurry Walls

Slurry walls have been widely employed for groundwater cutoff and have been used to contain groundwater contamination, in dewatering applications, and to control seepage under dams. A slurry wall is a low-permeability subsurface vertical barrier constructed by excavating a trench which is then backfilled with selected low-permeability materials, such as bentonite. The sides of the trench are kept stable during excavation by a slurry (a suspension of bentonite clay in water). Low concentrations of organic compounds do not appear to adversely affect the physiochemical properties of the clays and no significant increase in permeability would likely result from their interaction. Excavation is typically performed initially with a backhoe and with specialized equipment at greater depths. Because of the construction equipment used, the trench is typically 3 feet wide. Slurry walls are generally anchored into a low-permeability formation to minimize groundwater flow beneath the wall.

The slurry would contain sufficient solids and fluid density to maintain trench stability while allowing excavation operations to be conducted through it. To prevent caving, the level of the slurry would be maintained near the top of the trench and at least several feet above the groundwater table.

Grout Curtains

Installing a grout curtain involves injecting a liquid, slurry, or emulsion under pressure into the soil matrix. The procedure starts at the bottom of a borehole and proceeds upwards using progressively lower injection pressures. The injected material moves outward from the point of injection into the available pore space. The injected material then solidifies, causing a reduction in the permeability of the aquifer.

Sheet Piling

Sheet piling, as applied in the environmental industry, typically involves driving lengths of inter-connectable steel sheeting into the ground to form an impermeable barrier. The steel sheeting is available in a wide variety of configurations and strengths. The sheet piles would be driven from the surface through the entire design depth. The installation of sheet piling can be difficult or ineffective in conditions where the soil has a high proportion of large gravels or where extensive underground utilities exist.

The effectiveness of sheet piling as a groundwater cutoff technology depends on the integrity of the sheet interlock. During driving of the sheet piling, it is possible for the sheets to come out of interlock and wander out of position. Obviously, if this occurs, the sheet piling will not be an effective barrier to groundwater flow. Reportedly, it is difficult to maintain full interlock at depths over 80 feet. Even assuming the sheet piling remains initially interlocked, the interlocks may require to be grouted to reduce leakage.

Each of these methods would require the use of large, heavy construction equipment over several months. In addition to the noise and physical hazards, space will be needed for delivery, unloading, and storage of materials during construction.

Configuration of Containment Technologies at the Port Jervis Site

Three configurations were considered for the containment system: 1) a containment wall to bedrock, 2) partial containment with funnel and gate, and 3) a containment cell with an engineered bottom seal. The remainder of this section describes these configurations and provides the rationale for selecting the containment cell as the representative technology application carried forward in the Containment Alternative.

Containment Wall to Bedrock

This option would entail a containment wall surrounding the lateral extent of impacted soils on the MGP site and extending down to the bedrock. The shale bedrock surface would constitute the bottom of the containment.

This option has three major difficulties. The first problem is that the containment wall would need to be installed to the depth of bedrock, which varies from 145 feet to 185 feet bgs. While slurry walls have been designed for depths of up to 125 feet at other MGP sites [NYSDEC, 2004], an EPA study of 36 containment barriers has showed that slurry walls constructed at depths greater than 70 feet often result in unacceptably poor quality assurance and quality control of the slurry wall and the bottom key into bedrock [EPA, 1998]. Construction of a barrier wall to 185 feet bgs would be beyond the normal depth limits of this technology and would present significant constructability and quality assurance problems.

The second major problem arises from the fractures in the shale bedrock. The interface between the containment wall and the fractured shale bedrock surface could be a failure zone, allowing groundwater to enter the contained area and potentially allowing impacted groundwater or NAPL to migrate from the contained area. This has been the cause of previous containment system problems at other MGP sites [EPA, 1998]. To address this problem, borings would need to be advanced into the fractured shale until a competent zone is reached, and grout would be pumped into the fractured zone, forming a grout curtain along the perimeter of the slurry wall. This grout curtain technology has been incorporated into the Record of Decision (ROD) at another site facing a similar problem [NYSDEC, 2002], but at a depth of only 20 feet bgs. However, at the Port Jervis site, the much greater depths and the varying depths would pose problems in accurate placement of the grout borings and problems in assuring that the filling of the fractures was complete [EPA, 1998].

The third problem with this option is that the fractures in the bedrock surface forming the bottom of the contained area would allow some continued groundwater migration into and out of the contained area. Even if a groundwater pump and treatment system were installed to maintain a negative head within the contained area, local flow from the fractures would pose an uncertainty with regard to the success of the remedy.

Upon consideration of the major problems with this option, it was screened out and not carried forward into the evaluation of possible alternatives for the site.

Partial Containment with Funnel and Gate

In this option, containment walls would direct groundwater and NAPL flow through an in-situ treatment zone (gate). The containment walls would surround the impacted soils, with the gate area located downgradient, along Pike Street. This would direct the groundwater flow upward and through the gate area. The containment walls would therefore not be required to reach bedrock, but would only need to extend to below the impacted soils, to a depth of approximately 60 feet bgs. In-situ treatment in the gate area would consist of a NAPL recovery trench or closely spaced wells, and an aeration zone for in-situ biological treatment of dissolved impacts. This option has two major difficulties. The first problem is that the remedy relies on the successful and consistent direction of groundwater and NAPL flow upward within the contained area and through the gate area. However, the flow of groundwater and NAPL is difficult to accurately predict; DNAPL flow can be downward even when groundwater flow is upward [Cohen and Mercer, 1993]. Off-site migration of impacted groundwater and NAPL could therefore continue beneath the containment walls and beneath the gate area.

The second problem is that the remedy relies on the successful and consistent in-situ treatment of groundwater and collection and removal of NAPL in the gate area. However, the high groundwater flow velocities that would be created through the gate would probably be too rapid for successful treatment of groundwater and collection of NAPL.

Upon consideration of the major problems with this option, it was screened out and not carried forward into the evaluation of possible alternatives for the site.

Containment Cell

This option would entail a containment wall surrounding the lateral extent of impacted soils on the MGP site and extending below the vertical extent of impacted soils, to a maximum depth of approximately 70 feet bgs, with a bottom containment layer formed by an angled grout curtain. The vertical portions of the containment barrier would be constructed using a combination of slurry wall and sheet piling technologies. The grout curtain bottom would be constructed by advancing a series of parallel angled jet grouted borings. The boring layout would be designed such that the jetted grout would form overlapping columns running from the surface at one side of the site, to a depth below the impacted soils at the center of the site, and extending at depth to the far wall of the containment cell, as depicted in Figures 5-5A and 5-5B. The jet grout borings which would comprise the grout curtain would need to be installed with precision, using directional drilling technology [Willoughby, 2005]. The grout curtain would be keyed into the sides of the containment wall and the end wall with additional grout placed to seal these joints. This technology has been successfully employed at several test sites, but is still in development [Rumer and Ryan, 1995; Blakita, 2000; DOD, 1995]. A low permeability pavement cap would be constructed over the containment cell to minimize groundwater infiltration into the cell. A small groundwater pumping system would be operated to maintain a negative groundwater head within the cell. This option has a major difficulty associated with the constructability of the grout curtain bottom. If a few single obstructions, such as a few single large rocks are encountered, the design may be adjusted to go beneath and around them. However, if a layer of rock is encountered which obstructs the designed path of the borings, then the grout curtain may not be able to be completed without first removing the layer, either by drilling and fracturing the layer so that it can be competently grouted, or by excavating a deep trench at the layer and removing the rock so as to allow grouting to proceed. A layer of cobbles were encountered during the RI drilling program at a depth of approximately 18 feet bgs, and approximately 10 to 15 feet thick. However, the investigative drilling techniques cannot indicate whether this cobble layer would be of sufficient rock size and density to obstruct the jet grout borings.

A second difficulty of this option is the construction of the angled grout curtain. The grout columns will need to be placed precisely so that there is sufficient overlap between columns and so that there is a competent seal at the interface between the grout curtain and the sidewalls and endwalls of the vertical barrier. The precise layout, within the limits to the bending radius of the drilling rods used to advance the drill, can be accomplished using a transmitter (sonde) at the drill bit head. The containment cell layout would be complex due to the presence of the buildings and the other constraints of the property line and the depth of the impacts to be contained. While this appears feasible, this application of the technology is not routine or conventional, and its success has considerable uncertainty.

Therefore, while this technology option was carried forward into the evaluation of alternatives as the most viable containment option, there remains uncertainty regarding its constructability.

4.2 Assembly of Alternatives

The retained technologies were combined to form assemblies of six remedial alternatives, which are summarized in Table 4-2. The alternatives vary in their approach to meeting the RAOs. A detailed description and analysis of each alternative is presented in Section 5.

There is an interconnection of soil and groundwater at the site, where a large portion of the grossly impacted soil is below the water table and is assumed to be acting as a source of groundwater contamination. Thus, the linkage between soil and groundwater technologies was considered in the assembly of the remedial alternatives.

It is recognized that these assembled alternatives are not an exhaustive list of all possible scenarios. However, they form a representative range of remedial actions for the purposes of this FS. The final sizing, configuration, and designation of the specific processes to be used will occur during the design phase.

5 Detailed Analysis of Remedial Alternatives

This section presents a detailed description and evaluation of the remedial alternatives developed in Section 4. Section 5.1 defines the evaluation criteria against which the remedial actions are analyzed. Section 5.2 presents an analysis of remedial elements common to all of the alternatives. Section 5.3 presents a detailed analysis of each of the alternatives.

5.1 Description of Analysis Criteria

The remedial alternatives developed in this section are evaluated using the following seven criteria defined by the NCP and TAGM 4030:

1. Overall protection of human health and the environment
2. Compliance with SCGs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume
5. Short-term impacts and effectiveness
6. Implementability
7. Cost

5.1.1 Overall Protection of Human Health and the Environment

This criterion is an evaluation of the remedy's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced, or controlled through removal, treatment, engineering controls, or institutional controls. The remedy's ability to achieve each of the RAOs is evaluated.

5.1.2 Compliance with the Standards, Criteria, and Guidance

Compliance with SCGs addresses whether or not a remedy will meet applicable environmental laws, regulations, standards, and guidance. SCGs for the site will be listed along with a discussion of whether or not the remedy will achieve compliance. For those SCGs that will not be met, a discussion and evaluation of the impacts are provided.

5.1.3 Long-term Effectiveness and Permanence

This criterion evaluates the long-term effectiveness of the remedy after implementation. If COC or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated:

- The magnitude of the remaining risks (i.e. will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining residuals?);
- The adequacy of the engineering and institutional controls intended to limit the risk;
- The reliability of these controls; and
- The ability of the remedy to continue to meet RAOs in the future.

5.1.4 Reduction of Toxicity, Mobility or Volume

The remedy's ability to reduce the toxicity, mobility or volume of site contamination is evaluated. Preference will be given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the site.

5.1.5 Short-term Impacts and Effectiveness

The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during the construction and/or implementation are evaluated. A discussion of how the identified adverse impacts and health risks to the community or workers at the site will be controlled, and the effectiveness of the controls, will be presented. A discussion is provided of engineering controls that will be used to mitigate short term impacts (i.e. dust control measures). The length of time needed to achieve the remedial objectives is also estimated.

5.1.6 Implementability

The technical and administrative feasibility of implementing the remedy is evaluated. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.

5.1.7 Cost

Capital, operation, maintenance and monitoring costs are estimated for the remedy. This assessment evaluates the costs of the remedial actions on the basis of present worth. Orange and Rockland has established a discount rate of 3.8 percent for the present worth calculations in this FS. Unless otherwise noted, the estimated costs provided for the remedial actions have an accuracy of –30 to +50 percent, in accordance with FS guidance documents. A cost summary and breakdown for each of the six alternatives is provided in Appendix B.

5.2 Common Elements

Several remedial actions are expected to occur to varying degrees regardless of the alternative selected. These actions are referred to as common elements and are discussed in the following sections. The costs associated with the common elements are included in the estimates for each of the six alternatives.

5.2.1 Removal of MGP Structures and Contents

Removal of MGP structures is common, in varying degrees, to all six remedial alternatives. Removal of former MGP structures is typically required by NYSDEC during site remediation.

The on-site property contains several known or suspected MGP structures, including subsurface foundations for Gas Holders A and B, on-grade foundations for Gas Holders C and D, on-grade Purifier foundations, and subsurface tar structure foundations. Foundations may also be present for several former above ground storage tanks. All known underground storage tanks were previously removed.

This common remedial element involves demolition, excavation, and off-site disposal of Gas Holder A and Tar Separator O, both of which are grossly impacted structures. Both the structure and contents of Gas Holder A will be removed. Holder A is partially located under an open garage bay, the roof of which will require temporary support during the excavation. The southwest block wall of the garage bay will be removed and replaced if necessary. Removal of only the contents of Tar Separator O is anticipated because of its location near or below a loading dock to the main service center building. The cleaned Separator will be power-washed and the floor punctured to prevent pooling of water.

The slab-on-grade foundations for Gas Holders C and D will also be removed, though they are not known to be impacted. Complete removal of the Gas Holder D foundation may not be practicable due to the location of the existing active gas regulator station.

Other non-impacted slab-on-grade structures such as the Purifier foundations will not be removed except as necessary to expedite the selected remedial alternative.

Under Alternative 5, the foundation of Gas Holder B would be removed. Under the other four Alternatives, it is recognized that Gas Holder B does not contain significant impacts, does not appear to be a source of ongoing impacts to groundwater, and is in a location and depth that would render even partial removal nearly impracticable.

Other former MGP structures are also present partially or wholly below existing service center buildings, so removal would not be practicable. Based on the available data, these structures do not appear to contain sources of ongoing groundwater contamination.

All excavated materials will be pre-characterized for disposal in accordance with the requirements of the proposed receiving facilities. For the purpose of this FS, all excavated materials will be disposed of off site, rather than sorted for possible reuse as backfill. Clean backfill will be imported as necessary to establish a finished design grade. Backfill material containing COC in concentrations greater than TAGM 4046 and background values will not be used.

The depth of this work is anticipated to be approximately 3-feet for the slab-on-grade foundations of Holders C and D, 12-feet for Holder A, and 5-feet for the contents of Tar Separator O. This work will result in the removal and off-site disposal of approximately 1,800 cubic yards of impacted soil and debris.

At Holder A, if grossly impacted material is determined to be present at a depth greater than 12 feet, this material will be removed to the depth of the water table.

If encountered, MGP-related piping will be removed up to existing buildings or roads, then filled with grout and capped. Hydrocarbon impacted soil located outside of the former MGP structures will be addressed by the selected remedial alternative, not as a common element.

Removal of MGP structures will utilize standard construction equipment such as excavators, pneumatic hammers, front-end loaders, and dump trucks. Stockpiling of excavation soils will be minimized by pre-characterization of impacted materials (from clean overburden) so that these soils can be accepted by disposal facilities without stockpiling and testing. This will allow direct loading of trucks.

Odor, vapor, and dust control will be required for this action due to the immediate proximity of residential and commercial buildings. Excavation and handling of NAPL impacted soils will therefore be performed under temporary fabric structures (Sprung, or equivalent), to the extent practicable.

The structure will be equipped with an air handling and treatment system. Odor suppressing foam and plastic sheeting will also be required to contain air emissions from excavations located outside of the fabric structure.

Odors and vapors from the excavation of overburden soils and structures without substantial NAPL or sheen will be controlled with foam and will not require a fabric structure.

Work area and perimeter air monitoring will be performed per NYSDEC and NYSDOH guidance.

5.2.2 Removal of Off-site Surface Soil

During the RI, a small area of soil behind the restaurant building at 28 Pike Street at sample location SS1 was found to contain total PAHs in a concentration of 446 mg/Kg. Although the total PAH concentration is less than the TAGM 4046 cleanup objective of 500 mg/Kg for total SVOCs, several individual PAH concentrations were greater than their respective guidance values. Rather than complete additional analyses to determine the source of the PAHs (MGP-related or other sources) the soil will be removed. Note that little other surface soil is present in this area and the remaining areas of the property are covered with concrete pavement or buildings.

The soil at this location will be removed to a depth of 2 feet bgs, stockpiled on the O&R property and disposed of with other impacted soils from the site. The excavated area will be backfilled with clean imported soil and restored to its previous grade. The total volume of the soil is estimated to be approximately 1 cubic yard. This action is common to all 5 remedial alternatives.

Remediation of surface soil is not further discussed in this FS, except that portions of surface soil may be removed, depending on which of the remedial alternatives is ultimately selected. Surface soil in the grassy areas between the operations center and to the west of the O&R apartment building did not contain COCs in concentrations significantly greater than background concentrations, and these area are covered with grass.

5.2.3 Demolitions and Relocations

Demolition of O&R's existing operations and communications buildings is not anticipated or proposed in this FS. Likewise, relocation of the existing gas regulator station, hard pipe gas lines, or the municipal storm sewer, is not anticipated or proposed.

Depending on the alternative selected, demolition of the garage bay roof will likely be required. The extent of demolition (or temporary support) will depend on results of additional borings performed during a pre-design investigation.

On-site plastic gas lines and some other utilities may be temporarily relocated as necessary, depending on the remedial alternative selected.

Demolition of the vacant apartment building owned by O&R, though not necessarily required under all of the remedial alternatives, will be performed. The apartment building area will then be paved. An estimated demolition cost is included in this FS as a component of the site preparation task.

Orange and Rockland's operations center and payment office employees will require temporary relocation to an appropriate nearby facility during the remedial work at the site. An estimated cost for this relocation is included in this FS.

5.2.4 NAPL Recovery

NAPL recovery is common, in varying degrees, to all six remedial alternatives.

Under Alternatives 1 through 5, NAPL recovery wells will be installed at several locations along Pike Street. Alternatives 1, 2, 3, and 4 also call for varying degrees of on-site NAPL recovery.

NAPL recovery will result in the reduction of the potential source of hydrocarbon impacts to groundwater. Regardless of the alternative selected, however, residual non-recoverable hydrocarbon COC will continue to impact groundwater quality for the long-term. The NAPL recovery discussed herein will, therefore, focus on elimination of NAPL mobility, while also reducing the mass of NAPL to the extent practicable.

The most effective type of NAPL recovery for the hydrogeology of this site would require pumps placed in wells that would produce a slight drawdown of the water table to induce the flow of NAPL towards the wells. Recovery wells will be 4-inch diameter, screened at the appropriate depth, and fitted with product recovery pumps.

The initial wells will be installed during a pre-design investigation. At that time, the lateral extent of recoverable NAPL will be delineated and hydraulic conductivities of the surrounding soil will be determined.

The pumps will be operated one at a time, for a period of days to be determined, and at a flow rate assumed for this FS to be 10 to 20 gpm. Both NAPL and a quantity of water would be recovered by the pumps. The actual operating flow rate, and the operational duration, of each well will be adjusted based on field conditions after system startup.

The well pumps will be plumbed in tandem and will discharge to a central treatment system located on O&R property. The treatment system will consist of an oil-water separator, bag filters, Organoclay absorbent, and activated carbon, with a permitted discharge of the treated water to either the river or the sanitary sewer. Recovered NAPL would be containerized on site and periodically trucked to a recycling or disposal facility.

Directional drilling may be performed to place a conduit below Pike Street to incorporate locations south of Pike Street with the central on-site treatment system.

For the purpose of this FS, the NAPL recovery system would be expected to operate for 18 to 36 months, depending on selected alternative. The actual duration of operation would depend on when significant quantities of NAPL are no longer recoverable.

As each recovery well ceases production of significant quantities of NAPL, it could, depending on the selected remedial alternative, be refitted and utilized for in-situ groundwater bioremediation per Section 5.2.5. NAPL recovery could also continue on a more intermittent basis with hand balers or vacuum enhanced recovery. Additions of heat or surfactants are not proposed for this site due to cost and to the difficulty in hydraulically containing the mobilized COC.

5.2.5 In-situ Groundwater Bioremediation

Under all the Alternatives, in-situ groundwater bioremediation will be implemented upgradient of the Delaware River. A series of aeration wells will be installed in a position to intercept the groundwater plume prior to reaching the river. This linear configuration is also referred to as a Microbial Fence.

Under Alternatives 2, 3 and 5, additional aeration wells will be installed on site, as necessary, to intercept dissolved phase contaminants leaving the site from beneath buildings and other locations that were inaccessible to other remedial techniques.

VOCs and PAHs found at MGP sites are amenable to aerobic biodegradation, given appropriate subsurface characteristics. The natural process of biodegradation can be slow and limited by the availability of oxygen or nutrients. Therefore, in-situ biodegradation is enhanced by the addition of oxygen and/or nutrients to the aquifer.

Common methods of aquifer aeration include placement of oxygen releasing compounds (ORC) in the subsurface, injection of hydrogen peroxide or ozone, or air/oxygen aeration. For bioremediation at Port Jervis, air or oxygen aeration would likely be most cost effective due to the anticipated scope and long duration of the work. As discussed in Section 4.1.2, peroxide and ozone are not appropriate for this site.

The site-specific benefits and risks of an oxygen generator versus an air compressor would be evaluated during design of the system. The need for addition of nutrients to support the biodegradation process would also be addressed at that time.

For this FS, it is assumed that groundwater aeration through submerged diffusers in vertical wells will be sufficient to enhance biodegradation of the dissolved hydrocarbons. It is also assumed that, for operation and cost savings, the various alternative-specific systems will be centralized with a single compressed air source located on O&R property. The compressor could also be located off site, if a suitable location was available.

Sufficient air would be diffused into each well to satisfy the biological oxygen demand for biodegradation of the dissolved phase constituents transported into the radii of influence. The delivery of air or oxygen would ensure that the groundwater was saturated with dissolved oxygen as it continued its natural migration downgradient.

No groundwater pumping would be performed as part of this process.

The principal health and safety concerns are related to the construction of the wells and the managing of compressed air. Volatilization of VOCs to soil gas is also of concern, but the aeration rates will be minimized to provide sufficient oxygenation without excess stripping. Under contingency, should volatilization become excessive, soil vapor mitigation systems (radon-type) could be installed in or around affected structures.

In general, permeable soils (hydraulic conductivities greater than 3 feet per day) are necessary to provide pores that are large enough to allow effective biodegradation by aquifer aeration. The Port Jervis soils are highly permeable and should be within this limit. For this FS, it is assumed that the aeration wells would be spaced 7 to 10 feet on center and penetrate an average of 30 feet below the water table. Aeration rates are initially estimated to be 0.5 to 1 scfm per linear foot of the well network.

Operation of the in-situ biodegradation system is estimated for this FS to continue for a period of 30 years. The actual operational period would depend upon the actual rate of in-situ degradation. For long-term operations, aeration can be intermittent, depending on results of the groundwater monitoring program. Groundwater monitoring of the aquifer aeration system could be performed at additional wells located slightly downgradient.

A pre-design investigation, including pump tests and laboratory studies, will be needed to determine the optimal spacing of wells and the anticipated degradation rates prior to designing the system and final specification of equipment.

As each NAPL recovery well (Section 5.2.4) ceases production of significant quantities of NAPL, it also may, depending on the selected alternative, be refitted and utilized for bioremediation.

Construction of aeration trenches, as an alternative to vertical wells, would involve a major excavation project that would create several weeks of disruption to the surrounding neighborhood. Horizontal drilling techniques, however, will be considered during the remedial design.

5.2.6 Groundwater Monitoring

Groundwater monitoring would be a feature of all six alternatives because regardless of the remedial actions ultimately selected, on-site and off-site groundwater will not meet NYSDEC SCGs in the near future. For that reason, it is prudent to assume that a post-remediation 30-year groundwater monitoring program will be implemented.

Groundwater monitoring assures that migration of the plume and/or concentration changes are tracked and reported. A reasonable long-term monitoring program for the site may include approximately four monitoring wells being sampled once per year. Some new wells may be installed. Other existing wells may be decommissioned. The specifics of the program would be negotiated with the NYSDEC based on the selected remedial alternative and data compiled at the time.

5.2.7 Institutional Controls

Institutional controls are non-physical provisions that support the effectiveness of the remedy. Three such provisions, site ownership, current site use, and establishment of a site management plan, are relevant to the Port Jervis site and would be features of all six alternatives.

For the on-site area, the property will remain under the ownership of O&R. Current site use as a commercially zoned property, including the use and maintenance of the existing O&R buildings and pavement is anticipated to continue. Current off-site commercial and residential property use is also anticipated to continue as in its current configuration. Groundwater is not used either on site or at any of the impacted off-site properties.

Under each alternative, a Site Management Plan (SMP) would be established to manage the institutional controls, engineering controls, operations, maintenance, and monitoring required for the site. The SMP would be in effect until the project objectives are met and the site can be closed out. The SMP would provide information regarding the residual soil contaminants and would address any future subsurface work that would place workers in contact with impacted materials or would interfere with the effectiveness of the remedial program. The specific features of the SMP would be tailored to the selected remedy and would be developed in the final phase of the design and implementation of the remedy.

5.3 Detailed Analysis of Remedial Alternatives

The following sections present descriptions of each of the remedial alternatives and the results of the evaluation of the alternatives against the seven criteria defined above. A summary of these alternatives is presented in Table 4-2.

5.3.1 Alternative 1

Description

This remedial alternative includes the following sequential actions:

- O&R apartment building demolition, per Section 5.2.3, and removal of soil at 28 Pike Street, per Section 5.2.2,
- Excavation of MGP structures and contents, per Section 5.2.1,
- NAPL recovery from Pike Street and on-site areas, per Section 5.2.4,
- Downgradient in-situ groundwater bioremediation, per Section 5.2.5,
- Post-remedial groundwater monitoring and site management plan, per Sections 5.2.6 and 5.2.7.

Alternative 1 is presented conceptually in Figure 5-1.

Under this alternative, in addition to the common elements, NAPL will be aggressively recovered both on and off site.

Initially, surface features such as Gas Holder foundations (C and D) and the vacant apartment building will be removed. Excavation of subsurface MGP structures will then be completed per Section 5.2.1. The water table is typically 15 to 18 feet below grade, so significant excavation dewatering is not anticipated. Odor, vapor, and dust control will be performed per Section 5.2.1.

It is estimated that approximately 1,800 cubic yards of impacted soil and debris would be excavated and transported off site under this alternative. An equivalent quantity of clean soil would be imported as backfill.

Following excavation and backfilling, NAPL recovery wells will be installed at several locations on site and along Pike Street as shown on Figure 5-1. The wells and treatment system will be constructed per Section 5.2.4.

Following an assumed NAPL recovery period of 4 years, the wells and treatment system will be decommissioned. The actual duration of operation would depend on when significant quantities of NAPL are no longer recoverable. The duration will be more accurately estimated after the pre-design investigation described in Section 5.2.4 is completed.

Groundwater aeration wells will be installed, conceptually, as shown in Figure 5-1 to intercept dissolved phase contaminants upgradient of the Delaware River. In-situ groundwater bioremediation will be performed per Section 5.2.5 for an assumed period of 30 years.

Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. Based on soil gas and indoor air sampling at on-site and off-site locations, the risk for potential receptors to be exposed to vapors associated with impacted media is low, and the potential risk will be further reduced by the remedial actions. Impacted surface soil at 28 Pike Street would be removed to eliminate the potential for direct contact at this location. The potential for contact with PAH compounds in surface soil at the remaining areas of the site are low due to the low concentrations of PAHs and the maintenance of a pavement or vegetative cover in these areas. Removal of source material and NAPL will reduce the potential for ongoing soil and groundwater impacts. Although there is currently no quantifiable impact to the Delaware River, potential human or ecological receptors in the Delaware River area would be protected since COC in groundwater would be treated in-situ by a microbial fence located immediately upgradient of the Delaware River.

Compliance with SCGs

The removal of surface soil at 28 Pike Street and the maintenance of a pavement cover for surface soil at the site will be in compliance with location-specific SCGs (not significantly elevated above background concentrations). This alternative will not, however, comply with all SCGs because complete removal of SCG exceedances is impracticable. Excavation of MGP structures and recovery of mobile NAPL will be performed to meet the RAOs for the site and the Pike Street area. Since residual materials would remain, the RAOs would be met by the elimination of the potential migration and exposure pathways. The RAOs for the river area would be met with the installation and maintenance of the down gradient in-situ bioremediation system.

Long-term Effectiveness and Permanence

Removal of source material and NAPL would effectively and permanently decrease the potential for continued migration of residuals to subsurface soil and groundwater and to surface water and sediments in the Delaware River area.

Reduction of Mobility, Toxicity, or Volume Through Treatment

This remedial alternative will result in a reduction of mobility, toxicity and volume of COC. Excavation of MGP structures and recovery of mobile NAPL will reduce the volume of COC at the site. In-situ treatment of groundwater will further decrease the concentrations of COC in the off-site areas and prevent migration of COC to the river.

Short-term Impacts and Effectiveness

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. Excavation of MGP structures would be performed inside the fenced O&R property under temporary fabric structures. Noise from the operation of the air handling equipment would present a potential short-term impact to the community. Work zones would be established and monitored in the NAPL recovery areas during implementation.

Protection of Workers. Workers would 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 involved in the remedial and O&M activities, including NAPL recovery, will wear the appropriate PPE as required in a site-specific health and safety plan.

Environmental Impacts. The potential for environmental impacts from this alternative would be low. Impacts during the source removal and NAPL recovery actions will be addressed by use of spill prevention and control measures.

Time Until Response Objectives are Achieved. It is anticipated that the source removal excavation work will take approximately two months to perform. NAPL recovery is anticipated to be complete in a four-year period. The duration, however, will depend on the mobility and volume of NAPL in the subsurface. This alternative will not have a significant impact on the concentrations of COCs in groundwater over the short-term. In-situ groundwater bio-treatment will continue until RAOs are met, likely for a period of up to 30 years.

Implementability

Technical Feasibility. Removal of source materials by excavation and the installation of NAPL recovery and groundwater treatment wells are technically feasible using conventional excavation and drilling equipment. Excavation, transportation, and disposal of impacted soils are conventional remedial techniques. The design and construction of a NAPL recovery system under Pike Street will require a determination of site-specific characteristics to optimize the implementation and effectiveness of the system. The installation of the in-situ treatment wells at the site and in the Pike Street ROW will be performed in areas with extensive subsurface utilities which will need to be located and protected. Drilling in the area upgradient of the Delaware River will be difficult either on the land side of the river (due to the presence of buildings) or in the river shoreline area itself (due to difficult drilling conditions, cobbles, and boulders). Flooding and ice flows will severely damage wells installed along the river shoreline unless they are substantially armored.

Administrative Feasibility. O&R owns the property where the MGP structures would be excavated. The City of Port Jervis DPW would be notified and a plan developed to protect future workers who may perform subsurface work in the impacted roadway areas. Prior to the installation of the NAPL recovery wells in and around Pike Street, coordination with local authorities will be necessary to endure minimal disruption to the public and roadways in this area. An access agreement would need to be obtained for the off-site property to the southwest of the site to install and maintain the in-situ bioremediation wells up gradient of the Delaware River area.

Availability of Services and Materials. The services and materials required for this alternative are readily available. The installation of the NAPL recovery and in-situ groundwater treatment systems can be accomplished using standard drilling techniques.

Cost

The projected cost for this alternative, including the common elements, with NAPL recovery for 4 years, and present worth of groundwater treatment and monitoring for 30 years, is \$3.6 million, with an FS cost range of \$2.5 to \$5.4 million. Details of the cost estimate are provided in Appendix B.

5.3.2 Alternative 2

Description

This remedial alternative includes the following sequential actions:

- Apartment building demolition, per Section 5.2.3, and removal of soil behind 28 Pike Street, per Section 5.2.2;
- Excavation of MGP structures and contents, per Section 5.2.1;
- Focused excavation of deeper on-site NAPL and sheen impacted soils;
- NAPL recovery from Pike Street and from residual on-site soils, if any, per Section 5.2.4;
- Downgradient in-situ groundwater bioremediation, per Section 5.2.5; and
- Post-remedial groundwater monitoring and site management plan, per Sections 5.2.6 and 5.2.7.

Alternative 2 is presented conceptually in Figure 5-2.

Under this alternative, in addition to the common elements, focused excavation of on-site NAPL and sheen impacted soils will be completed in two specific areas that are not adjacent to buildings, and to a depth achievable by pre-engineered shoring (trench box) methods with moderate dewatering (approximately 20 feet below ground surface). These areas, shown in Figure 5-2, lie directly beneath and north and south of Gas Holder A. These areas may contain NAPL impacted soil that is able to be removed by excavating to approximately 20 feet. Other areas, such as the area between the communications building and Pike Street, contain NAPL-impacted soils starting at depths too great for conventional trench-box excavation, as shown in Figure 3-2.

Initially, surface features will be removed, including the Gas Holder foundations (C and D), the vacant apartment building, and on-site pavement within the area to be excavated.

Excavation of the subsurface MGP structures would follow. The excavation would extend beneath the central portion of Gas Holder A, with the lateral extent being limited by the maintenance of a safe distance from the warehouse building. The excavation of Gas Holder A would be extended to include the additional excavation areas. The north area would be excavated toward Brown Street in several progressive moves of the trench-box. The extent of the excavation would be limited by the underground gas pipeline in Brown Street, precluding any excavation in Brown Street. An appropriate safe off-set distance would be maintained between the excavation and the gas pipeline.

The south area would be excavated toward the large storm sewer pipeline. The lateral extent of the excavation would be limited by the warehouse building to the north and the communications building and large storm sewer pipe to the east. An appropriate safe off-set distance would be maintained between the excavation and these site features.

The following considerations would apply to these excavation activities:

- Odor, vapor, and dust control would be performed per Section 5.2.1.
- The structural integrity of the existing buildings, storm sewer pipe and gas pipelines would be protected.
- The water table is typically 15 to 18 feet below grade. Localized excavation pit dewatering would be performed in each of the areas, if necessary. Dewatering is further discussed in Section 4.1.4.
- The excavated areas would be backfilled with clean soil.
- The excavated area would then be paved to reduce infiltration to the groundwater.

It is estimated that approximately 4,600 cubic yards of impacted soil and debris would be excavated and transported off site under this alternative. An equivalent quantity of clean soil would be imported as backfill.

Following excavation and backfilling, a NAPL recovery program will be initiated as discussed in Section 5.2.4. Potential on-site and off-site recovery well locations are shown on Figure 5-2. The on-site location would include an area below the municipal storm sewer that is not accessible to excavation. The final configuration of recovery well locations and their operation will be determined after a pre-design investigation as described in Section 5.2.4.

The NAPL recovery system would be expected to operate for an initial period of 18 months. The actual duration of operation would depend on when significant quantities of NAPL are no longer recoverable. The duration will be more accurately estimated after the pre-design investigation, described in Section 5.2.4 is completed. As each recovery well ceases production of significant quantities of NAPL, it may be refitted and utilized for in-situ bioremediation per Section 5.2.5.

Groundwater aeration wells will be installed, conceptually, as shown in Figure 5-2 to intercept dissolved phase contaminants upgradient of the Delaware River. In-situ groundwater bioremediation will be performed per Section 5.2.5. Because additional NAPL-containing soil would be removed under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 20 years.

Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. The risk for potential receptors to be exposed to vapors associated with impacted media is low, and the potential risk will be further reduced by the remedial actions. The potential for contact with PAH compounds in surface soil is low due to the removal of soil, the low concentrations of PAHs at the site and the maintenance of a pavement or vegetative covers. Under this alternative, the bulk of the grossly impacted subsurface soils that pose a potential threat to future subsurface workers will have been removed from the site. Removal of source material and mobile NAPL will reduce the potential for ongoing soil and groundwater impacts. Although there is currently no quantifiable impact to the Delaware River, potential human or ecological receptors in the Delaware River area would be protected since COC in groundwater would be treated in-situ at the NAPL-recovery well locations and by a microbial fence located immediately upgradient of the Delaware River.

Compliance with Standards, Criteria, and Guidance

The removal of surface soil at 28 Pike Street and the maintenance of a pavement cover for surface soil at the site will be in compliance with location-specific SCGs (not significantly elevated above background concentrations). This alternative will not, however, comply with all SCGs because complete removal of SCG exceedances, such as the TAGM 4046 exceedances below the service center, is impracticable. Excavation of MGP structures, excavation of NAPL-impacted soil, and recovery of mobile NAPL, will be performed to meet the RAOs for the site and the Pike Street area. Since residual materials would remain, the RAOs would be met by the elimination of the potential migration and exposure pathways. The RAOs for the river area would be met with the installation and maintenance of the down gradient in-situ bioremediation system.

Long-term Effectiveness and Permanence

This alternative would be effective because a substantial portion of the impacted soil above the action levels stated in the RAOs would be removed from the site upon completion of the excavation phase of the remedial action. The remaining residual materials would be substantially reduced by mobile NAPL recovery and in-situ bioremediation. These actions would greatly reduce the potential for migration of residuals to surface water and to sediments in the Delaware River area.

Reduction of Mobility, Toxicity, or Volume Through Treatment

This remedial alternative will result in a substantial reduction of mobility, toxicity and volume of COC. Excavation of source material and impacted soil, with recovery of mobile NAPL, will reduce the volume of COC at the site. In-situ treatment of groundwater will further decrease the concentrations of COC in the off-site areas and prevent migration of COC to the river.

Short-term Impacts and Effectiveness

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. Excavation of MGP structures and soil would be performed inside the fenced O&R property under temporary fabric structures. Noise from the operation of the air handling equipment would present a potential short-term impact to the community. Work zones would be established and monitored in the NAPL recovery areas during implementation. All off-site groundwater remediation equipment would be placed subsurface.

Protection of Workers. Workers would 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 involved in the remedial and O&M activities, including NAPL recovery, will wear the appropriate PPE as required in a site-specific health and safety plan.

Environmental Impacts. The potential for environmental impacts for this alternative would be low. Potential releases during the removal of MGP structures, the removal of NAPL-impacted soil and during the residual NAPL recovery, will be addressed by the use of spill prevention and air emission control measures. NAPL recovery and in-situ groundwater treatment would be performed using methods that would not mobilize COC in the subsurface, thereby reducing the potential that previously non-impacted areas would be impacted.

Time Until Response Objectives are Achieved. The source removal construction activities for this alternative would be completed in approximately six months. NAPL recovery is anticipated to be complete over an 18-month period, though the duration will depend on the mobility and volume of NAPL in the subsurface. For in-situ bioremediation, a site assessment, including characterization of the microbial populations and hydraulic modeling, will be needed. A pilot study is typical in the design of an in-situ bioremediation project. Treatment time varies depending on the contaminant type and concentration, oxygen transfer rates, and site homogeneity. Because additional NAPL-containing soil would be removed under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 20 years.

Implementability

Technical Feasibility. Removal of source materials by excavation and the installation of NAPL recovery and groundwater treatment wells are technically feasible using conventional excavation and drilling equipment. Excavation to a depth of 20 feet, transportation, and disposal of impacted soils are conventional remedial techniques.

The design and construction of a NAPL recovery system under Pike Street will require a determination of site-specific characteristics to optimize the implementation and effectiveness of the system.

The installation of the in-situ treatment wells at the site and in the Pike Street ROW will be performed in areas with extensive subsurface utilities which will need to be located and protected.

Drilling in the area upgradient of the Delaware River will be difficult either on the land side of the river (due to the presence of buildings) or in the river shoreline area itself (due to difficult drilling conditions, cobbles, and boulders). Flooding and ice flows will severely damage wells installed along the river shoreline unless they are substantially armored.

Administrative Feasibility. O&R owns the property where the MGP structures and the bulk of the NAPL impacted soil would be excavated. The City of Port Jervis DPW would be notified and a plan developed to protect subsurface workers who may complete work to repair or replace subsurface utilities in the impacted roadway areas. Prior to the installation and operation of the NAPL recovery and in-situ treatment wells in and around the Pike Street ROW, coordination with local authorities will be necessary to endure minimal disruption to the public and roadways in this area. An access agreement would need to be obtained for the off-site property to the southwest of the site to install and maintain the in-situ treatment wells up gradient of the Delaware River area.

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 backfill material due to the significant quantities of material involved. Excavation uses conventional construction equipment that is readily available. The installation of the NAPL recovery and in-situ groundwater treatment systems can be accomplished using standard drilling techniques.

Cost

The projected cost for this alternative, including the common elements, with NAPL recovery for 18 months, and present worth of groundwater treatment for 20 years and monitoring for 30 years, is $5.4 million, with an FS cost range of $3.8 to $8.1 million. Details of the cost estimate are provided in Appendix B.

5.3.3 Alternative 3

Description

This remedial alternative includes the following sequential actions:

- Apartment building demolition, per Section 5.2.3, and removal of soil behind 28 Pike Street, per Section 5.2.2;
- Excavation of MGP structures and contents, per Section 5.2.1;
- Extensive excavation of deeper on-site NAPL and sheen impacted soils;
- NAPL recovery from Pike Street and from residual on-site soils, if any, per Section 5.2.4;
- Downgradient in-situ groundwater bioremediation, per Section 5.2.5; and
- Post-remedial groundwater monitoring and site management plan, per Sections 5.2.6 and 5.2.7.

Alternative 3 is presented conceptually in Figure 5-3.

Under this alternative, in addition to the common elements, excavation of on-site NAPL and sheen impacted soils will be completed to the extent practicable.

Initially, surface features will be removed, including the Gas Holder foundations (C and D), the vacant apartment building, and on-site pavement within the area to be excavated. Excavation of the subsurface MGP structures would follow.

The soil excavation would comprise three areas: north, central, and south. The north area would be excavated to a depth of 30 feet. The lateral extent of the excavation would be limited by the gas pipeline beneath Brown Street and by the warehouse building. The overhang roof on the northwest side of the warehouse would be temporarily dismantled to allow for maximum excavation of impacted soils, including those beneath Gas Holder A.

The central area would be excavated to a depth of 50 feet. The lateral extent of the excavation would be limited by the warehouse building to the north and the communications building and large storm sewer pipe to the east.

The south area would be excavated to a depth of 40 feet. The lateral extent of the excavation would be limited by the office building to the north, the communications building and large storm sewer pipe to the west, and Pike Street to the south.

The following considerations would apply to these excavation activities:

- Odor, vapor, and dust control would be performed per Section 5.2.1.
- The structural integrity of the existing buildings, storm sewer pipe and gas pipelines would be protected. The conceptual design shown includes a 10-foot offset from the buildings to allow for construction. This would be evaluated and modified, if necessary, during the remedial design of the remedy.
- The design and installation of the excavation sidewall support systems will be substantial tasks. A combination of soldier pile and lagging walls, sheet pile walls or reinforced slurry walls would be used, as appropriate to the depths, loads, and actual subsurface conditions encountered. Excavation sidewall support is further discussed in Section 4.1.4.
- The water table is typically 15 to 18 feet below grade. Localized excavation pit dewatering would be performed in each of the deeper areas. Dewatering is further discussed in Section 4.1.4.
- The excavated areas would be backfilled with clean soil.
- The excavated area would then be paved to reduce infiltration to the groundwater.

It is estimated that approximately 29,500 cubic yards of impacted soil and debris would be excavated and transported off site under this alternative. An equivalent quantity of clean soil would be imported as backfill.

Following excavation and backfilling, a NAPL recovery program will be initiated as discussed in Section 5.2.4. Potential on-site and off-site recovery well locations are shown on Figure 5-3. The on-site location would include an area below the municipal storm sewer that is not accessible to excavation. The final configuration of recovery well locations and their operation will be determined after a pre-design investigation as described in Section 5.2.4.

The NAPL recovery system would be expected to operate for an initial period of 18 months. The actual duration of operation would depend on when significant quantities of NAPL are no longer recoverable. The duration will be more accurately estimated after the pre-design investigation, described in Section 5.2.4 is completed. As each recovery well ceases production of significant quantities of NAPL, it may be refitted and utilized for in-situ bioremediation per Section 5.2.5.

Groundwater aeration wells will be installed, conceptually, as shown in Figure 5-3 to intercept dissolved phase contaminants upgradient of the Delaware River. In-situ groundwater bioremediation will be performed per Section 5.2.5. Because additional NAPL-containing soil would be removed under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 10 years.

Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. The risk for potential receptors to be exposed to vapors associated with impacted media is low, and the potential risk will be further reduced by the remedial actions. The potential for contact with PAH compounds in surface soil is low due to the removal of soil, the low concentrations of PAHs at the site and the maintenance of a pavement or vegetative covers. Under this alternative, the bulk of the grossly impacted subsurface soils that pose a potential threat to future subsurface workers will have been removed from the site. Removal of source material and mobile NAPL will reduce the potential for ongoing soil and groundwater impacts. Potential human or ecological receptors in the Delaware River area would be protected since COC in groundwater would be treated in-situ at the NAPL recovery well locations and by a microbial fence located immediately upgradient of the Delaware River.

Compliance with Standards, Criteria, and Guidance

The removal of surface soil at 28 Pike Street and the maintenance of a pavement cover for surface soil at the site will be in compliance with location-specific SCGs (not significantly elevated above background concentrations). This alternative will not, however, comply with all SCGs because complete removal of SCG exceedances, such as the TAGM 4046 exceedances below the service center, is impracticable. Excavation of MGP structures, excavation of NAPL-impacted soil, and recovery of mobile NAPL, will be performed to meet the RAOs for the site and the Pike Street area. Since residual materials would remain, the RAOs would be met by the elimination of the potential migration and exposure pathways. The RAOs for the river area would be met with the installation and maintenance of the down gradient in-situ bioremediation system.

Long-term Effectiveness and Permanence

This alternative would be effective because most of the residual impacted soil above the action levels stated in the RAOs would be removed from the site upon completion of the excavation phase of the remedial action. The remaining residual materials would be substantially reduced by mobile NAPL recovery and in-situ bioremediation. These actions would greatly reduce the potential for migration of residuals to surface water and to sediments in the Delaware River area.

Reduction of Mobility, Toxicity, or Volume Through Treatment

This remedial alternative will result in a substantial reduction of mobility, toxicity and volume of COC. Excavation of source material and impacted soil, with recovery of mobile NAPL, will reduce the volume of COC at the site. In-situ treatment of groundwater will further decrease the concentrations of COC in the off-site areas and prevent migration of COC to the river.

Short-term Impacts and Effectiveness

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. Excavation of MGP structures and soil would be performed inside the fenced O&R property under temporary fabric structures. Work zones would be established and monitored in the NAPL recovery areas during implementation. All off-site groundwater remediation equipment would be placed subsurface. Noise from the operation of the air handling equipment would present a potential short-term impact to the community. Work zones would be established and monitored in the NAPL recovery areas during implementation.

Protection of Workers. Workers would 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 involved in the remedial and O&M activities, including NAPL recovery, will wear the appropriate PPE as required in a site-specific health and safety plan.

Environmental Impacts. The potential for environmental impacts for this alternative would be low. Potential releases during the removal of MGP structures, the removal of NAPL-impacted soil and during the residual NAPL recovery, will be addressed by the use of spill prevention and air emission control measures. NAPL recovery and in-situ groundwater treatment would be performed using methods that would not mobilize COC in the subsurface, thereby reducing the potential that previously non-impacted areas would be impacted.

Time Until Response Objectives are Achieved. The source removal construction activities for this alternative would be completed in approximately 11 months . NAPL recovery is anticipated to be complete over an 18-month period, though the duration will depend on the mobility and volume of NAPL in the subsurface. For in-situ bioremediation, a site assessment, including characterization of the microbial populations and hydraulic modeling, will be required. A pilot study is typical in the design of an in-situ bioremediation project. Treatment time varies depending on the contaminant type and concentration, oxygen transfer rates, and site homogeneity. In-situ groundwater treatment is anticipated to be continued for at least a 10 year period.

Implementability

Technical Feasibility. Removal of source materials by excavation and the installation of NAPL recovery and groundwater treatment wells are technically feasible using conventional excavation and drilling equipment. Excavation, transportation, and disposal of impacted soils are conventional remedial techniques. However, the extensive excavation of soils from the deeper zone would require the installation of a safe shoring system and a reliable dewatering system. This would present significant technical difficulties and risks to the structural integrity of the adjacent buildings. For example, substantial dewatering would be required to accomplish the deep excavations, and it is uncertain whether or not effective dewatering could be accomplished. Substantial dewatering of the sand and gravel formation present at the Port Jervis site could lead to subsidence and possible building foundation failures. Dewatering would produce an extremely large quantity of impacted water. On-site storage and treatment, or off-site transportation and treatment of the large quantity of water may not be technically or practically feasible.

The design and construction of a NAPL recovery system under Pike Street will require a determination of site-specific characteristics to optimize the implementation and effectiveness of the system.

The installation of the in-situ treatment wells at the site and in the Pike Street ROW will be performed in areas with extensive subsurface utilities which will need to be located and protected.

Drilling in the area upgradient of the Delaware River will be difficult either on the land side of the river (due to the presence of buildings) or in the river shoreline area itself (due to difficult drilling conditions, cobbles, and boulders). Flooding and ice flows will severely damage wells installed along the river shoreline unless they are substantially armored.

Administrative Feasibility. O&R owns the property where the MGP structures and the bulk of the NAPL impacted soil would be excavated. The City of Port Jervis DPW would be notified and a plan developed to protect subsurface workers who may complete work to repair or replace subsurface utilities in the impacted roadway areas. Prior to the installation and operation of the NAPL recovery and in-situ treatment wells in and around the Pike Street ROW, coordination with local authorities will be necessary to endure minimal disruption to the public and roadways in this area. An access agreement would need to be obtained for the off-site property to the southwest of the site to install and maintain the in-situ treatment wells up gradient of the Delaware River area.

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 backfill material due to the significant quantities of material involved. Excavation uses conventional construction equipment that is readily available. Installation of adequate shoring and an adequate dewatering system would require specialized contractors. The installation of the NAPL recovery and in-situ groundwater treatment systems can be accomplished using standard drilling techniques.

Cost

The projected cost for this alternative, including the common elements, with NAPL recovery for 18 months, and present worth of groundwater treatment for 10 years and monitoring for 30 years, is $18 million, with an FS cost range of $13 to $27 million. Details of the cost estimate are provided in Appendix B.

5.3.4 Alternative 4

Description

This remedial alternative includes the following sequential actions:

- Apartment building demolition, per Section 5.2.3, and removal of soil behind 28 Pike Street, per Section 5.2.2,
- Excavation of MGP structures and contents, per Section 5.2.1,
- Excavation of other on-site impacted soil to 15-feet bgs,
- In-situ solidification (ISS) of impacted soils below 15-feet bgs,
- NAPL recovery from Pike Street, and from residual on-site soils, if any, per Section 5.2.4,
- Downgradient in-situ groundwater bioremediation, per Section 5.2.5,
- Post-remedial groundwater monitoring and a site management plan, per Sections 5.2.6 and 5.2.7.

Alternative 4 is presented conceptually in Figure 5-4.

Under this alternative, in addition to the common elements, excavation or solidification of on-site NAPL impacted soils will be completed to the extent practicable.

Initially, surface features such as Gas Holder foundations (C and D), the vacant apartment building, and on site pavement will be removed. Excavation to 15-feet deep will then be possible to remove MGP structures and impacted soil above the groundwater level. Excavation will also provide room for the solidified soil to expand. An expansion of up to 30% is anticipated during ISS.

Additional, partial, excavation from 15 feet bgs to 30 feet bgs may also be required prior to ISS to remove large subsurface obstructions within the coarse grained alluvium layer. Based on the boring logs and observations of the alluvium layer at the river edge, large cobbles may be present at these depths throughout the site. Assuming that the cobbles are present, there is a risk that they could be of sufficient size to hinder the ISS process unless they were removed. The remaining deeper soil at the site is sand, which would be very amenable to ISS. Because of the difficulties of dewatering and odor control requirements at this site, the removal of the subsurface obstructions at the depths required may not be technically feasible.

Following excavation, ISS would be performed to the limits shown on Figure 5-4. Impacted soils below 15 feet bgs would be augered and mixed with pozzolanic agents. This process would be designed and controlled to produce overlapping columns of solidified soil, resulting in a monolithic solidified mass.

The permeability of this mass would be such that groundwater would be substantially unable to penetrate it. The migration pathway of MGP constituents to groundwater would be greatly reduced if not eliminated. Similarly, volatilization of COC into soil gas would be effectively eliminated.

The solidification process results in an increase in soil volume, typically thirty percent (30%). The soil expansion will partially fill the excavation. Clean imported fill would be placed to restore previous grade.

The following considerations would apply to these work activities:

- Odor, vapor, and dust control would be performed per Section 5.2.1. Excavation of MGP structures will be performed within temporary fabric structures. Odor controlling foam, rather than a temporary fabric structure, will be used during ISS because of the height of the equipment.

- The structural integrity of the existing buildings, storm sewer pipe and gas pipelines would be protected. The conceptual design shown includes a 10-foot offset from the buildings to allow for construction.

This would be evaluated and modified, if necessary, during the remedial design of the remedy.

- The design and installation of the excavation sidewall support systems will be moderate tasks. Soldier pile and lagging walls, or sheet pile walls, would be used as appropriate to the depths, loads, and actual subsurface conditions encountered. Excavation sidewall support is further discussed in Section 4.1.4.

- The excavated areas would be backfilled with clean soil.

- The excavated area would then be paved to reduce infiltration to the groundwater.

It is estimated that approximately 13,000 cubic yards of moderately impacted soil would be excavated and shipped off site under this alternative. Approximately 12,500 cubic yards of impacted soil and debris would be solidified in-situ and then another 4,000 cubic yards would be planned for excavation associated with obstruction removal.

Following excavation, ISS, and backfilling, a NAPL recovery program will be initiated as discussed in Section 5.2.4. Potential on-site and off-site recovery well locations are shown on Figure 5-4. The on-site location would include an area below the municipal storm sewer that is not accessible to excavation. The final configuration of recovery well locations and their operation will be determined after a pre-design investigation as described in Section 5.2.4.

The NAPL recovery system would be expected to operate for an initial period of 18 months. The actual duration of operation would depend on when significant quantities of NAPL are no longer recoverable. The duration will be more accurately estimated after the pre-design investigation, described in Section 5.2.4 is completed. As each recovery well ceases production of significant quantities of NAPL, it may be refitted and utilized for in-situ bioremediation per Section 5.2.5.

Groundwater aeration wells will be installed, conceptually, as shown in 5-4 to intercept dissolved phase contaminants upgradient of the Delaware River. In-situ groundwater bioremediation will be performed per Section 5.2.5. Because additional NAPL-containing soil would be removed or immobilized under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 20 years.

Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. Currently, the risk for potential receptors to be exposed to vapors associated with impacted media is low, and the potential risk will be further reduced by the remedial actions. The potential for contact with COC in surface soil is also low. Under this alternative, some of the grossly impacted subsurface soils that pose a potential threat to future subsurface workers will have been removed from the site. Deeper soils will have been solidified. Removal of source material, NAPL recovery, and solidification of deep soil impacts, will greatly reduce the potential for ongoing soil and groundwater impacts. Although there is currently no quantifiable impact to the Delaware River, potential human or ecological receptors in the Delaware River area would be protected since COC in groundwater would be treated in-situ at the NAPL recovery well locations and by a microbial fence located immediately upgradient of the Delaware River.

Compliance with Standards, Criteria, and Guidance

The removal of surface soil at 28 Pike Street and the maintenance of a pavement cover for surface soil at the site will be in compliance with location-specific SCGs (not significantly elevated above background concentrations). This alternative will not, however, comply with all SCGs because complete removal of SCG exceedances, such as the TAGM 4046 exceedances below the service center, is impracticable. Excavation of MGP structures, excavation and solidification of NAPL-impacted soil, and recovery of mobile NAPL, will be performed to meet the RAOs for the site and the Pike Street area. Since residual materials would remain, the RAOs would be met by the elimination of the potential migration and exposure pathways. The RAOs for the river area would be met with the installation and maintenance of the down gradient in-situ bioremediation system.

Long-term Effectiveness and Permanence

This alternative would be effective because most of the residual impacted soil above the action levels stated in the RAOs would be permanently immobilized or removed from the site upon completion of the remedial action. The remaining residual materials would be substantially reduced by mobile NAPL recovery and in-situ bioremediation. These actions would greatly reduce the potential for migration of residuals to surface water and to sediments in the Delaware River area.

Reduction of Mobility, Toxicity, or Volume Through Treatment

This remedial alternative will result in a substantial reduction of mobility, toxicity and volume of COC. Excavation or solidification of source material and impacted soil, with recovery of mobile NAPL, will reduce the volume and mobility of COC at the site. In-situ treatment of groundwater will further decrease the concentrations of COC in the off-site areas and prevent migration of COC to the river.

Short-term Impacts and Effectiveness

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. Excavation of MGP structures and soil would be performed inside the fenced O&R property under temporary fabric structures. Noise from the operation of the air handling equipment would present a potential short-term impact to the community. Deeper excavation of obstructions prior to and during ISS, and the ISS work itself, would not be practical to perform within temporary fabric structures. This presents a potential short-term impact to the community.

Work zones would be established and monitored in the NAPL recovery areas during implementation. All off-site groundwater remediation equipment would be placed subsurface.

Protection of Workers. Workers would 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 involved in the remedial and O&M activities, including NAPL recovery, will wear the appropriate PPE as required in a site-specific health and safety plan.

Environmental Impacts. The potential for environmental impacts for this alternative would be low. Potential releases during the removal of MGP structures, the removal of NAPL-impacted soil and during the residual NAPL recovery, will be addressed by the use of spill prevention and air emission control measures. NAPL recovery and in-situ groundwater treatment would be performed using methods that would not mobilize COC in the subsurface, thereby reducing the potential that previously non-impacted areas would be impacted.

Time Until Response Objectives are Achieved. It is anticipated that the excavation and ISS work will take approximately 8 months to perform. NAPL recovery is anticipated to be complete in an 18-month period. The duration, however, will depend on the mobility and volume of NAPL in the subsurface. This alternative will not have a significant impact on the concentrations of COCs in groundwater over the short-term. In-situ groundwater treatment will continue until RAOs are met, likely for a period of at least 10 years.

Implementability

Technical Feasibility. Removal of source materials by excavation and the installation of NAPL recovery and groundwater treatment wells are technically feasible using conventional excavation and drilling equipment. Excavation, transportation, and disposal of impacted soils are conventional remedial techniques. Solidification of soil using ISS will require a specialized contractor and equipment. However, the excavation of obstructions from the deeper zone will require the installation of a safe shoring system and a reliable dewatering system, which may not be technically or practically feasible to implement at this site. Although the pre-excavation will attempt to remove obstructions, the removal will be difficult and may not be effective. In addition, the execution of ISS, which requires large mixing and storage equipment, within the small area available at this site may not be practically feasible. The design and construction of a NAPL recovery system under Pike Street will require a determination of site-specific characteristics to optimize the implementation and effectiveness of the system. The installation of the in-situ treatment wells at the site and in the Pike Street ROW will be performed in areas with extensive subsurface utilities which will need to be located and protected. Drilling in the area upgradient of the Delaware River will be difficult either on the land side of the river (due to the presence of buildings) or in the river shoreline area itself (due to difficult drilling conditions, cobbles, and boulders). Flooding and ice flows will severely damage wells installed along the river shoreline unless they are substantially armored.

Administrative Feasibility. O&R owns the property where the MGP structures and the bulk of the NAPL impacted soil would be excavated and solidified. The City of Port Jervis DPW would be notified and a plan developed to protect subsurface workers who may complete work to repair or replace subsurface utilities in the impacted roadway areas. Prior to the installation and operation of the NAPL recovery and in-situ treatment wells in and around the Pike Street ROW, coordination with local authorities will be necessary to endure minimal disruption to the public and roadways in this area. An access agreement would need to be obtained for the off-site property to the southwest of the site to install and maintain the in-situ treatment wells up gradient of the Delaware River area.

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 backfill material due to the significant quantities of material involved. Excavation uses conventional construction equipment that is readily available. ISS uses modified construction equipment with specialized attachments and features. There are a relatively small number of qualified contractors available to perform ISS. The installation of the NAPL recovery and in-situ groundwater treatment systems can be accomplished using standard drilling techniques.

Cost

The projected cost for this alternative, including the common elements, with NAPL recovery for 18 months, and present worth of groundwater treatment for 10 years and monitoring for 30 years, is $11 million, with an FS cost range of $7.7 to $16 million. Details of the cost estimate are provided in Appendix B.

5.3.5 Alternative 5

Description

This remedial alternative includes the following sequential actions:

- Apartment building demolition, per Section 5.2.3, and removal of soil behind 28 Pike Street, per Section 5.2.2,
- Excavation of MGP structures and contents, per Section 5.2.1,
- Installation of vertical containment barriers, followed by construction of a grout curtain bottom seal barrier, and a pavement cap.
- NAPL recovery from Pike Street, per Section 5.2.4,
- Downgradient in-situ groundwater bioremediation, per Section 5.2.5,
- Post-remedial groundwater monitoring and site management plan, per Sections 5.2.6 and 5.2.7.

Alternative 5 is presented conceptually in Figures 5-5A and 5-5B.

Under this alternative, in addition to the common elements, off-site migration of impacted groundwater and NAPL would be mitigated by containment of on-site sources.

As described in Section 4.1.5, a containment cell featuring vertical barrier walls and a grout curtain bottom seal was selected as the most viable containment technology for this site. The vertical barriers, consisting of a combination of slurry walls and steel sheet piling, would be installed along the site property line parallel to Brown Street, then across the site to the northeast corner of the warehouse building, then parallel to the warehouse and office buildings, and finally along the property line at Pike Street. Figure 5-5A shows the conceptual layout of the containment cell.

The grout curtain bottom seal would be installed from the southwest side of the site, beneath the impacted soils, and then meeting the bottom of the vertical walls at the other side of the site. Figure 5-5B shows a cross section of the conceptual layout of the grout curtain bottom seal.

The location of the containment cell was determined by the following site-specific considerations:

- Containment, to the extent possible, of soils impacted by NAPL, tar-like material, staining, or sheen.

- The location of the containment cell would avoid gas pipelines and other critical buried utility lines along Brown Street, King Street and Pike Street and the gas regulator station and gas line along the southwest side of the site.

- The structural integrity of the existing buildings would be protected. The conceptual design shown includes a 10-foot offset from the buildings to allow for construction. This would be evaluated and modified, if necessary, during the remedial design of the remedy.

- The space between the O&R building and the building at 28 Pike Street is approximately 18 inches wide and is not sufficient to allow any construction between the buildings.

- The overhang roof on the northwest side of the warehouse would be temporarily dismantled to allow for maximum containment of impacted soils.

- The barrier would need to be placed beneath the storm drain pipe in two locations. For the purposes of this FS, it is assumed that this could be accomplished, if necessary, by temporary removal of a section of the pipe, installation of the barrier beneath that section, and replacement of the pipe.

The layout as shown in Figure 5-5A would involve installation of approximately 540 linear feet of vertical wall to an average depth of 50 feet. The grout curtain portion would comprise up to 40,000 square feet. The construction of the slurry wall and grout curtain portions of the containment cell would result in the generation of approximately 3,500 cubic yards of impacted soil. This soil would be transported off site to approved treatment/disposal facilities.

The final step in the construction of the containment cell would be the installation of low-permeability pavement cap over the unpaved areas of the site. The purpose of the cap would be to minimize groundwater infiltration into the cell. A small groundwater pumping system would be operated to maintain a negative groundwater head within the cell. The system would be designed for approximately 5 gallons per minute, minimum and would be operated in perpetuity, but would otherwise be similar to that described in Section 5.2.4.

Following excavation and backfilling, a NAPL recovery program will be initiated as discussed in Section 5.2.4. Potential recovery well locations are shown on Figure 5-5A. The final configuration of recovery well locations and their operation will be determined after a pre-design investigation as described in Section 5.2.4.

The NAPL recovery system would be expected to operate for an initial period of 18 months. The actual duration of operation would depend on when significant quantities of NAPL are no longer recoverable. The duration will be more accurately estimated after the pre-design investigation, described in Section 5.2.4 is completed. As each recovery well ceases production of significant quantities of NAPL, it may be refitted and utilized for in-situ bioremediation per Section 5.2.5.

Groundwater aeration wells will be installed, conceptually, as shown in Figure 5-5 to intercept dissolved phase contaminants upgradient of the Delaware River. In-situ groundwater bioremediation will be performed per Section 5.2.5. Because additional NAPL-containing soil would be contained under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 10 years.

Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. The risk for potential receptors to be exposed to vapors associated with impacted media is low, and the potential risk will be further reduced by the remedial actions. The potential for contact with PAH compounds in surface soil is low due to the removal of soil, the low concentrations of PAHs at the site and the maintenance of a pavement or vegetative covers. Under this alternative, some of the grossly impacted subsurface soils that pose a potential threat to future subsurface workers will have been removed from the site. Containment will immobilize most, but not all, of the deeper impacts. Groundwater hydraulic control will reduce the potential for ongoing soil and groundwater impacts. Potential human or ecological receptors in the Delaware River area would be protected since COC in groundwater would be treated in-situ at the NAPL recovery well locations and by a microbial fence located immediately up gradient of the River.

Compliance with Standards, Criteria, and Guidance

The removal of surface soil at 28 Pike Street and the maintenance of a pavement cover for surface soil at the site will be in compliance with location-specific SCGs (not significantly elevated above background concentrations). This alternative will not, however, comply with all SCGs because complete removal of SCG exceedances, such as the TAGM 4046 exceedances below the service center, is impracticable. The physical containment technology discussed in this alternative would be designed to minimize further migration of residuals from the site. Installation of a hydraulic control system could slowly lower concentrations of COC in groundwater over time, but SCGs within the contained area would not be met in the foreseeable future. Excavation of MGP structures and recovery of mobile NAPL, will be performed to meet the RAOs for the site and the Pike Street area. Since residual materials would remain, the RAOs would be met by the elimination of the potential migration and exposure pathways. The RAOs for the river area would be met with the installation and maintenance of the down gradient in-situ bioremediation system.

Long-term Effectiveness and Permanence

This alternative represents a long-term and permanent remedy that would contain a large volume of impacted materials at the site. This alternative would be effective, as source material would be removed from structures to prevent any ongoing releases, and most of the impacted soil and groundwater in the deeper zones would be contained so that the potential for impacts to off-site groundwater would be reduced. The hydraulic control (pump and treat) system would slowly reduce COC concentrations in the contained area over time. Regular monitoring would be necessary to verify that the concentrations of COC are decreasing in the affected area, as well as ensuring that the impacts are not migrating to previously uncontaminated areas or to the river.

Reduction of Mobility, Toxicity, or Volume Through Treatment

This remedial alternative will result in a large reduction of mobility, toxicity and volume of COC. Excavation of source material and impacted soil will reduce the volume of COC at the site. Containment of the deeper impacts would reduce the mobility of residuals. On-site groundwater treatment will effectively reduce the toxicity and volume of residual COC. In-situ treatment of groundwater will further decrease the concentrations of COC in the off-site areas and prevent migration of COC to the river.

Short-term Impacts and Effectiveness

Protection of Community. This alternative is protective of the community, however, extensive controls would need to be in place during construction to minimize disruption to the neighborhood. During the implementation of this alternative, measures would be taken to monitor and reduce the potential for air emissions during source removal actions. Excavation of MGP structures would be performed inside the fenced O&R property under temporary fabric structures. Noise from the operation of the air handling equipment would present a potential short-term impact to the community. Work zones would be established and monitored in the NAPL recovery areas during implementation. All off-site groundwater remediation equipment would be placed subsurface. The installation of the containment cell would constitute a large-scale construction project involving the use of specialized heavy equipment. The barriers would need to be installed around building structures. Precautions would have to be taken during the design phase to ensure exiting foundations had adequate protection from all construction activities. Construction could entail temporary disruption of traffic, as well as temporary disruptions in utility services. Noise associated with construction activities would interfere with some daily activities in the residential and business community.

Protection of Workers. Workers would 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 involved in the remedial and O&M activities, including NAPL recovery, will wear the appropriate PPE as required in a site-specific health and safety plan. Additional health and safety issues would be associated with the construction of the containment system barriers.

Environmental Impacts. It is unlikely that this alternative would produce any substantial short-term environmental impacts. Environmental impacts during the remedial actions will be addressed by use of spill prevention and control measures, and erosion control measures.

Time Until Response Objectives are Achieved. It is anticipated that the remedy could be implemented in approximately eight months and that on-site remedial objectives would then be met. NAPL recovery is anticipated to be complete in an 18-month period. The duration, however, will depend on the mobility and volume of NAPL in the subsurface. It is anticipated that off site in-situ groundwater treatment would be performed for at least 10 years. Because additional NAPL-containing soil would be contained under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 10 years.

Implementability

Technical Feasibility. This remedy would rely upon grout curtain technology that is still under development for environmental applications. The ability to construct a containment cell of the size, depth, and complexity required at this site would be at the limits of the technical feasibility of this technology. The difficulties involved in construction are further discussed in Section 4.1.5. The other aspects of this remedy, including the common elements, are all technically feasible, as discussed in previous Sections.

Administrative Feasibility. O&R owns the property where the MGP structures would be excavated. Prior to the installation of the barrier containment system, coordination with local authorities will be necessary to endure minimal disruption to the public and roadways in all areas surrounding the O&R property. Special administrative coordination would be required for temporary diversion pumping of the stormwater flow during the (possible) removal and replacement of the effected sections of the stormwater pipe. An access agreement would need to be obtained for the off-site property to the southwest of the site to install and maintain the in-situ treatment wells up gradient of the Delaware River area.

Availability of Services and Materials. The services and materials required for this alternative are available. Installation of the barrier systems would require specialized contractors, some of which have patented processes that may not be readily available. For the removal of MGP structures, multiple facilities may need to be identified for both treatment of excavated soil and provision of backfill material due to the significant quantities of material involved. Excavation uses conventional construction equipment that is readily available. The installation of the NAPL recovery and in-situ groundwater treatment systems can be accomplished using standard drilling techniques.

Cost

The projected cost for this alternative, including the common elements, with NAPL recovery for 18 months, and present worth of groundwater treatment for 10 years and monitoring for 30 years, is $10 million, with an FS cost range of $7 to $15 million. Details of the cost estimate are provided in Appendix B.

5.3.6 Alternative 6

Description

This remedial alternative includes the following sequential actions:

- Apartment building demolition, per Section 5.2.3, and removal of soil behind 28 Pike Street, per Section 5.2.2,
- Excavation of MGP structures and contents, per Section 5.2.1,
- Excavation of all other on- and off-site MGP related soil exceeding TAGM 4046 contaminant levels, to the extent practicable,
- Residual NAPL recovery from on-site soils, if any, per Section 5.2.4.
- Downgradient in-situ groundwater bioremediation, per Section 5.2.5,
- Post-remedial groundwater monitoring and site management plan, per Sections 5.2.6 and 5.2.7.

Alternative 6 is presented conceptually in Figure 5-6. This alternative is included in the FS to hypothetically evaluate a complete (to the extent feasible) removal scenario. While this alternative may be technically feasible, it is not considered technically practicable, nor economically feasible.

NAPL recovery (the common element discussed in Section 5.2.4) may or may not be required under this alternative, as the intent would be to remove all on- and off-site MGP impacts.

Initially, surface features will be removed, including the Gas Holder foundations (C and D), the vacant apartment building, and on-site pavement within the area to be excavated. Excavation of the subsurface MGP structures would follow.

The soil excavation would comprise six on-site areas including those described in Section 5.3.2, plus partial removal of Gas Holder B. Four off-site excavation areas include portions of Pike Street and the residential property to the south.

Excavation depths are up to 50 feet deep. The lateral extents are limited by utilities and existing structures.

The following considerations would apply to these excavation activities:

- Odor, vapor, and dust control would be performed per Section 5.2.1.

- The structural integrity of the existing buildings, storm sewer pipe and gas pipelines would be protected. The conceptual design shown includes a 10-foot offset from the buildings to allow for construction. This would be evaluated and modified, if necessary, during the remedial design of the remedy.

- The design and installation of the excavation sidewall support systems will be substantial tasks. A combination of soldier pile and lagging walls, sheet pile walls or reinforced slurry walls would be used, as appropriate to the depths, loads, and actual subsurface conditions encountered. Excavation sidewall support is further discussed in Section 4.1.4.

- The water table is typically 15 to 18 feet below grade. Localized dewatering would be performed in each of the deeper areas. Dewatering is further discussed in Section 4.1.4.

- The excavated areas would be backfilled with clean soil.

- The on-site excavated area would then be paved to reduce infiltration to the groundwater. Off-site excavated areas would be restored to previous condition.

It is estimated that approximately 69,900 cubic yards of impacted soil and debris would be excavated and transported off site under this alternative. An equivalent quantity of clean soil would be imported as backfill.

Groundwater aeration wells will be installed, conceptually, as shown in Figure 5-6 to intercept dissolved phase contaminants upgradient of the Delaware River. In-situ groundwater bioremediation will be performed per Section 5.2.5. Because additional NAPL-containing soil would be removed under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 10 years.

Overall Protection of Human Health and the Environment

This remedial alternative is protective of human health and the environment. The risk for potential receptors to be exposed to vapors associated with impacted media is, however, higher than the other remedial alternatives due to extensive excavation adjacent to residential structures. Under this alternative, the bulk of the grossly impacted subsurface soils that pose a potential threat to future subsurface workers will have been removed from the site. Removal of source material and less impacted soils will reduce the potential for ongoing groundwater impacts. Although there is currently no quantifiable impact to the Delaware River, potential human or ecological receptors in the Delaware River area would be protected since COC in groundwater would be treated in-situ at the NAPL recovery well locations and by a microbial fence located immediately upgradient of the Delaware River.

Compliance with Standards, Criteria, and Guidance

The removal of surface soil at 28 Pike Street and the maintenance of a pavement cover for surface soil at the site will be in compliance with location-specific SCGs (not significantly elevated above background concentrations). This alternative will not, however, comply with all SCGs because complete removal of SCG exceedances, such as the TAGM 4046 exceedances below the service center, is impracticable. Excavation of MGP structures, excavation of accessible impacted soil, and recovery of mobile NAPL, will be performed to meet the RAOs for the site and the Pike Street area. Since residual materials would remain, the RAOs would be met by the elimination of the potential migration and exposure pathways. The RAOs for the river area would be met with the installation and maintenance of the down gradient in-situ bioremediation system.

Long-term Effectiveness and Permanence

This alternative would be effective and permanent. The majority of the source material and impacted soil above SCGs would be removed from the on- and off-site areas. Residuals would remain below existing structures but ongoing impacts to groundwater would be greatly reduced. The remaining COC in groundwater would be permanently reduced by in-situ bioremediation. These actions would greatly reduce the potential for migration of residuals to surface water and to sediments in the Delaware River area.

Reduction of Mobility, Toxicity, or Volume Through Treatment

This remedial alternative will result in a large reduction of mobility, toxicity and volume of COC. Excavation of source material and impacted soil will reduce the volume of COC at the site. In-situ treatment of groundwater will further decrease the concentrations of COC in the off-site areas and prevent migration of COC to the river.

Short-term Impacts and Effectiveness

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. Excavation of MGP structures and soil would be performed under temporary fabric structures. Noise from the operation of the air handling equipment would present a potential short-term impact to the community. Extensive disruption of traffic and the community would, however, occur during excavation of the Pike Street ROW and off-site residential areas. Alternatively, off-site residential and commercial properties could be purchased, and the buildings demolished prior to soil removal. Overhead and underground utilities along Pike Street may be temporarily disrupted. All off-site groundwater remediation equipment would be placed subsurface.

Protection of Workers. Workers would 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 involved in the remedial and O&M activities, including NAPL recovery, will wear the appropriate PPE as required in a site-specific health and safety plan.

Environmental Impacts. The potential for environmental impacts from this alternative could be high, though impacts during the work will be addressed by use of spill prevention and control measures.

Time Until Response Objectives are Achieved. The construction activities involved with this alternative could be completed in approximately 24 months. In-situ groundwater treatment will continue until RAOs are met, likely for a period of up to 10 years. Because additional NAPL-containing soil would be removed under this alternative, in-situ groundwater treatment is anticipated to be continued for a period of approximately 10 years.

Implementability

Technical Feasibility. Excavation, transportation, and disposal of impacted soils are conventional remedial techniques. However, the excavation of soils from the deep soil zone below the water table will require the installation of a safe shoring system and a large-scale, reliable dewatering system. This would present significant technical difficulties and risks to the structural integrity of the adjacent buildings. For example, while substantial dewatering would be required to accomplish the deep excavations, dewatering of the sand and gravel formation present at the Port Jervis site could lead to subsidence and possible building foundation failures. Dewatering would produce an extremely large quantity of impacted water. On-site storage and treatment, or off-site transportation and treatment of the large quantity of water may not be technically feasible.

In addition the excavation work in the Pike Street ROW would be difficult to implement due to the need protect or reroute extensive overhead and underground utilities, and then reconstruct the roadway. Traffic would be hindered on Pike Street for approximately eight months with periodic closures of the bridge.

Administrative Feasibility. Administratively, this alternative would be difficult to implement. An acceptable transportation plan would need to be developed for the large quantities of soil that would need to be transported to a treatment and disposal facility. Coordination with local authorities would be required to establish a plan to reroute Pike Street while excavation and backfilling is performed. An access agreement would need to be obtained for the off-site property to the southwest of the site to install and maintain the in-situ treatment wells up gradient of the Delaware River area. The off-site property owner to the southwest of the site would need to be relocated while the property is excavated.

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 backfill material due to the significant quantities of material involved. Excavation uses conventional construction equipment that is readily available, though support of the excavation sidewalls may require specialized engineering services. The installation of the in-situ groundwater treatment systems can be accomplished using standard drilling techniques.

Cost

The projected cost for this alternative, including the common elements, with NAPL recovery for 4 years, and present worth of groundwater treatment for 10 years and monitoring for 30 years, is $37 million, with an FS cost range of $26 to $55 million. Details of the cost estimate are provided in Appendix B.

5.4 Comparative Analysis of Alternatives

A comparative analysis of the alternatives was conducted in which the alternatives were compared to one another with regard to each of the seven analysis criteria. A summary of the comparative analysis is presented in Table 5-1.

Overall Protection of Human Health and the Environment

All six of the alternatives include common elements that would result in overall protection of human health and the environment. They would meet the RAOs for surface soil and achieve overall protection of human health and the environment by removal of the soil pile at 28 Pike Street, and the maintenance of a pavement or grass cover in the remaining areas of the site.

All six alternatives would meet the RAOs for groundwater over time. They would achieve overall protection of human health and the environment by the remedial actions and the implementation of groundwater bioremediation.

All six alternatives would be protective of human health and the environment by eliminating potential exposure pathways, either by removal, solidification, or containment of impacted soils and NAPL. In addition, a Site Management Plan would be used to control potential exposures to residual subsurface impacts.

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

1. Alternative 6 would be most protective because it would involve the most complete removal of impacted materials.
2. Alternative 3 would be the second most protective because it would involve the next most complete removal of impacted materials.
3. Alternative 2 would be the next most protective because it would involve the next most complete removal of impacted materials.
4. Alternative 4 would be the next most protective. Uncertainty regarding the implementability and completeness of solidification coverage in obstructed areas would render this alternative slightly less protective than Alternative 3.
5. Alternative 5 would be less protective because of the uncertainty regarding the implementability, completeness and long-term effectiveness of the containment.
6. Alternative 1 would be less protective because it would involve the least removal, immobilization, or containment of impacted materials, leaving more potential for long-term groundwater impacts that would need to be treated by the common element of the in-situ groundwater bioremediation system.

Compliance with SCGs

None of the alternatives, in the short term, meet all of the NYSDEC recommended standards, criteria, and guidance values.

Excavation of contaminated soils would result in reduction of COC mass, but soils in excess of SCGs would remain.

Groundwater will remain unusable (unless it is treated) for the foreseeable future. It is anticipated that NYSDEC SCGs would not be fully met but that following the start of active in-situ biotreatment, concentrations would be reduced and natural attenuation would then continue to improve groundwater quality over time. For all of the alternatives, in-situ bioremediation would remain active for an extended period. While the exact time periods are difficult to predict, the treatment period could be approximately 10 years for Alternatives 3, 4, 5 and 6 because there would be greater source removal. Alternative 2 may require a longer period, perhaps 20 years. Alternative 1 would require longer still, perhaps 30 years.

Long-term Effectiveness and Permanence

All 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 identical to the ranking indicated for Overall Protection of Human Health and Environment, above.

Reduction of Toxicity, Mobility, or Volume

All of the 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 identical to the ranking indicated for Overall Protection of Human Health and Environment, above.

Short-term Impacts and Effectiveness

All of the alternatives would have some degree of short-term impacts. Their short term effectiveness, as indicated by the time until response objectives are achieved, differs from alternative to alternative with respect to the objectives for deep soil and NAPL, but is largely equivalent with respect to surface soil (which all would rapidly achieve) and groundwater (which all would achieve only over a period of many years).

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

1. Alternative 1 would involve primarily in-situ and on-site technologies and therefore would have the least substantial short-term negative impacts.

2. Alternative 2 would involve primarily in-situ and on-site technologies, with more excavation than Alternative 1, and would have low-to-moderate short-term negative impacts.

3. Alternative 5 would be conducted primarily on-site, and construction of the containment cell would involve less excavation than alternatives 3, 4, and 6. It would therefore involve less potential for short-term impacts.

4. Alternatives 3 and 4 would be conducted primarily on-site but would involve heavy construction activities, including shoring and excavation, noise, and potential air quality impacts, and would therefore have more potential for short-term impacts.

5. Alternative 6 would involve extensive and deep excavation and transport of large quantities of soil. Its short-term negative impacts would therefore be substantial. In the short term, Alternative 6 would meet NYSDEC recommended cleanup criteria for surface soil within the work area, but subsurface exceedances of SCGs would remain beneath the existing buildings and underground utilities that cannot be removed.

Implementability

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

1. Alternative 1 could be implemented readily with the most certainty.

2. Alternative 2 could be implemented readily with a high degree of certainty.

3. Alternative 3 could be implemented, but with difficulty and uncertainty inherent in deep excavation work in sandy soils immediately adjacent to existing buildings.

4. Alternative 4 could be implemented, but with substantial difficulty and uncertainty with regard to ISS through the cobble zone to reach the required depths.

5. Alternative 5 could be implemented, but with substantial difficulty and uncertainty with regard to constructing the vertical walls, angled grout curtain bottom seal, and the connections between these elements.

6. Alternative 6 is not considered practicable due to extensive and deep excavation within residential areas and public roadways, including underground gas pipelines and a major communications line that are not feasible to re-route.

Cost

The FS cost estimates for the six alternatives are ranked as follows:

Alternative 1	$3.6 million
Alternative 2	$5.4 million
Alternative 3	$18 million
Alternative 4	$11 million
Alternative 5	$10 million
Alternative 6	$37 million

5.5 Recommended Remedial Alternative

Upon consideration of the six alternatives and their respective attributes and limitations, Alternative 2 emerged as the recommended remedy for the Port Jervis site. While other alternatives (3, 4, 5, and 6) would involve more extensive source removal, immobilization or containment, the added benefit of these is small for the substantial additional cost, adverse impacts, and uncertainty that they would entail. Alternative 2 includes all of the Common Elements described in Alternative 1 and adds focused removal of on-site soil containing source material and could be done with greater certainty and acceptable overall effectiveness and cost.

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Table 4-1
Remedial Technologies Screening
Port Jervis MGP Site

Groundwater/NAPL Technologies

General Response	Technology	Process	Applicability to O&R Property	Applicability to Street Areas	Applicability to Downgradient Off-site Property
No Action					
Limited Action	Institutional Controls	Environmental Easement	**Possibly Applicable**	**Possibly Applicable**	**Possibly Applicable**
		Zoning / Ordinance	**Possibly Applicable**	**Possibly Applicable**	**Possibly Applicable**
		Current Site Use	**Applicable**	**Applicable**	**Applicable**
		Site Management Plan	**Applicable**	**Applicable**	**Applicable**
	Environmental Monitoring	Groundwater Monitoring	**Applicable**	**Applicable**	**Applicable**
		Monitored Natural Attenuation	**Applicable**	**Applicable**	**Applicable**
Containment	Trenched Slurry Wall	Pumped - Portland, Bentonite, or Blend	**Not Applicable due to 140 ft depth**	**Not Applicable due to small area**	**Not Applicable due to 140 ft depth**
		HDPE liner	**Not Applicable due to 140 ft depth**	**Not Applicable due to small area**	**Not Applicable due to 140 ft depth**
	Augered Slurry Wall	In-situ Solidification - Portland, Bentonite or Blend	**Possibly Applicable: depth to bedrock reduces feasibility. Quality control at 140 ft is a problem. Applicable in combination with grout curtain bottom.**	**Not Applicable due to small area and existing utility conduits and pipe, street disturbance.**	**Marginally Applicable: depth to bedrock reduces feasibility. Quality control at 140 ft is a problem.**
	Grout Curtain Wall/Bottom	Pressure Grouting - Portland. Bentonite or Blend	**Applicable in combination with vertical barriers**	**Not Applicable due to small area and street disturbance**	**Applicable as adjunct to augered wall**
	Sheet Pile Wall	Steel - Grouted Joints	**Possibly Applicable: depth to bedrock reduces feasibility. Quality control at 140 ft is a problem. Applicable in combination with grout curtain bottom.**	**Not Applicable due to small area**	**Marginally Applicable: depth to bedrock reduces feasibility. Quality control at 140ft is a problem.**
		Steel - Standard Joints	**Not Applicable due to low tolerance for leakage.**	**Not Applicable due to small area**	**Not Applicable due to low tolerance for leakage**
		HDPE - Grouted	**Not Applicable. HDPE only has advantages over steel in low pH Ground Water where steel will have too short a life. Also due to depth required.**	**Not Applicable due to small area**	**Not Applicable. HDPE only has advantages over steel in low pH Ground Water where steel will have too short a life. Also due to depth required.**
	Hydraulic	Induced Drawdown - Pump and Treat	**Applicable for Ground Water. May not be effective for NAPL migration. Applicable in conjunction with physical containment barrier.**	**Applicable for Ground Water. May not be effective for NAPL migration. Applicable in conjunction with physical containment barrier.**	**Applicable for Ground Water. May not be effective for NAPL migration. Applicable in conjunction with physical containment barrier.**
In-situ treatment	Biological Treatment	Oxygenation - ORC	**Effective for Ground Water only, for low concentrations at sides of property.**	**Effective for Ground Water only, for Brown St. and Water St.**	**Potentially Applicable, but may not provide sufficient radius of influence.**
		Oxygenation - Air Diffusion	**Effective for Ground Water only, for low concentrations at sides of property.**	**Effective for Ground Water only, for Brown St. and Water St.**	**Applicable**
		Oxygenation - H_2O_2 Low Conc., Injection.	**Effective for Ground Water only, for low concentrations at sides of property.**	**Effective for Ground Water only, for Brown St. and Water St.**	**Not Applicable due to concern regarding vapor emissions.**
		Oxygenation - Ozone Sparging	**Effective for Ground Water only, for low concentrations at sides of property.**	**Effective for Ground Water only, for Brown St. and Water St.**	**Not Applicable due to concern regarding vapor emissions.**
		Microbial Fence (treatment only at the property line to prevent further migration, using one or more of the above oxygenation processes.)	**Applicable along the border between O&R property and the private property at Pike & King Streets.**	**Not Applicable since Ground Water impacts are far beyond the O&R property line.**	**Applicable to prevent further migration of Ground Water impacts toward Delaware River.**
		Nitrate Enhancement	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**
		Co-metobolic Treatment	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**
		Dechlorination - HRC (e-)	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**
		Dechlorination - Edible oil (e-)	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**
		Dechlorination - Molasses (e-)	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**	**Not Applicable to MGP Impacts**
		Phytoremediation/ Constructed Wetlands	**Not applicable on the property due to active vehicle use, parking, and buildings.**	**Not Applicable in streets**	**Not Applicable at properties**

Table 4-1 (Cont'd.)
Remedial Technologies Screening
Port Jervis MGP Site

General Response	Technology	Process	Applicability to O&R Property	Applicability to Street Areas	Applicability to Downgradient Off-site Property
In-situ Treatment, cont.	Chemical Treatment	Oxidation - Ozone	May not be effective for higher PAH concentrations	May not be effective for higher PAH concentrations	May not be effective for higher PAH concentrations
		Oxidation - H_2O_2/Fenton's	Applicable	Applicable	Applicable
		Oxidation - KMnO4	Applicable	Applicable	Applicable
		Oxidation - NaMnO4	Applicable	Applicable	Applicable
		Oxidation - Calcium Polysulfide	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts
		Reactive barrier (Similar in purpose to the microbial fence. Treatment at the property line to prevent further migration using one or more of the above oxidation processes).	Applicable along the border between O&R property and the private property at Pike & King Streets.	Not Applicable since Ground Water impacts are far beyond the O&R property line.	Applicable to prevent further migration of Ground Water impacts toward Delaware River.
		Nano Scale Iron	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts
	Physical Treatment	Air Sparging - with Vapor Recovery	Not Applicable to PAHs	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts
		Air Sparging - without Vapor Recovery	Not Applicable to PAHs	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts
		Bioslurping	Not Applicable to PAHs	Not Applicable to MGP Impacts	Not Applicable to MGP Impacts
		Dual Phase Extraction	Not Applicable. Applicable to LNAPL but not DNAPL.	Not Applicable	Not Applicable
		Permeable barrier - GAC (Similar in purpose to the microbial fence. Treatment at the property line to prevent further migration)	Applicable along the border between O&R property and the private property at Pike & King Streets.	Not Applicable since Ground Water impacts are far beyond the O&R property line.	Applicable to prevent further migration of Ground Water impacts toward Delaware River.
		Groundwater Flushing	Not Applicable to MGP Impacts. Only effective for non-adsorbed compounds.	Not Applicable	Not Applicable
		(Funnel and Gate)	Applicable as adjunct to permeable barrier technologies	Applicable as adjunct to permeable barrier technologies	Applicable as adjunct to permeable barrier technologies
		(Hydrofracturing)	Not Applicable at site	Not Applicable at site	Not Applicable at site
Ex-situ Treatment	Biological Treatment	Activated Sludge	Not Applicable at site	Not Applicable at site	Not Applicable at site
		Fluidized Bed Reactor	Not Applicable at site	Not Applicable at site	Not Applicable at site
		Attached Growth Methanogens	Not Applicable at site	Not Applicable at site	Not Applicable at site
		Constructed Wetland	Not Applicable at site	Not Applicable at site	Not Applicable at site
	Physical / Chemical Treatment	Oxidation - KMnO4	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not applicable due to lack of space
		Oxidation - UV	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Gravity Separation	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Sedimentation, with Coagulation	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Dissolved Air Floatation	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Filtration - Granular / Multi-granular	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Filtration - Cartridge / Bag	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Air Stripping - Tower	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Air Stripping - Shallow Tray	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Adsorption - GAC	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Adsorption - Organoclay	Possibly Applicable as part of above-ground treatment train	Not Applicable due to lack of space	Not Applicable due to lack of space
		Adsorption - Ionic Resin	Possibly needed as pre-treatment to POTW	Not Applicable due to lack of space	Not Applicable due to lack of space
		Adsorption - Cationic Resin	Possibly needed as pre-treatment to POTW	Not Applicable due to lack of space	Not Applicable due to lack of space
		Distillation	Not Applicable to MGP impacts	Not Applicable due to lack of space	Not Applicable due to lack of space
		POTW Treatment	Applicable		
	NAPL Recovery	Passive or Low Flow	Applicable	Applicable	Not Applicable due to lack of NAPL present
		High Flow (Pump and Treat)	Applicable for short-term pumping of entrapped NAPL	Applicable for short-term pumping of entrapped NAPL	Not Applicable due to lack of NAPL present
		Heat Enhanced Recovery	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.	Not applicable due to concern regarding control of NAPL migration cause by this mobilization technology.	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.
		Steam (pressure) Enhanced Recovery	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.	Not applicable due to concern regarding control of NAPL migration cause by this mobilization technology.	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.
		Sound/Vibration Enhanced Recovery	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.	Not applicable due to concern regarding control of NAPL migration cause by this mobilization technology.	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.
		Surfactant Enhanced Recovery	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.	Not applicable due to concern regarding control of NAPL migration cause by this mobilization technology.	Not Applicable due to concern regarding control of NAPL migration caused by this mobilization technology.

Table 4-1 (Cont'd.)
Remedial Technologies Screening
Port Jervis MGP Site

Soil Technologies

General Response	Technology	Process	Applicability to O&R Property	Applicability to Street Areas	Applicability to Downgradient Off-site Property
No action	(n/a)	(n/a)			
Limited action	Institutional Controls	Environmental Easement	**Possibly Applicable**	**Possibly Applicable**	**Possibly Applicable**
		Zoning / Ordinance	**Possibly applicable**	**Possibly Applicable**	**Possibly applicable**
		Current Site Use	**Applicable**	**Applicable**	**Applicable**
		Site Management Plan	**Applicable**	**Applicable**	**Applicable**
	Capping	Asphalt cap	**Highly Applicable**	**Highly Applicable**	**Highly Applicable**
		HDPE cap	**Highly Applicable**	**Highly Applicable**	**Highly Applicable**
		Clay cap	**Highly Applicable**	**Highly Applicable**	**Highly Applicable**
		Soil cover	**Highly Applicable**	**Highly Applicable**	**Highly Applicable**
		RCRA Landfill	**Not Applicable**	**Not Applicable**	**Not Applicable**
	In-situ Solidification	Bucket/blender mixed - Portland, bentonite, fly ash, slag, activated carbon, blend	**Possibly Applicable. Practicable only for soils reachable by excavator bucket: 40 ft max with extended arm. Applicable to soils not requiring the more rigorous mixing of an auger rig and where mobilization cost would dominate.**	**Not Applicable due to small area and existing utility conduits and pipe, street disturbance.**	**Possibly Applicable. Practicable only for soils reachable by excavator bucket: 40 ft max with extended arm. Applicable to soils not requiring the more rigorous mixing of an auger rig and where mobilization cost would dominate.**
		Auger Rig Mixed - Portland, bentonite, fly ash, slag, activated carbon, blend	**Applicable**	**Not Applicable due to small area and existing utility conduits and pipe, street disturbance.**	**Applicable**
		Pressure Jet Grout - Portland, bentonite, fly ash, slag activated carbon, blend	**Applicable to areas with obstructions including buried structures and piping. Pressure grouting beneath buildings not advised due to potential structural damage.**	**Applicable to areas with obstructions including buried structures and piping.**	**Applicable to areas with obstructions including buried structures and piping.**
		Chemical Fixation with Polymer	**Not Applicable - Experimental**	**Not Applicable - Experimental**	**Not Applicable - Experimental**
In-situ treatment	Biological treatment	Oxygenation - ORC	**Not Applicable. Unsaturated soils cannot be contacted by ORC.**	**Not Applicable. Unsaturated soils cannot be contacted by ORC.**	**Not Applicable. Unsaturated soils cannot be contacted by ORC.**
		Oxygenation - Ozone	**Potentially Applicable- experimental.**	**Potentially Applicable - experimental.**	**Potentially Applicable - Experimental.**
		Oxygenation - H2O2	**Not Applicable. Unsaturated soils cannot be contacted by H_2O_2.**	**Not Applicable. Unsaturated soils cannot be contacted by H_2O_2.**	**Not Applicable. Unsaturated soils cannot be contacted by H_2O_2.**
		Oxygenation - Air	**Potentially Applicable for enhancement of long-term biological action on light ends, not heavily impacted soil.**	**Potentially Applicable for enhancement of long-term biological action on light ends, not heavily impacted soil.**	**Potentially Applicable for enhancement of long-term biological action on light ends, not heavily impacted soil.**
		Phytoremediation/ Constructed Wetlands	**Not applicable on the property due to active vehicle use, parking, and buildings.**	**Not applicable in streets.**	**Potentially Applicable - experimental.**
	Chemical Treatment: All processes may be potentially applicable. However, Insufficient contact with oxidant to provide effective treatment in vadoze zone. Flooding of vadoze zone may not be practicable.	Oxidation - Ozone	**May not be effective.**	**May not be effective.**	**May not be effective.**
		Oxidation - H2O2/Fenton's	**May not be effective.**	**May not be effective.**	**May not be effective.**
		Oxidation - KMnO4	**May not be effective.**	**May not be effective.**	**May not be effective.**
		Oxidation - NaMnO4	**May not be effective.**	**May not be effective.**	**May not be effective.**
		Oxidation - Calcium Polysulfide	**May not be effective.**	**May not be effective.**	**May not be effective.**
		Lime addition	**May not be effective.**	**May not be effective.**	**May not be effective.**

Table 4-1 (Cont'd.)
Remedial Technologies Screening
Port Jervis MGP Site

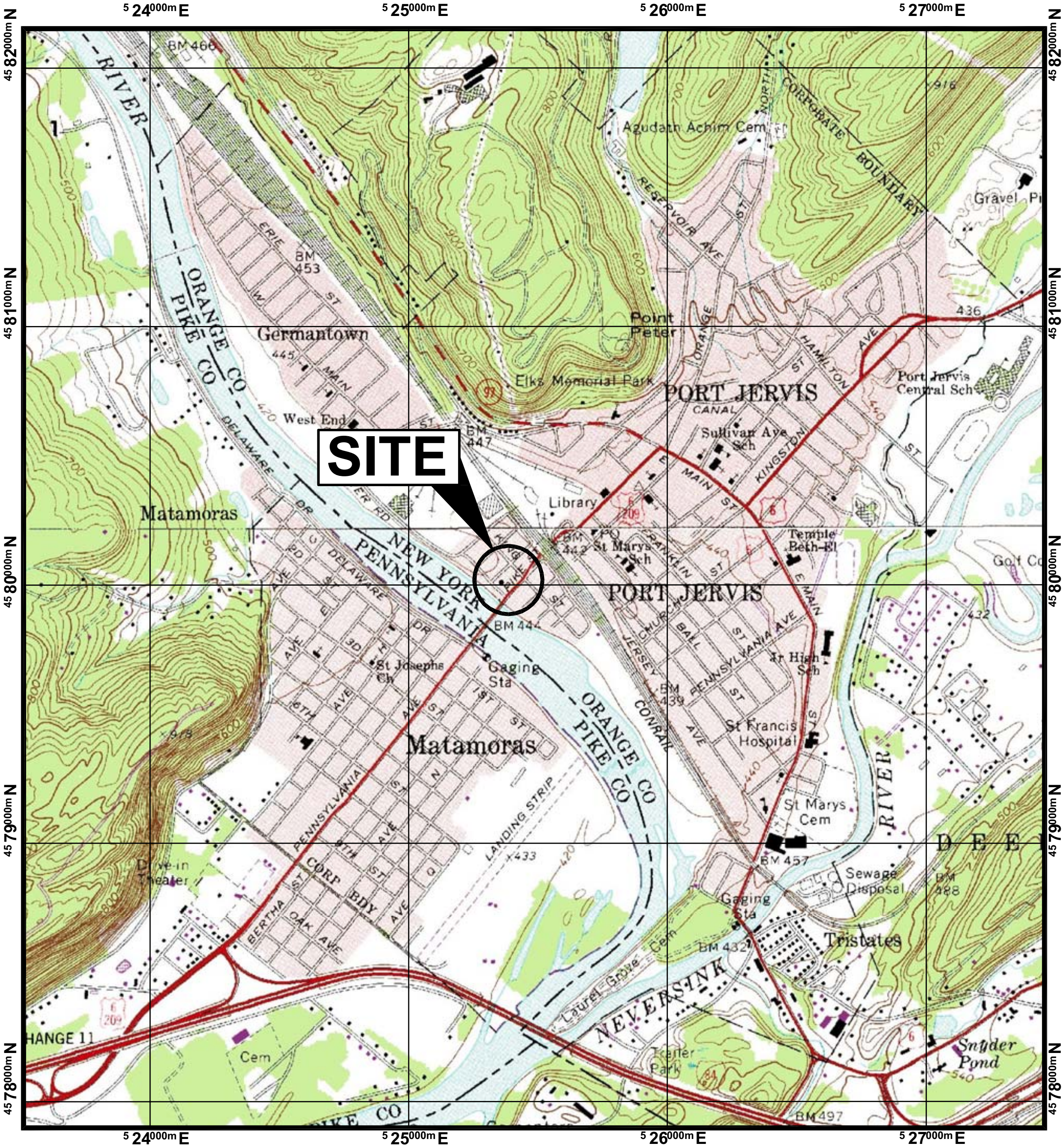
General Response	Technology	Process	Applicability to O&R Property	Applicability to Street Areas	Applicability to Downgradient Off-site Property
In-situ treatment, cont.	Physical treatment	Chemical fixation	**See ISS, above.**	**See ISS, above.**	**See ISS, above.**
		Soil flushing	**Not Applicable. Simple flushing not effective for hydrophobic compounds such as PAHs.**	**Not Applicable. Simple flushing not effective for hydrophobic compounds such as PAHs.**	**Not Applicable. Simple flushing not effective for hydrophobic compounds such as PAHs.**
		Surfactant enhanced recovery	Not Applicable. Experimental. Insufficient hydraulic control.	Not Applicable. Experimental. Insufficient hydraulic control.	Not Applicable. Experimental. Insufficient hydraulic control.
		Electrokinetic separation	**Not Applicable to MGP impacts.**	**Not Applicable to MGP impacts.**	**Not Applicable to MGP impacts.**
		Vitrification	**Potentially applicable- experimental. Extremely high energy cost.**	**Not applicable to street areas. Disruption of streets.**	**Potentially applicable - experimental. Extremely high energy cost.**
		Thermal resistivity	**Potentially Applicable - experimental.**	**Potentially Applicable - experimental.**	**Not applicable due to lack of NAPL.**
		Electromagnetic heating	**Potentially applicable - experimental. Used in conjunction with soil vapor extraction and NAPL recovery.**	**Potentially applicable - experimental. Used in conjunction with soil vapor extraction and NAPL recovery.**	**Not applicable due to lack of NAPL.**
		Heat enhanced recovery	**Potentially applicable - experimental. Used in conjunction with soil vapor extraction and NAPL recovery.**	**Potentially applicable - experimental. Used in conjunction with soil vapor extraction and NAPL recovery.**	**Not applicable due to lack of NAPL.**
		Steam enhanced recovery	**Potentially applicable - experimental. Used in conjunction with soil vapor extraction and NAPL recovery.**	**Potentially applicable - experimental. Used in conjunction with soil vapor extraction and NAPL recovery.**	**Not applicable due to lack of NAPL.**
		Soil vapor extraction	**Potentially applicable for VOCs in soil.**	**Potentially applicable for VOCs in soil.**	**Potentially applicable for VOCs in soil.**
Ex-situ treatment	Excavation	Soil removal - surface	**Applicable to small area of surface soil adjacent to Pike St.**	**Not applicable to street areas.**	**Applicable to non-paved, unbuilt areas.**
		Soil removal - above water table	**Applicable to areas not covered by buildings.**	**Potentially Applicable, but disruptive of streets and critical utilities.**	**Applicable to areas not covered by buildings.**
		Soil removal - below water table	**Possibly Applicable to areas not covered by buildings.**	**Potentially Applicable, but disruptive of streets and critical utilities.**	**Possibly Applicable to areas not covered by buildings.**
		Soil removal - deep excavation	**Possibly Applicable to areas not covered by buildings.**	**Potentially Applicable, but disruptive of streets and critical utilities.**	**Possibly Applicable to areas not covered by buildings.**
		(Sprung Structure)	**Applicable**	**Applicable**	**Applicable**
		(Soldier Beam and Lagging)	**Possibly Applicable**	**Possibly Applicable**	**Possibly Applicable**
		(Sheet piling)	**Applicable**	**Applicable**	**Applicable**
		(Slurry Wall)	**Applicable**	**Applicable**	**Applicable**
		(Trench Box)	**Applicable**	**Applicable**	**Applicable**
		(Slurry Support and Wet Excavation)	**Not Applicable**	**Not Applicable**	**Not Applicable**
	Excavation and On-site Treatment: **Not Applicable at this site due to space limitations.**	Chemical Oxidation	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Lime addition	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Solidification - hot asphalt	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Solidification - cold mix asphalt	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Solidification - cement	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Thermal desorption	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Incineration - fluidized bed	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Incineration - rotary kiln	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Incineration - co-burning	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Incineration - brick manufacture	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Soil washing - acid	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Soil washing - base	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Soil washing - solvent	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Separation - magnetic	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Land farm	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Biopile	**Not Applicable**	**Not Applicable**	**Not Applicable**
		Slurry phase treatment	**Not Applicable**	**Not Applicable**	**Not Applicable**
	Excavation and Off-site Treatment/ Disposal	Lime addition for moisture control	**Applicable**	**Applicable**	**Applicable**
		Solidification - cement	**Applicable**	**Applicable**	**Applicable**
		Thermal desorption	**Applicable**	**Applicable**	**Applicable**
		Landfill (Debris Only)	**Applicable**	**Applicable**	**Applicable**

Table 4-2
Identification of Remedial Alternatives
Port Jervis MGP Site

Alternative	On-site (ORU) Property	Off-site	Comments
Alternative 1	Removal of MGP Structures and Contents Residual NAPL Recovery In-situ Groundwater Bioremediation	NAPL Recovery in Pike Street Downgradient In-situ Groundwater Bioremediation	Source removal alternative
Alternative 2	Removal of MGP Structures and Contents Focused Excavation of NAPL-impacted Soils Residual NAPL Recovery In-situ Groundwater Bioremediation	NAPL Recovery and In-situ Bioremediation in Pike Street Downgradient In-situ Groundwater Bioremediation	Enhanced source removal alternative
Alternative 3	Removal of MGP Structures and Contents Extensive Excavation of NAPL and Sheen-impacted Soils Residual NAPL Recovery In-situ Groundwater Bioremediation	NAPL Recovery and In-situ Bioremediation in Pike Street Downgradient In-situ Groundwater Bioremediation	Extensive source removal alternative
Alternative 4	Removal of MGP Structures and Contents Excavation of Impacted Overburden Soil In-situ Solidification of Impacted Soils Below Water Table In-situ Groundwater Bioremediation	NAPL Recovery and In-situ Bioremediation in Pike Street Downgradient In-situ Groundwater Bioremediation	In-situ Solidification alternative
Alternative 5	Removal of MGP Structures and Contents Containment by Barrier Wall/Grout Curtain Groundwater Pump and Treat for Hydraulic Control	NAPL Recovery and In-Situ Bioremediation in Pike Street Downgradient In-situ Groundwater Bioremediation	Containment alternative
Alternative 6	Removal of MGP Structures and Contents Excavation of Soil in Exceedance of TAGM 4046 Values	Excavation of Soil in Exceedance of TAGM 4046 Values Downgradient In-situ Groundwater Bioremediation	Full removal alternative, to extent practicable, with extensive dewatering

Table 5-1
Comparative Analysis of Alternatives
Port Jervis MGP Site

Detailed Analysis Criteria	On-site: Removal of MGP Structures and Contents; Residual NAPL Recovery Off-site: Recovery of NAPL in Pike Street; Down Gradient In-situ Groundwater Bioremediation	On-site: Removal of MGP Structures and Contents; Focused Excavation of NAPL-impacted Soils; Residual NAPL Recovery; In-situ Bioremediation Off-site: NAPL Recovery and In-situ Bioremediation in Pike Street; Down Gradient In-situ Groundwater Bioremediation	On-site: Removal of MGP Structures and Contents; Extensive Excavation of NAPL and Sheen-impacted Soils; Residual NAPL Recovery; In-situ Bioremediation Off-site: NAPL Recovery and In-situ Bioremediation in Pike Street; Down Gradient In-situ Groundwater Bioremediation	On-site: Removal of MGP Structures and Contents; Excavation of Impacted Overburden Soil; In-situ Solidification of Impacted Soil Below the Water Table; In-situ Groundwater Bioremediation Off-site: NAPL Recovery and In-situ Bioremediation in Pike Street; Down Gradient In-situ Groundwater Bioremediation	On-site: Removal of MGP Structures and Contents; Containment by Barrier Wall and Grout Curtain Bottom; Groundwater Pump and Treat Off-site: NAPL Recovery and In-situ Bioremediation in Pike Street; Down Gradient In-situ Groundwater Bioremediation	On-site: Removal of MGP Structures and Contents; Excavation of Soil in Exceedance of TAGM 4046 Values; In-situ Groundwater Bioremediation Off-site: Excavation of Soil in Exceedance of TAGM 4046 Values; Downgradient In-situ Groundwater Bioremediation
	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**
1. Overall Protection of Human Health and the Environment	Achieved. Protective of the river.	Achieved. Protective of the river.	Achieved. Protective of the river.	Achieved. Protective of the river.	Achieved. Protective of the river.	Achieved. Protective of the river.
2. Compliance with SCGs	Achieved for surface soils. Groundwater use restrictions required.	Achieved for surface soils. Groundwater use restrictions required.	Achieved for surface soils. Groundwater use restrictions required.	Achieved for surface soils. Groundwater use restrictions required.	Achieved for surface soils. Groundwater use restrictions required.	Achieved for surface and subsurface soils. Groundwater use restrictions required.
3. Long-term Effectiveness and Permanence	Effective protection achieved over a long time frame.	Effective over time.	Effective over time.	Effective over time.	Effective over time.	Effective over time.
4. Reduction of Toxicity, Mobility, or Volume	Moderate reduction in mobility and volume, toxicity reduced over time. Groundwater bioremediation for 30 years.	Great volume and mobility reduction. Substantial source removal. Reduction in COI concentrations in groundwater over time.	Great volume and mobility reduction. Extensive source removal. Reduction in COI concentrations in groundwater over time.	Great volume and mobility reduction. Extensive source removal and immobilization. Reduction in COI concentrations in groundwater over time.	Moderate reduction in volume; reduction of mobility by containment. Reduction in COI concentrations in groundwater over time.	Highest reduction of volume.
5. Short-term Impacts and Effectiveness	Lower impacts due to less off-site transport than other alternatives. Moderate short-term effectiveness resulting from MGP structure removal, and NAPL recovery program.	Moderate impacts due to off-site transport. Good short-term effectiveness resulting from augmented source removal.	High impacts due to structure construction, noise, extensive deep excavation, and off-site transport. High short-term effectiveness resulting from extensive source removal.	High impacts due to structure construction, noise, excavation, and off-site transport. High short-term effectiveness resulting from extensive source removal and immobilization.	Moderate due to off-site transport and extensive on-site construction activities. High short term effectiveness resulting from extensive containment.	Highest impacts due to structure construction, noise, off-site transport, and extensive on-site and off-site construction activities. High short-term effectiveness resulting from extensive source removal.
6. Implementability	Good.	Good.	Moderate to Low. Deep excavations require extensive shoring and groundwater pumping and treatment.	Low. ISS may not be implementable below cobble layer, resulting in substantial deep pre-excavation.	Low. Containment cell construction relies on relatively new technology for a very challenging site configuration.	Low. Extensive off-site excavations may not be implementable. Deep excavations require extensive shoring and groundwater pumping and treatment.
7. Cost FS Range of –30% +50%	$3.6 M $2.5 to $5.4 M	$5.4 M $3.8 to $8.1 M	$18 M $13 to $27 M	$11 M $7.7to $16M	$10 M $7 to $15 M	$37 M $26 to $55 M



SCALE 1:24000

1   1/2   0   1 MILE

1000   0   1000   2000   3000   4000   5000   6000   7000 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

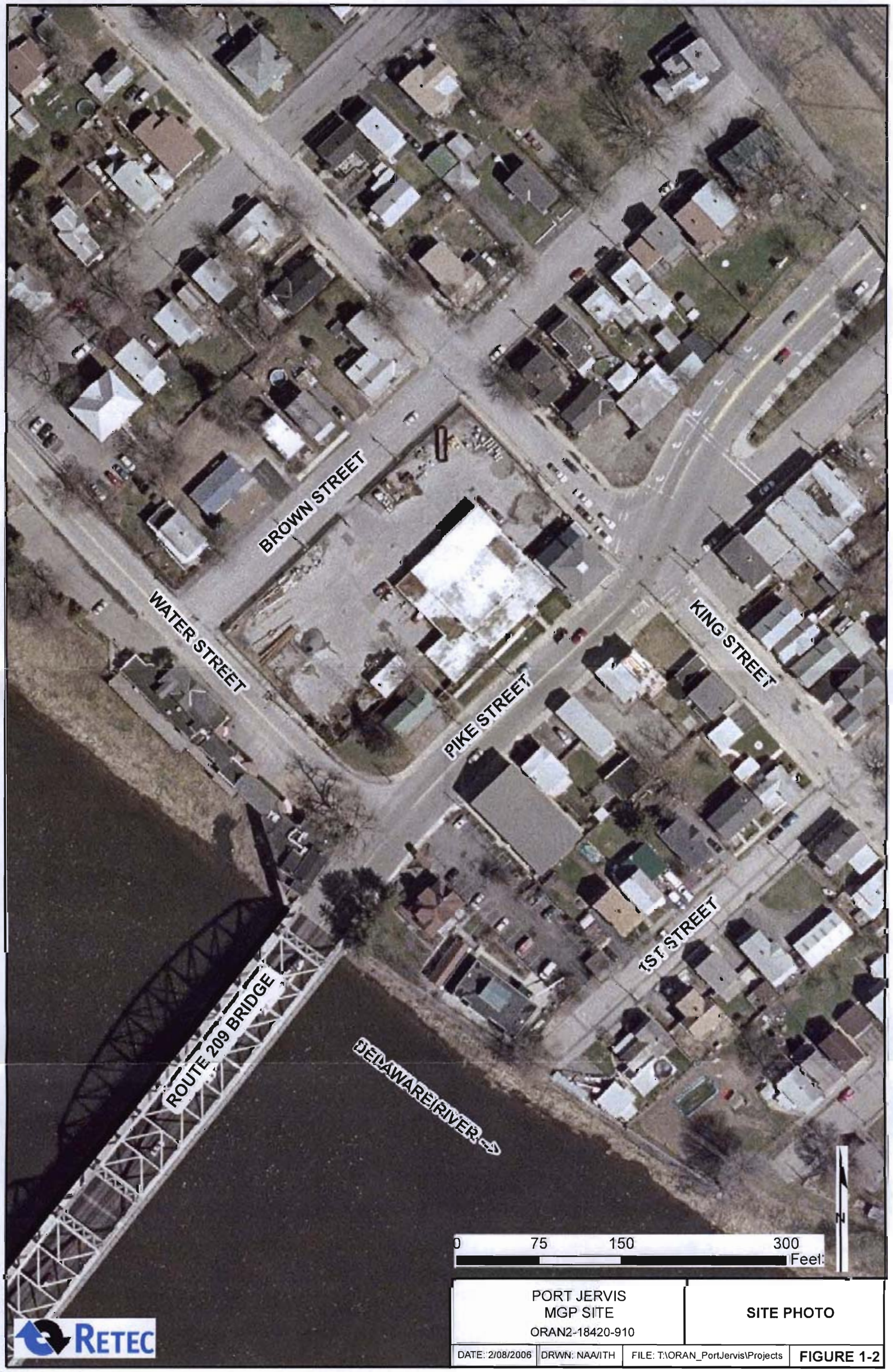
UNITED STATES GEOLOGIC SURVEY
PORT JERVIS NORTH QUADRANGLE
PORT JERVIS SOUTH QUADRANGLE
PORT JERVIS, NEW YORK

7.5 MINUTE SERIES (TOPOGRAPHIC)

RETEC

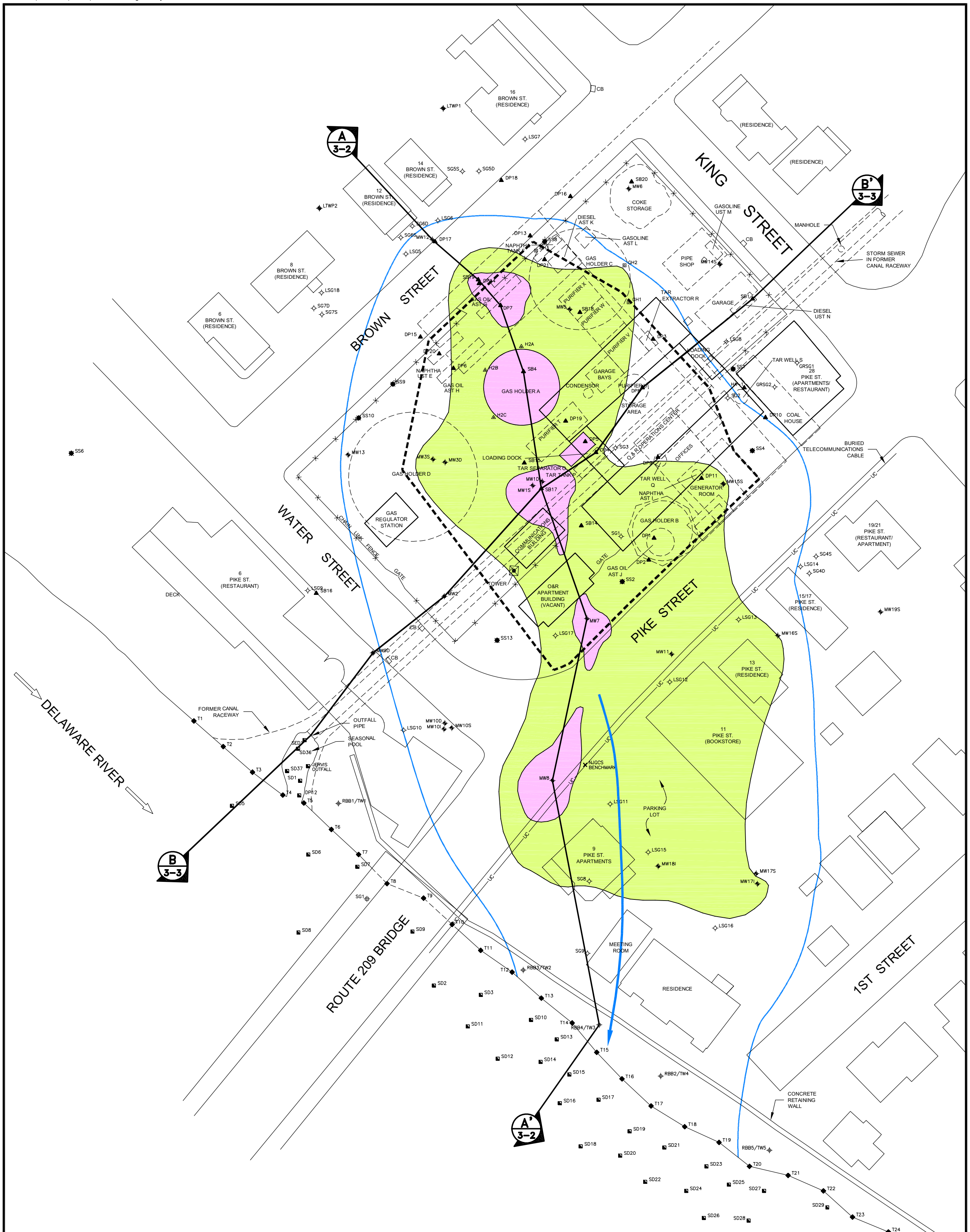
PORT JERVIS MGP SITE ORAN2-18420-910	SITE LOCATION MAP
DATE: 3/30/06 DRWN: MAW/BIL	FIGURE 1-1

File: J:\18420\910\FIG1-1.dwg Layout: Retec-Bill User: mwilliamson Plotted: Mar 30, 2006 - 10:11am Xref's:



BROWN STREET
WATER STREET
KING STREET
PIKE STREET
1ST STREET
ROUTE 209 BRIDGE
DELAWARE RIVER
0 75 150 300
Feet
N
RETEC
PORT JERVIS
MGP SITE
ORAN2-18420-910
SITE PHOTO
DATE: 2/08/2006
DRWN: NAA/ITH
FILE: T:\ORAN_PortJervis\Projects
FIGURE 1-2

File: J:\18420\910\FIG3-1.dwg Layout: Retec-BI User: mwilliamson Plotted: Mar 30, 2006 - 10:11am Xref's:



LEGEND

- SUBSURFACE SOILS >500 mg/kg TOTAL PAHs AND/OR >10 mg/kg TOTAL BTEX
- LIMIT OF GROUNDWATER IMPACTS
- GROUNDWATER FLOW
- STAINING OR SHEEN
- NAPL OR TAR-LIKE MATERIAL

30 0 60

1"=60'

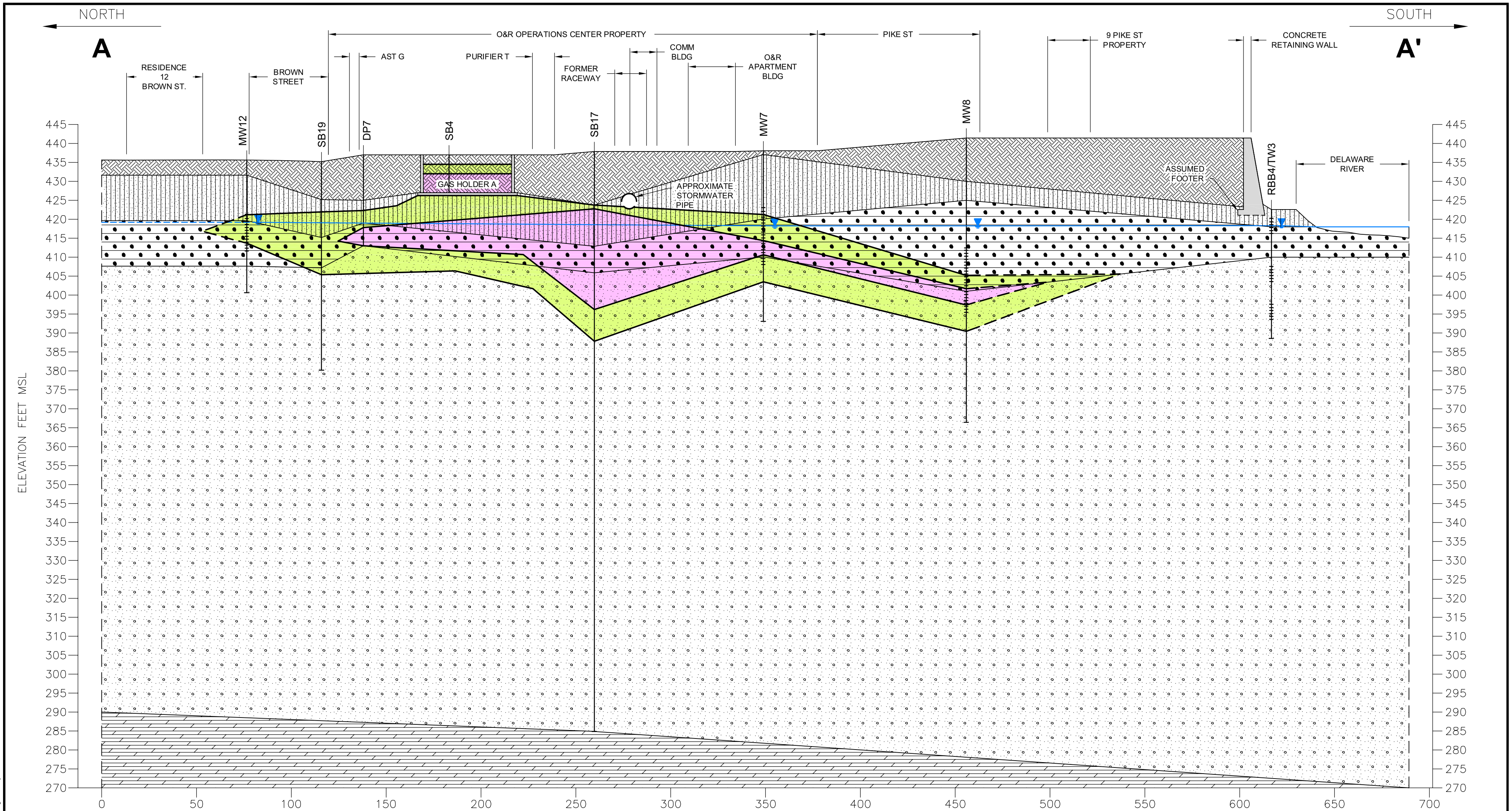
RETEC

PORT JERVIS
MGP SITE
ORAN2-18420-910

SITE PLAN AND EXTENT OF IMPACTS

DATE: 3/30/06 DRWN: MAW/BIL

FIGURE 3-1



LEGEND

- FILL
- SHALE BEDROCK
- GM–COARSE GRAINED ALUVIUM
- SW–GLACIAL OUTWASH
- SM–FINE GRAINED ALLUVIUM
- SOIL WITH HYDROCARBON–LIKE STAINING, SHEEN OR NAPL BLEBS
- SOIL SATURATED WITH TAR–LIKE MATERIAL OR NAPL
- PIEZOMETRIC SURFACE (NOVEMBER 5, 2004)
- WELL SCREENED SECTION
- SOIL BORING

HORIZONTAL SCALE
1" = 50'

NOTES:

1. THE DESCRIPTIONS AND COLORED PORTIONS OF THE FIGURE ARE GENERAL IN NATURE AND ARE BASED ON A LIMITED NUMBER OF SAMPLES. REFER TO THE BORELOGS AND THE RESULTS OF THE CHEMICAL ANALYSES FOR SPECIFIC INFORMATION REGARDING THE SUBSURFACE GEOLOGIC UNITS AND THE DISTRIBUTION OF HYDROCARBONS.

2. THE CROSS SECTION IS SHOWN AS DIRECT DISTANCE THROUGH THE WELLS (MW) AND BORINGS (SB).

RETEC

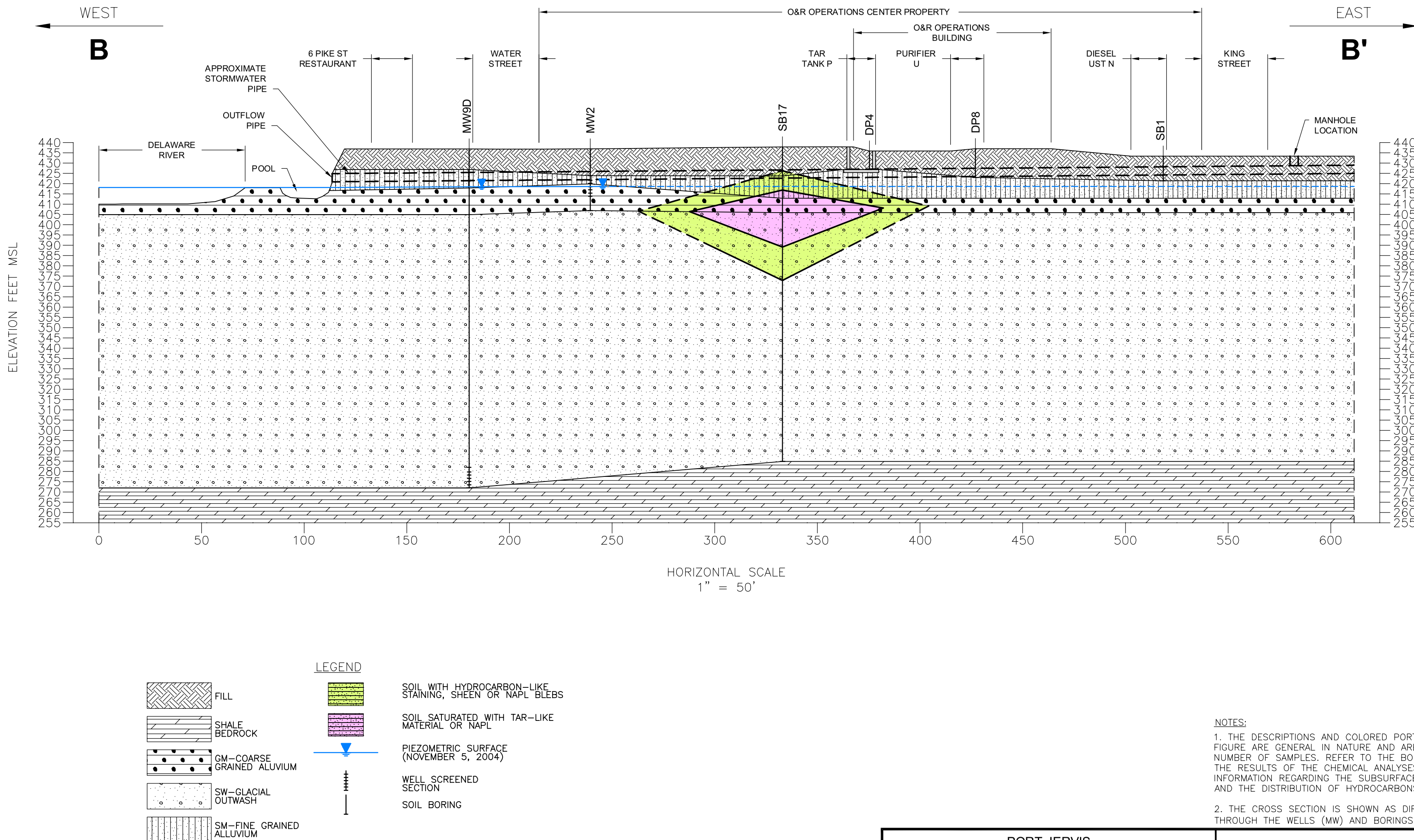
PORT JERVIS
MGP SITE
ORAN2-18420-910

DATE: 3/30/06 DRWN: MAW/BIL

CROSS SECTION A-A'
EXTENT OF IMPACTS

FIGURE 3-2

File: J:\18420\910\XSECT A-A FINAL.dwg Layout: ANSI_BI-LJ User: mwilliamson Plotted: Mar 30, 2006 – 10:11am Xref's:



NOTES:

1. THE DESCRIPTIONS AND COLORED PORTIONS OF THE FIGURE ARE GENERAL IN NATURE AND ARE BASED ON A LIMITED NUMBER OF SAMPLES. REFER TO THE BORELOGS AND THE RESULTS OF THE CHEMICAL ANALYSES FOR SPECIFIC INFORMATION REGARDING THE SUBSURFACE GEOLOGIC UNITS AND THE DISTRIBUTION OF HYDROCARBONS.

2. THE CROSS SECTION IS SHOWN AS DIRECT DISTANCE THROUGH THE WELLS (MW) AND BORINGS (SB).

RETEC

PORT JERVIS
MGP SITE
ORAN2-18420-910

DATE: 3/30/06 DRWN: MAW/BIL

CROSS SECTION B-B'
EXTENT OF IMPACTS

FIGURE 3-3

File: J:\18420\910\XSECT B-B FINAL.dwg Layout: ANSI_BI-LJ User: mwilliamson Plotted: Mar 30, 2006 - 10:12am Xref's:

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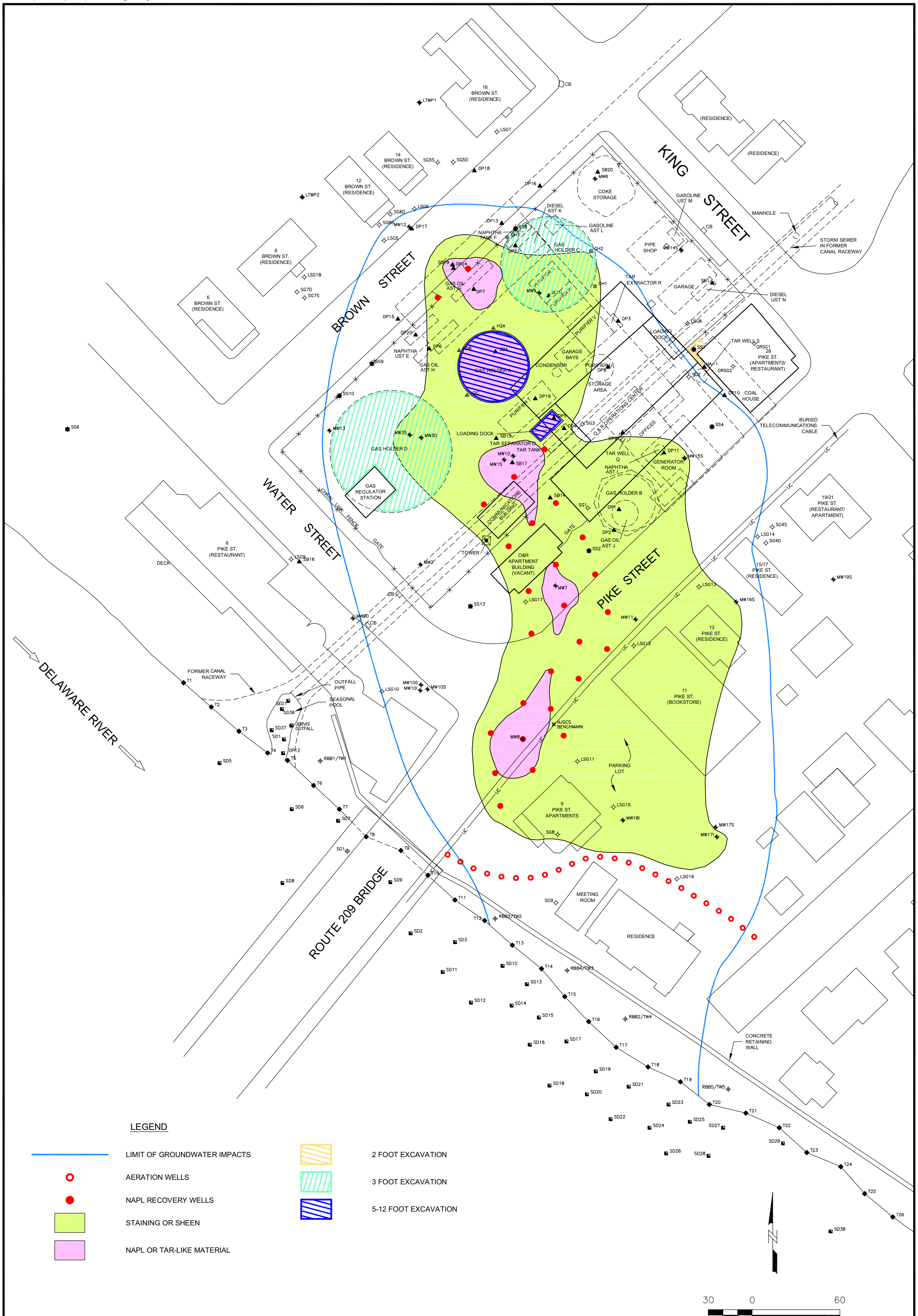


LEGEND

(blue line)	LIMIT OF GROUNDWATER IMPACTS	(yellow hatch)	2 FOOT EXCAVATION
(open red circle)	AERATION WELLS	(green hatch)	3 FOOT EXCAVATION
(red dot)	NAPL RECOVERY WELLS	(blue hatch)	5-12 FOOT EXCAVATION
(green fill)	STAINING OR SHEEN		
(pink fill)	NAPL OR TAR-LIKE MATERIAL		

30 0 60

1"=60'

RETEC

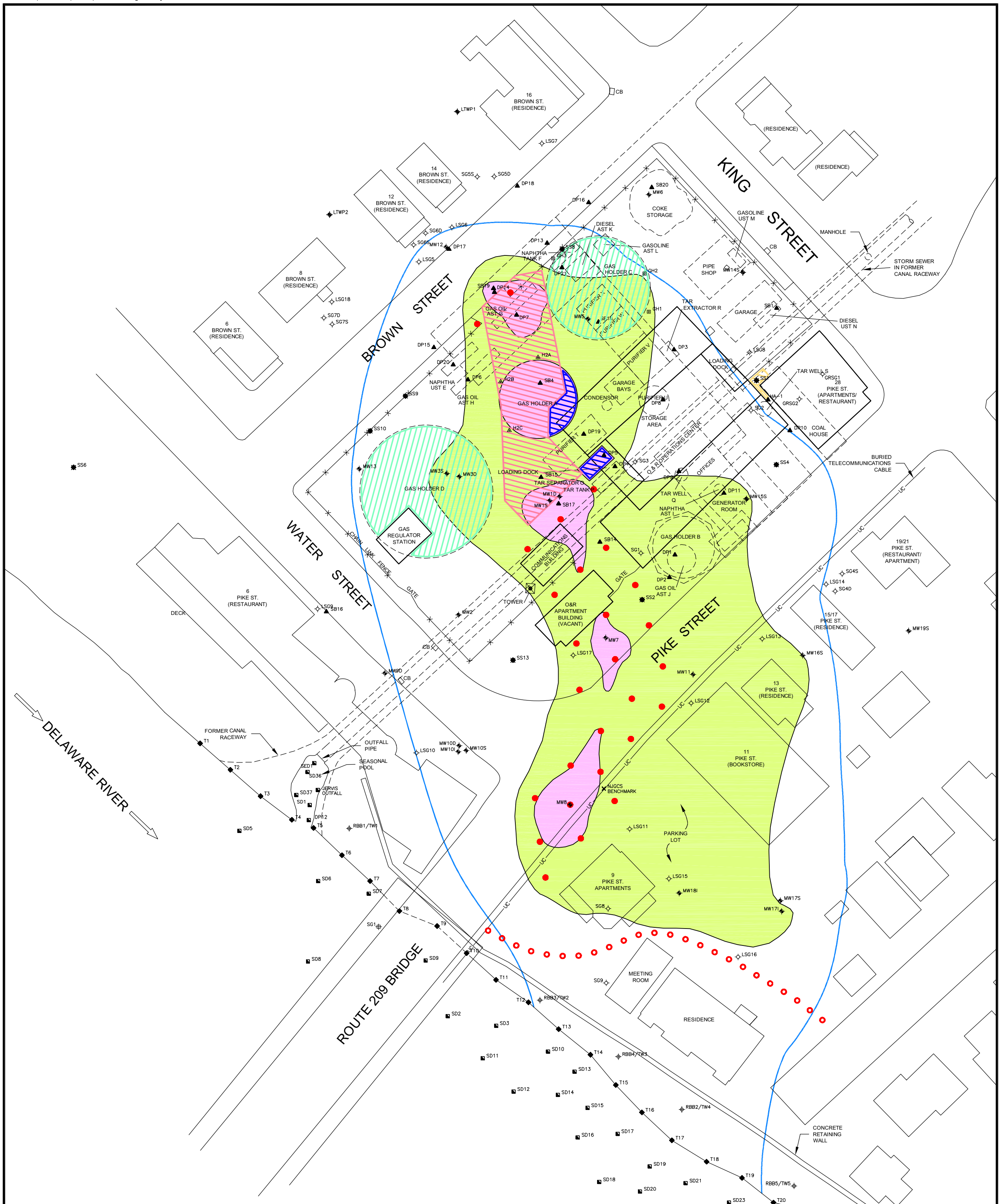
PORT JERVIS
MGP SITE
ORAN2-18420-910

FEASIBILITY STUDY ALTERNATIVE 1

DATE: 3/30/06 DRWN: MAW/BIL

FIGURE 5-1

File: J:\18420\910\ALT_2.dwg Layout: Retec-BI User: mwilliamson Plotted: Mar 30, 2006 - 10:10am Xref's:



LEGEND

- LIMIT OF GROUNDWATER IMPACTS
- AERATION WELLS
- NAPL RECOVERY WELLS
- STAINING OR SHEEN
- NAPL OR TAR-LIKE MATERIAL
- 2 FOOT EXCAVATION
- 3 FOOT EXCAVATION
- 5-12 FOOT EXCAVATION
- 20 FOOT EXCAVATION

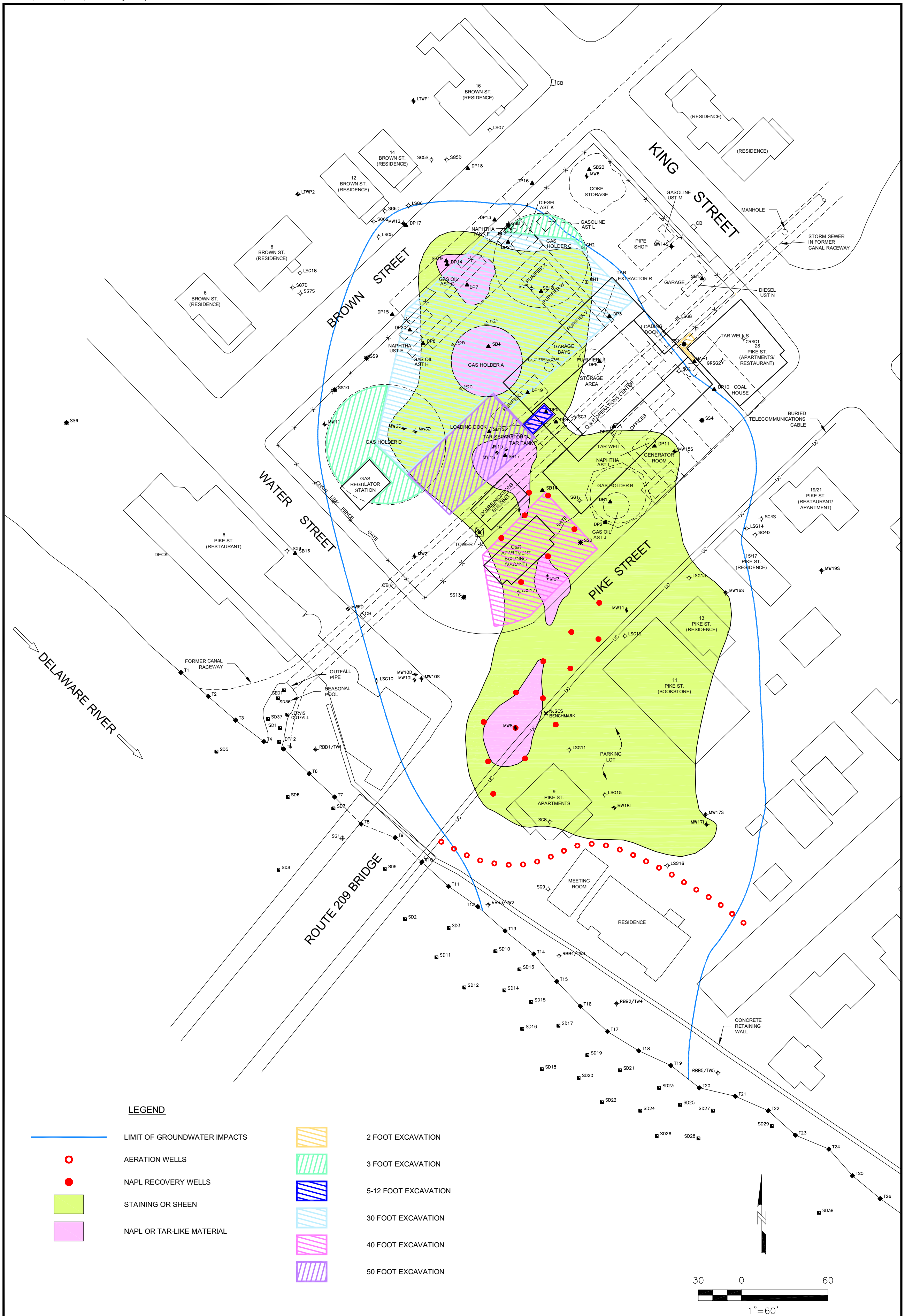
NOTE:
LIMITS OF EXCAVATION ARE CONCEPTUAL ONLY. ACTUAL EXCAVATION LIMITS WILL BE DETERMINED BASED ON FIELD OBSERVATIONS AND CONFIRMATORY SAMPLING.

30 0 60
1"=60'

RETEC

PORT JERVIS MGP SITE ORAN2-18420-910	FEASIBILITY STUDY ALTERNATIVE 2
DATE: 3/30/06 DRWN: MAW/BIL	FIGURE 5-2

File: J:\18420\910\ALT_3.dwg Layout: Retec-BI User: mwilliamson Plotted: Mar 30, 2006 - 10:10am Xref's:



RETEC

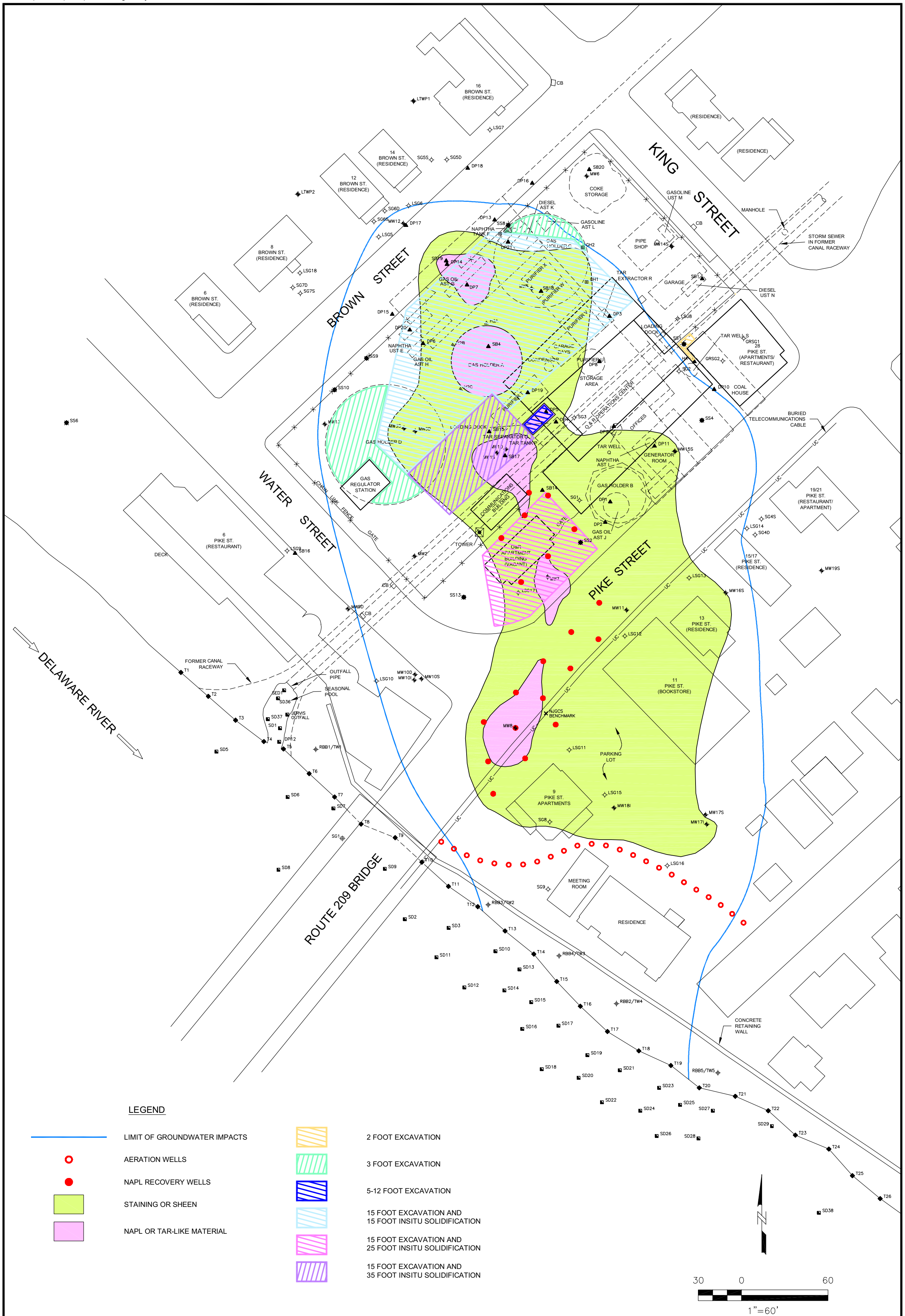
PORT JERVIS MGP SITE

ORAN2-18420-910

DATE: 3/30/06 | DRWN: MAW/BIL

FEASIBILITY STUDY ALTERNATIVE 3

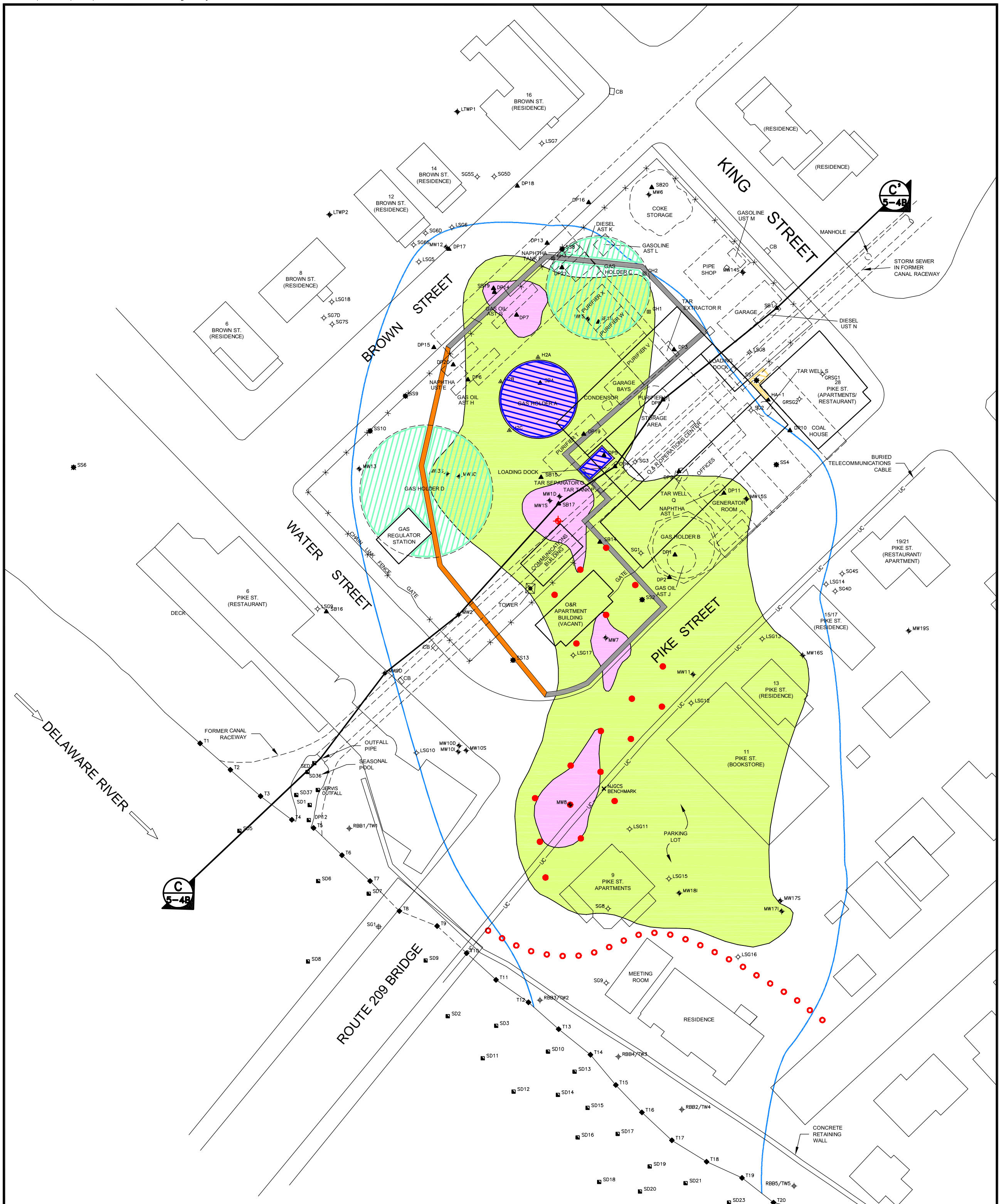
FIGURE 5-3



RETEC

PORT JERVIS MGP SITE ORAN2-18420-910	**FEASIBILITY STUDY ALTERNATIVE 4**
DATE: 3/30/06 DRWN: MAW/BIL	**FIGURE 5-4**

File: J:\18420\910\ALT_5-SITEPLAN.dwg Layout: Retec-BI User: mwilliamson Plotted: Mar 30, 2006 - 10:10am Xref's:



LEGEND

- LIMIT OF GROUNDWATER IMPACTS
- BARRIER WALL
- GROUT CURTAIN
- AERATION WELLS
- NAPL RECOVERY WELLS
- STAINING OR SHEEN
- NAPL OR TAR-LIKE MATERIAL
- PROPOSED GROUNDWATER RECOVERY WELL
- 2 FOOT EXCAVATION
- 3 FOOT EXCAVATION
- 5-12 FOOT EXCAVATION

30 0 60

1"=60'

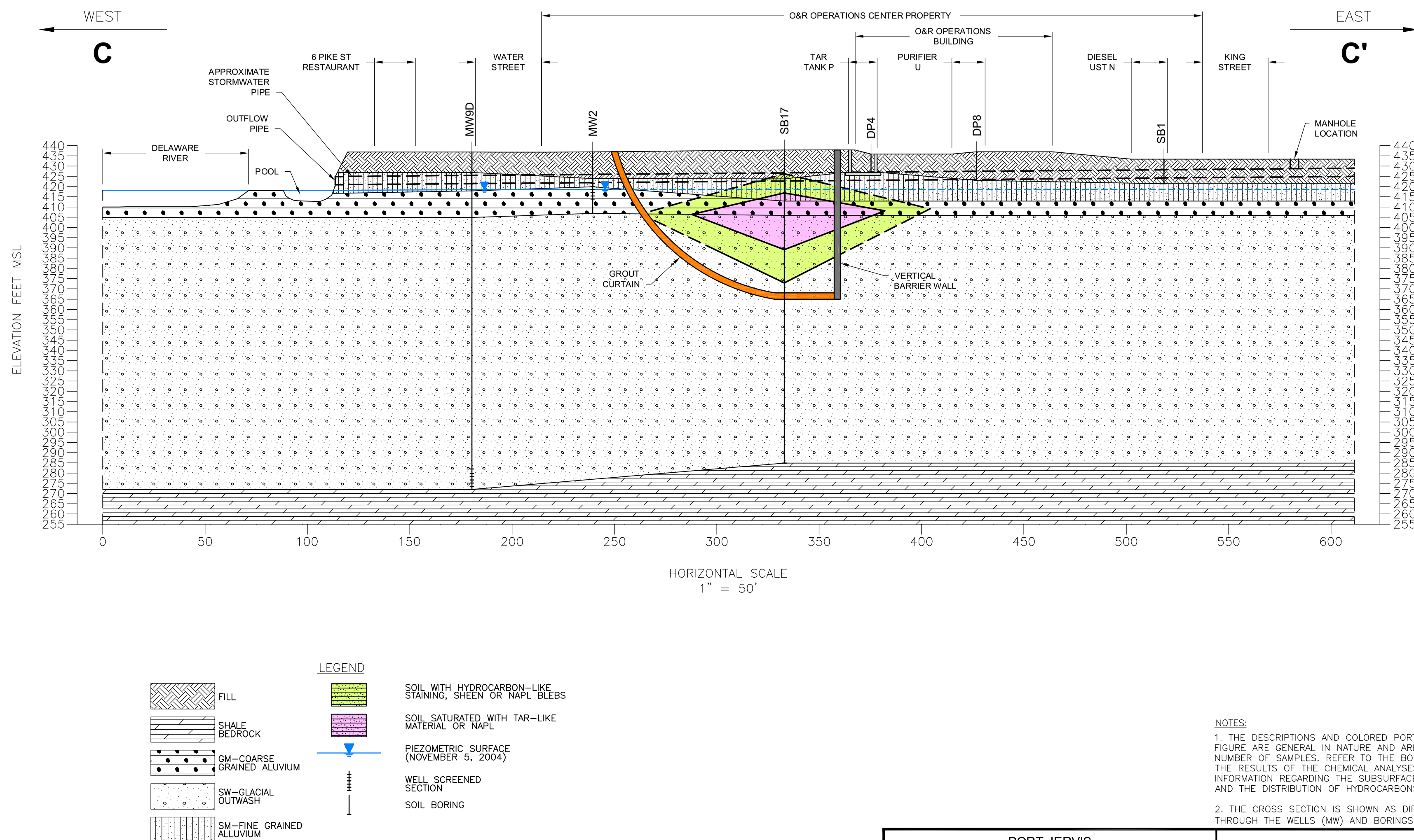
RETEC

PORT JERVIS
MGP SITE
ORAN2-18420-910

DATE: 3/30/06 DRWN: MAW/BIL

FEASIBILITY STUDY
ALTERNATIVE 5 SITE PLAN

FIGURE 5-5A



NOTES:

1. THE DESCRIPTIONS AND COLORED PORTIONS OF THE FIGURE ARE GENERAL IN NATURE AND ARE BASED ON A LIMITED NUMBER OF SAMPLES. REFER TO THE BORELOGS AND THE RESULTS OF THE CHEMICAL ANALYSES FOR SPECIFIC INFORMATION REGARDING THE SUBSURFACE GEOLOGIC UNITS AND THE DISTRIBUTION OF HYDROCARBONS.

2. THE CROSS SECTION IS SHOWN AS DIRECT DISTANCE THROUGH THE WELLS (MW) AND BORINGS (SB).

RETEC

PORT JERVIS MGP SITE ORAN2-18420-910	FEASIBILITY STUDY ALTERNATIVE 5 CROSS SECTION
DATE: 3/30/06 DRWN: MAW/BIL	FIGURE 5-5B

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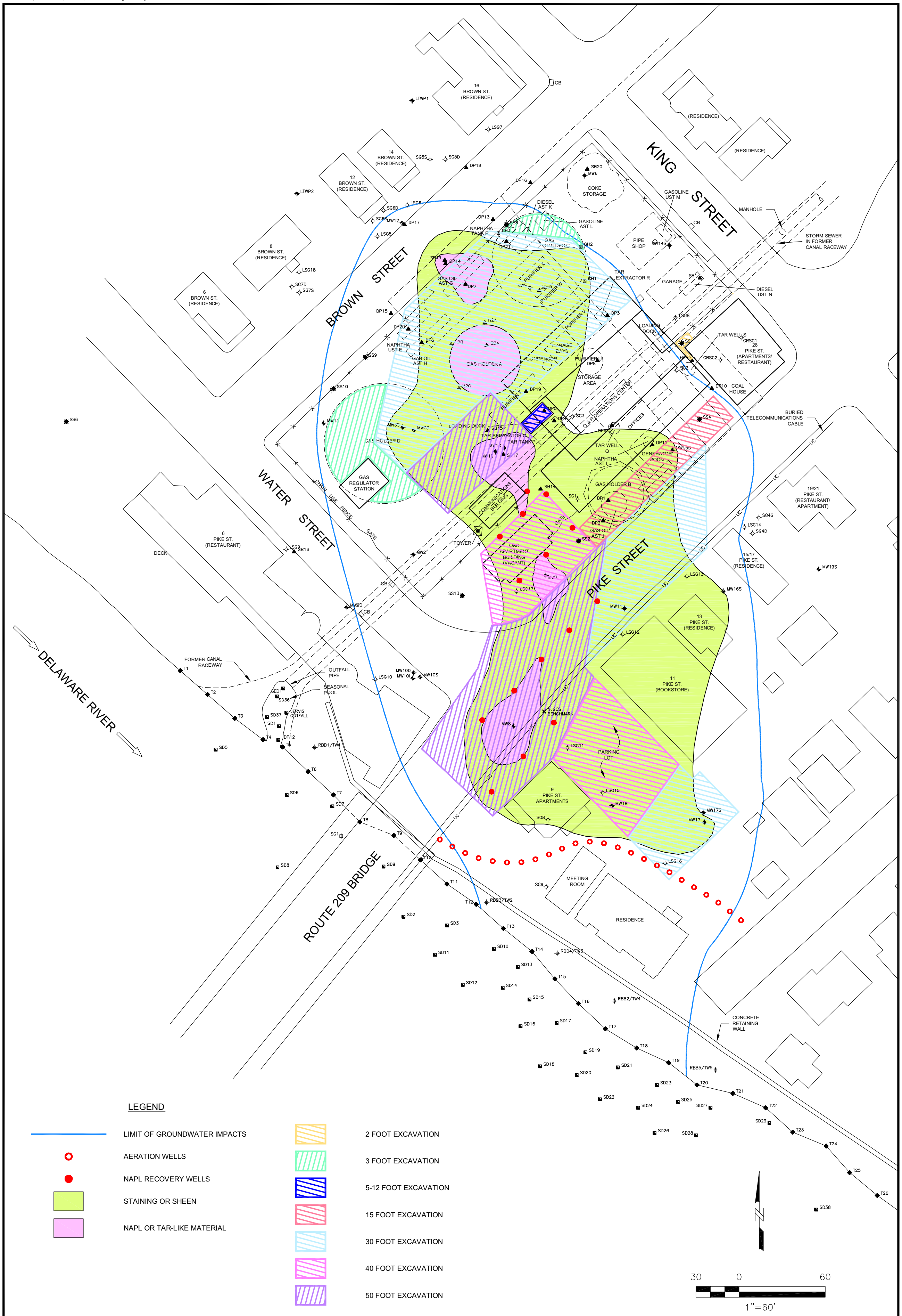
File: J:\18420\910\ALT_6.dwg Layout: Retec-BI User: mwilliamson Plotted: Mar 30, 2006 - 10:11am Xref's:



RETEC

PORT JERVIS
MGP SITE
ORAN2-18420-910

FEASIBILITY STUDY
ALTERNATIVE 6

DATE: 3/30/06 | DRWN: MAW/BIL

FIGURE 5-6

APPENDIX A - Volume Estimates, page 1 of 2

Port Jervis MGP Site

Alternative #1 Soil Excavation Volumes

	area, sqft	depth, ft	volume, cuft	volume, cuyd		
28 Pike Street	71	0.5	36	1		
Holder C	3,164	3	9,492	352		
Holder D	4,660	3	13,980	518		
Tar Separator O	229	8	1,832	68	NAPL	Aeration
Holder A	1,915	12	22,980	851	Wells	Wells
Total	10,039		48,320	**1,790**	27	30

Alternative #2 Soil Excavation Volumes

	area, sqft	depth, ft	volume, cuft	volume, cuyd		
28 Pike Street	71	0.5	36	1		
Holder C	574	3	1,722	64		
Holder D	2,374	3	7,122	264		
Tar Separator O	229	8	1,832	68		
Holder A	338	12	4,056	150		
20-foot	5,519	20	110,380	4,088	NAPL	Aeration
Total	9,105		125,148	**4,635**	27	30

Alternative #3 Soil Excavation Volumes

	area, sqft	depth, ft	volume, cuft	volume, cuyd		
28 Pike Street	71	0.5	36	1		
Holder C	574	3	1,722	64		
Holder D	2,374	3	7,122	264		
Tar Separator O	229	8	1,832	68		
30-foot	15,314	30	459,420	17,016		
40-foot	4,034	40	161,360	5,976	NAPL	Aeration
50-foot	3,285	50	164,250	6,083	Wells	Wells
Total	25,881		795,742	**29,472**	13	30

Alternative #4 Soil Excavation and ISS Volumes

	area, sqft	depth, ft	volume, cuft	volume, cuyd		
28 Pike Street	71	0.5	36	1		
Holder C	574	3	1,722	64		
Holder D	2,374	3	7,122	264		
Tar Separator O	229	8	1,832	68		
30-foot	15,314	15	229,710	8,508		
40-foot	4,034	15	60,510	2,241		
50-foot	3,285	15	49,275	1,825		
Total SOIL	25,881		350,207	**12,971**		
30-foot	15,314	15	229,710	8,508		
40-foot	4,034	25	100,850	3,735	NAPL	Aeration
50-foot	3,285	35	114,975	4,258	Wells	Wells
Total ISS	22,633		445,535	**16,501**	13	30

Alternative #5 Soil Excavation Volumes

	area, sqft	depth, ft	volume, cuft	volume, cuyd		
28 Pike Street	71	0.5	36	1		
Holder C	3,164	3	9,492	352		
Holder D	4,660	3	13,980	518		
Tar Separator O	229	8	1,832	68		
Holder A	1,915	12	22,980	851		
	area, sqft	thickness, ft	volume, cuft	volume, cuyd		
Vertical Barrier	31,600	3	94,800	3,511	GW&NAPL	Aeration
Grout Curtain	36,955	3	n/a	n/a	Wells	Wells
Total	78,594		143,120	**5,301**	13	30

Alternative #6 Soil Excavation Volumes

	area, sqft	depth, ft	volume, cuft	volume, cuyd		
28 Pike Street	71	0.5	36	1		
Holder C	574	3	1,722	64		
Holder D	2,374	3	7,122	264		
Tar Separator O	229	8	1,832	68		
15-foot	2,469	15	37,035	1,372		
30-foot (north)	15,314	30	459,420	17,016		
30-foot (middle)	5,917	30	177,510	6,574		
30-foot (south)	3,151	30	94,530	3,501		
40-foot (north)	4,034	40	161,360	5,976		
40-foot (south)	5,344	40	213,760	7,917		
50-foot (north)	3,285	50	164,250	6,083	NAPL	Aeration
50-foot (south)	11,379	50	568,950	21,072	Wells	Wells
Total	54,141		1,887,527	**69,908**	1	30

Notes:
1. Areas computed by CADD from FS Figures.
2. All volumes are in-place. Excavated material volumes will be greater.

Port Jervis MGP Site

OTHER VOLUMES

Location	Area (sqft)	Impacts Avg Thickness (ft)	Impacts Volume (cuyd)	Overburden Avg Thickness (ft)	Overburden Volume (cuyd)
Soil & NAPL @ DP-7	993	5	184	18	662
Soil & NAPL @ SB-17	1,505	25	1,394	15	836
Soil & NAPL @ MW-7	685	6	152	22	558
Soil & NAPL @ MW-8	1,746	8	517	38	2,457
Soil & NAPL @ GasHolder A	1,915	4	284	6	426
Soil & NAPL @ Tar Sep O	229	1	8	5	42
Soil & NAPL Subtotal, minimum	---	---	2,539	---	4,982
Maximum NAPL Extent, approx.	26,000	11	10,593	23	22,389
Soil with Sheen & NAPL, onsite	30,422	22	24,788	14	15,774
Soil with Sheen & NAPL, offsite	29,551	15	16,417	30	32,834
Soil with Sheen & NAPL, total	59,973	---	41,206	---	48,609
Soil > 500 mg/Kg PAHs	36,971	25	34,232	12	16,432
Subsurface Soil > TAGM, on site	Assume approximately same as on-site Soil with > 500 mg PAHs.				
Subsurface Soil > TAGM, off site	Assume approximately same as off-site Soil with Sheen.				
Soil with Groundwater Impacts	129,773	60	288,384	18	86,515
Apartment Building, footprint	1,099				

MGP Remediation, Port Jervis, NY

Alternative 1

March 2006

Description	Quantity	Units	Unit Cost	Cost	Notes
Contractor Mobilization	1	LS	$100,000	$100,000	Trailers, Sprung structure, excavators
Site Preparation, Clearing, Access, Fencing	1	LS	$60,000	$60,000	Apt. bldg. demo, trees, temp fence
Demobilization and Decon	1	LS	$50,000	$50,000	50% of mobilization
General Conditions	1	LS	$4,000	$4,000	Contractor's H&S, reporting, misc.
Standby	2	days	$5,000	$10,000	
Excavation, Transport, Disposal (hazardous)	0	cuyd	$225	$0	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz soil)	790	cuyd	$100	$79,000	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz debris)	1,000	cuyd	$120	$120,000	Includes screening as necessary
Imported Backfill	1,790	cuyd	$50	$89,500	TAGM 4046 compliant, placed and compacted
Other Restoration	17,000	sqft	$5.00	$85,000	Asphalt pavement
Sheet Piling (temporary, cantilevered)	0	sqft	$80	$0	No sidewall support @ Holder A
Temporary Support of Garage Bays	1	LS	$25,000	$25,000	Support southwest corner
Water Handling/Treatment/Discharge	0	months	$500,000	$0	No excavation below water table
Odor/Vapor Mitigation	2	months	$90,000	$180,000	Sprung Structure, foam, Biosolve
NAPL Wells	27	each	$3,200	$86,400	4" diam PVC x 50' deep (avg.)
NAPL System	1	LS	$107,000	$107,000	Treatment system, pumps, structure, etc.
NAPL O&M - Waste Disposal	4	years	$8,100	$32,400	100 gallons/well x $3/gallon
NAPL O&M - Labor	4	years	$35,000	$140,000	
Aeration Wells	30	each	$2,600	$78,000	2" diam PVC x 50' deep (avg.)
Aeration System	1	LS	$277,200	$277,200	iSOC diffusers, plumbing, manifolds, shed, etc.
Aeration O&M - Equipment & Utilities	30	years	$28,500	$505,014	Compressor operations, Present Value, i = 3.8%
Aeration O&M - Labor	30	years	$20,000	$354,396	Present Value, i = 3.8%
Trenching, Horizontal Drilling	1	LS	$60,000	$60,000	
Perimeter Air Monitoring	2	months	$42,000	$84,000	Air Logics subcontract, during excavation
Surveying	2	months	$2,000	$4,000	Surveyor subcontract
Permits/Agreements	1	LS	$100,000	$100,000	Deed restrictions and access agreements.
Site Engineering and H&S	4	months	$50,000	$200,000	Engineer, H&S officer, phones, field supplies, eqpmt.
Sub-Total				**$2,830,910**	
O&R Office Space rental	4	months	$10,000	$40,000	Budgetary Estimate Only. To be finalized in design.
Pre-Design Investigation	1	LS	$75,000	$75,000	Recoverable NAPL study, bioremediation study
Remedial Design	6.0	%		$169,855	
Project Management	3.0	%		$84,927	
Final Engineering Report	1.0	%		$28,309	
Contractor Bonding	2.0	%		$56,618	Only for excavation contractor, not NAPL or bio.
Contingency	10.0	%		$283,091	Lower contingency than other Alt. due to known scope.
TOTAL				$3,568,711	
				$3,600,000	Rounded Final Value

MGP Remediation, Port Jervis, NY

Alternative 2

Description	Quantity	Units	Unit Cost	Cost	Notes
Contractor Mobilization	1	LS	$400,000	$400,000	Trailers, Sprung, with re-mobe, excavators
Site Preparation, Clearing, Access, Fencing	1	LS	$80,000	$80,000	Apt. bldg. demo, trees, temp fence
Demobilization and Decon	1	LS	$150,000	$150,000	50% of mobilization
General Conditions	1	LS	$25,000	$25,000	Contractor's H&S, reporting, misc.
Standby	10	days	$10,000	$100,000	
Excavation, Transport, Disposal (hazardous)	0	cuyd	$225	$0	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz soil)	3,663	cuyd	$100	$366,300	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz debris)	1,000	cuyd	$120	$120,000	Includes screening as necessary
Imported Backfill	4,663	cuyd	$50	$233,150	TAGM 4046 compliant, placed and compacted
Pavement	17,000	sqft	$5.00	$85,000	Asphalt pavement
Shoring (Pre-engineered Trench Box)	4	months	$30,000	$120,000	Rolling Strut Trench Box, American Shoring, Inc.
Temporary Support of Garage Bays	1	LS	$25,000	$25,000	Support southwest corner
Water Handling/Treatment/Discharge	1	months	$300,000	$300,000	50 gpm @ $0.12/gal Only on during active, deep excavation
Odor/Vapor Mitigation	6	months	$90,000	$540,000	Sprung Structure, foam, Biosolve
NAPL Wells	27	each	$3,200	$86,400	4" diam PVC x 50' deep (avg.)
NAPL System	1	LS	$107,000	$107,000	Treatment system, pumps, structure, etc.
NAPL O&M - Waste Disposal	1.5	years	$8,100	$12,150	100 gallons/well x $3/gallon
NAPL O&M - Labor	1.5	years	$35,000	$52,500	
Aeration Wells	30	each	$2,600	$78,000	2" diam PVC x 50' deep (avg.)
Aeration System	1	LS	$277,200	$277,200	iSOC diffusers, plumbing, manifolds, shed, etc.
Aeration O&M - Equipment & Utilities	10	years	$28,500	$233,481	Compressor operations, Present Value, i = 3.8%
Aeration/ Monitoring O&M - Labor	20	years	$20,000	$276,684	Present Value, i = 3.8%
Trenching, Horizontal Drilling	1	LS	$60,000	$60,000	
Perimeter Air Monitoring	6	months	$42,000	$252,000	Air Logics subcontract, during excavation
Surveying	6	months	$2,000	$12,000	Surveyor subcontract
Permits/Agreements	1	LS	$100,000	$100,000	Deed restrictions and access agreements.
Site Engineering and H&S	6	months	$50,000	$300,000	Engineer, H&S officer, phones, field supplies, eqpmt.
Sub-Total				**$4,391,865**	
O&R Office Space rental	6	months	$10,000	$60,000	Budgetary Estimate Only. To be finalized in design.
Pre-Design Investigation	1.0	%		$43,919	NAPL and biotreatment studies, full precharacterization.
Remedial Design	3.0	%		$131,756	Includes Geotechnical design of shoring, water mgmt.
Project Management	2.0	%		$87,837	
Final Engineering Report	0.5	%		$21,959	
Contingency	15.0	%		$658,780	Includes increased excavation areas, increased NAPL and biotreatment based on predesign studies.
TOTAL				$5,396,115	
				$5,400,000	Rounded Final Value

MGP Remediation, Port Jervis, NY

Alternative 3

March 2006

Description	Quantity	Units	Unit Cost	Cost	Notes
Contractor Mobilization	1	LS	$300,000	$300,000	Trailers, Sprung, excavators
Site Preparation, Clearing, Access, Fencing	1	LS	$80,000	$80,000	Apt. bldg. demo, trees, temp fence
Demobilization and Decon	1	LS	$150,000	$150,000	50% of mobilization
General Conditions	1	LS	$25,000	$25,000	Contractor's H&S, reporting, misc.
Standby	10	days	$10,000	$100,000	
Excavation, Transport, Disposal (hazardous)	0	cuyd	$225	$0	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz soil)	28,472	cuyd	$100	$2,847,200	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz debris)	1,000	cuyd	$120	$120,000	Includes screening as necessary
Imported Backfill	29,472	cuyd	$50	$1,473,600	TAGM 4046 compliant, placed and compacted
Pavement	29,500	sqft	$5.00	$147,500	Asphalt pavement
Shoring (temporary sheet piling, with tiebacks)	51,600	sqft	$90	$4,644,000	530 LF x 40' + 250 LF x 60' + 240LF x 80' Unit price has 10% discount for re-use of sheet piling.
Water Handling/Treatment/Discharge	4	months	$500,000	$2,000,000	100 gpm @ $0.12/gal Only on during active, deep excavation
Odor/Vapor Mitigation	11	months	$90,000	$990,000	Sprung Structure, foam, Biosolve
NAPL Wells	13	each	$3,200	$41,600	4" diam PVC x 50' deep (avg.)
NAPL System	1	LS	$93,000	$93,000	Treatment system, pumps, structure, etc.
NAPL O&M - Waste Disposal	1.5	years	$3,900	$5,850	100 gallons/well x $3/gallon
NAPL O&M - Labor	1.5	years	$35,000	$52,500	
Aeration Wells	30	each	$2,600	$78,000	2" diam PVC x 50' deep (avg.)
Aeration System	1	LS	$212,800	$212,800	iSOC diffusers, plumbing, manifolds, shed, etc.
Aeration O&M - Equipment & Utilities	10	years	$21,500	$176,134	Compressor operations, Present Value, i = 3.8%
Aeration/ Monitoring O&M - Labor	30	years	$20,000	$354,396	Present Value, i = 3.8%
Trenching, Horizontal Drilling	1	LS	$60,000	$60,000	
Perimeter Air Monitoring	11	months	$42,000	$462,000	Air Logics subcontract, during excavation
Surveying	11	months	$2,000	$22,000	Surveyor subcontract
Permits/Agreements	1	LS	$100,000	$100,000	Deed restrictions and access agreements.
Site Engineering and H&S	11	months	$50,000	$550,000	Engineer, H&S officer, phones, field supplies, eqpmt.
Sub-Total				**$15,085,580**	
O&R Office Space rental	11	months	$10,000	$110,000	Budgetary Estimate Only. To be finalized in design.H99
Pre-Design Investigation	1.0	%		$150,856	NAPL and biotreatment studies, full precharacterization.
Remedial Design	3.0	%		$452,567	Includes Geotechnical design of shoring, water mgmt.
Project Management	2.0	%		$301,712	
Final Engineering Report	0.5	%		$75,428	
Contingency	15.0	%		$2,262,837	Includes increased excavation areas, increased NAPL and biotreatment based on predesign studies.
TOTAL				$18,438,980	
				$18,000,000	Rounded Final Value

MGP Remediation, Port Jervis, NY

Alternative 4

March 2006

Description	Quantity	Units	Unit Cost	Cost	Notes
Contractor Mobilization	1	LS	$300,000	$300,000	Trailers, Sprung, excavators, ISS rig
Site Preparation, Clearing, Access, Fencing	1	LS	$80,000	$80,000	Apt. bldg. demo, trees, temp fence
Demobilization and Decon	1	LS	$150,000	$150,000	50% of mobilization
General Conditions	1	LS	$25,000	$25,000	Contractor's H&S, reporting, misc.
Standby	20	days	$10,000	$200,000	
Excavation, Transport, Disposal (hazardous)	0	cuyd	$225.00	$0	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz soil)	11,971	cuyd	$100.00	$1,197,100	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz debris)	1,000	cuyd	$120.00	$120,000	Includes screening as necessary
Imported Backfill	12,971	cuyd	$50	$648,550	TAGM 4046 compliant, placed and compacted
Pavement	29,500	sqft	$5.00	$147,500	Asphalt pavement
Sheet Piling (temporary, cantilevered)	33,200	sqft	$60	$1,992,000	40' sheets x 830 LF
Water Handling/Treatment/Discharge	0	months	$500,000	$0	No excavation below water table
Odor/Vapor Mitigation	6	months	$90,000.00	$540,000	Sprung Structure, foam, Biosolve
In Situ Solidification	12,501	cuyd	$80.00	$1,000,080	100 cuyd/day
Excavation, Transport, Disposal (ISS pre-excav.)	4,000	cuyd	$100.00	$400,000	Obstruction clearance, 20%
NAPL Wells	13	each	$3,200	$41,600	4" diam PVC x 50' deep (avg.)
NAPL System	1	LS	$93,000	$93,000	Treatment system, pumps, structure, etc.
NAPL O&M - Waste Disposal	1.5	years	$3,900	$5,850	100 gallons/well x $3/gallon
NAPL O&M - Labor	1.5	years	$35,000	$52,500	
Aeration Wells	30	each	$2,600	$78,000	2" diam PVC x 50' deep (avg.)
Aeration System	1	LS	$212,800	$212,800	iSOC diffusers, plumbing, manifolds, shed, etc.
Aeration O&M - Equipment & Utilities	10	years	$21,500	$176,134	Compressor operations, Present Value, i = 3.8%
Aeration/ Monitoring O&M - Labor	30	years	$20,000	$354,396	Present Value, i = 3.8%
Trenching, Horizontal Drilling	1	LS	$60,000	$60,000	
Perimeter Air Monitoring	8	months	$42,000.00	$336,000	Air Logics subcontract, during excavation
Surveying	8	months	$2,000.00	$16,000	Surveyor subcontract
Permits/Agreements	1	LS	$100,000	$100,000	Deed restrictions and access agreements.
Site Engineering and H&S	8	months	$50,000	$400,000	Engineer, H&S officer, phones, field supplies, eqpmt.
Sub-Total				**$8,726,510**	
O&R Office Space rental	8	months	$10,000	$80,000	Budgetary Estimate Only. To be finalized in design.
Pre-Design Investigation	3.0	%		$261,795	NAPL and biotreatment studies, precharacterization. Testing of ISS feasibility through cobble layer
Remedial Design	5.0	%		$436,326	Includes Geotechnical design of shoring, ISS
Project Management	2.0	%		$174,530	
Final Engineering Report	0.5	%		$43,633	
Contingency	20.0	%		$1,745,302	Includes larger excavation and ISS volume, problems with ISS implementation, NAPL and biotreatment based on predesign studies.
TOTAL				$11,468,096	
				$11,000,000	Rounded Final Value

MGP Remediation, Port Jervis, NY

Alternative 5

March 2006

Description	Quantity	Units	Unit Cost	Cost	Notes
Contractor Mobilization	1	LS	$300,000	$300,000	Trailers, Sprung, excavators, trencher, etc.
Site Preparation, Clearing, Access, Fencing	1	LS	$60,000	$60,000	Apt. bldg. demo, trees, temp fence, etc.
Demobilization and Decon	1	LS	$150,000	$150,000	50% of mobilization
General Conditions	1	LS	$25,000	$25,000	Contractor's H&S, reporting, misc.
Standby	20	days	$10,000	$200,000	
Excavation, Transport, Disposal (hazardous)	0	cuyd	$225	$0	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz soil)	4,301	cuyd	$100	$430,100	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz debris)	1,000	cuyd	$120	$120,000	Includes screening as necessary
Imported Backfill	5,301	cuyd	$50	$265,050	TAGM 4046 compliant, placed and compacted
Top Soil	8,000	sqft	$1.20	$9,600	6", with hydroseed
Other Restoration	21,500	sqft	$5.00	$107,500	Asphalt pavement
Vertical Wall	35,000	sqft	$50	$1,750,000	
Grout Curtain Bottom Seal	40,000	sqft	$50	$2,000,000	
Water Handling/Treatment/Discharge	0	months	$500,000	$0	No excavation dewatering
Odor/Vapor Mitigation	2	months	$90,000	$180,000	Sprung Structure, foam, Biosolve
NAPL Wells	13	each	$3,200	$41,600	4" diam PVC x 50' deep (avg.)
NAPL System	1	LS	$93,000	$93,000	Treatment system, pumps, structure, etc.
NAPL O&M - Waste Disposal	1.5	years	$3,900	$5,850	100 gallons/well x $3/gallon
NAPL O&M - Labor	1.5	years	$35,000	$52,500	
Aeration Wells	30	each	$2,600	$78,000	2" diam PVC x 50' deep (avg.)
Aeration System	1	LS	$212,800	$212,800	iSOC diffusers, plumbing, manifolds, shed, etc.
Aeration O&M - Equipment & Utilities	10	years	$21,500	$176,134	Compressor operations, Present Value, i = 3.8%
Aeration O&M - Labor	30	years	$20,000	$354,396	Present Value, i = 3.8%
Trenching, Horizontal Drilling	1	LS	$60,000	$60,000	
Hydraulic Containment and GW Treatment	30	years	$30,000	$531,594	Present Value, i = 3.8%
Perimeter Air Monitoring	8	months	$42,000	$336,000	Air Logics subcontract, during excavation
Surveying	8	months	$2,000	$16,000	Surveyor subcontract
Permits/Agreements	1	LS	$100,000	$100,000	Deed restrictions and access agreements.
Site Engineering and H&S	8	months	$50,000	$400,000	Engineer, H&S officer, phones, field supplies, eqpmt.
Sub-Total				**$8,055,124**	
O&R Office Space rental	8	months	$10,000	$80,000	Budgetary Estimate Only. To be finalized in design.
Pre-Design Investigation	1.5	%		$120,827	Includes pre- characterization of extent
Remedial Design	2.0	%		$161,102	Includes design of grout and wall systems
Project Management	2.0	%		$161,102	
Final Engineering Report	0.5	%		$40,276	
Contingency	20.0	%		$1,611,025	Possible items include storm sewer pipe removal, increased area or depth of containment, implementation problems due to unproven technology.
TOTAL				$10,229,457	
				$10,000,000	Rounded Final Value

MGP Remediation, Port Jervis, NY

Alternative 6

March 2006

Description	Quantity	Units	Unit Cost	Cost	Notes
Contractor Mobilization	1	LS	$300,000	$300,000	Trailers, Sprung, excavators, etc.
Site Preparation, Clearing, Access, Fencing	1	LS	$60,000	$60,000	Apt. bldg. demo, trees, temp fence, etc.
Demobilization and Decon	1	LS	$150,000	$150,000	50% of mobilization
General Conditions	1	LS	$40,000	$40,000	Contractor's H&S, reporting, misc.
Standby	15	days	$10,000	$150,000	
Excavation, Transport, Disposal (hazardous)	0	cuyd	$225	$0	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz soil)	67,908	cuyd	$100	$6,790,800	100 cuyd (150 tons) per day
Excavation, Transport, Disposal (non-haz debris)	2,000	cuyd	$120	$240,000	Includes screening as necessary
Imported Backfill	69,908	cuyd	$50	$3,495,400	TAGM 4046 compliant, placed and compacted
Top Soil	20,000	sqft	$1.20	$24,000	6", with hydroseed
Other Restoration - Private	21,500	sqft	$5.00	$107,500	Asphalt pavement
Other Restoration - Municipal	15,000	sqft	$15.00	$225,000	Asphalt pavement
Shoring (temporary sheet piling, with tiebacks)	113,400	sqft	$90	$10,206,000	Unit price has 10% discount for re-use of sheet piling.
Water Handling/Treatment/Discharge	9	months	$500,000	$4,500,000	100 gpm @ $0.12/gal Only on during active, deep excavation
Odor/Vapor Mitigation	24	months	$90,000	$2,160,000	Sprung Structure, foam, Biosolve
NAPL Wells	13	each	$3,200	$41,600	4" diam PVC x 50' deep (avg.)
NAPL System	1	LS	$93,000	$93,000	Treatment system, pumps, structure, etc.
NAPL O&M - Waste Disposal	1.5	years	$3,900	$5,850	100 gallons/well x $3/gallon
NAPL O&M - Labor	1.5	years	$35,000	$52,500	
Aeration Wells	30	each	$2,600	$78,000	2" diam PVC x 50' deep (avg.)
Aeration System	1	LS	$212,800	$212,800	iSOC diffusers, plumbing, manifolds, shed, etc.
Aeration O&M - Equipment & Utilities	10	years	$21,500	$176,134	Compressor operations, Present Value, i = 3.8%
Aeration / Monitoring O&M - Labor	30	years	$20,000	$354,396	Present Value, i = 3.8%
Trenching, Horizontal Drilling	1	LS	$60,000	$60,000	
Perimeter Air Monitoring	24	months	$42,000	$1,008,000	Air Logics subcontract, during excavation
Surveying	24	months	$2,000	$48,000	Surveyor subcontract
Permits/Agreements	1	LS	$200,000	$200,000	Deed restrictions and access agreements.
Site Engineering and H&S	24	months	$50,000	$1,200,000	Engineer, H&S officer, phones, field supplies, eqpmt.
Sub-Total				**$31,978,980**	
O&R Office Space rental	24	months	$10,000	$240,000	Budgetary Estimate Only. To be finalized in design.
Pre-Design Investigation	1.0	%		$319,790	Includes full precharacterization
Remedial Design	1.0	%		$319,790	
Project Management	2.0	%		$639,580	
Final Engineering Report	0.5	%		$159,895	
Contingency	10.0	%		$3,197,898	
TOTAL				$36,855,933	
				$37,000,000	Rounded Final Value

Table C-1
Surface Soil and Background Sample Results
Port Jervis MGP Site

Sample Name Area	TAGM 4046 (Note 1)	SS5 Background	SS6 Background	SS7 Background	Concentration Range Detected On-site Samples	Highest Background Concentration (Note 2)	SS1 Off-site	SS2 On-site	SS20 On-site Duplicate	SS3 On-site	SS4 On-site	SS8 On-site	SS9 On-site	SS10 On-site
Compound of Concern														
PAHs (mg/Kg)														
Naphthalene	13	ND	ND	ND	ND - 3.5	ND	3.5	ND	ND	0.077	0.14	0.34	ND	ND
Acenaphthylene	41	0.12	0.05	0.1	ND - 1.2	0.12	1.2	0.39	0.47	0.4	0.12	1.8	0.2	0.15
Acenaphthene	50	ND	ND	ND	ND - 11	ND	11	ND	ND	ND	0.73	ND	ND	ND
Fluorene	50	ND	ND	ND	ND - 10	ND	10	ND	ND	ND	0.57	0.42	ND	ND
Phenanthrene	50	0.58	0.28	0.36	0.58 - 72	0.58	72	0.75	1.5	1.2	5.7	7	0.58	1.8
Anthracene	50	0.09	0.039	0.32	ND - 16	0.32	16	0.18	0.32	0.2	0.89	1.3	ND	0.2
Fluoranthene	50	1.3	0.56	0.87	1.4 - 89	1.3	89	2.2	3.5	2.7	8.8	11	1.4	4.1
Pyrene	50	1	0.44	0.56	1.5 - 61	1	61	2.2	2.6	2.1	6.7	12	1.5	2.2
Benzo(a)anthracene	0.224	0.61	0.23	0.51	0.7 - 38	0.61	38	1.4	1.8	1.2	3.6	8.1	0.7	0.56
Chrysene	0.4	0.83	0.35	0.88	0.93 - 41	0.88	41	1.7	2.2	1.7	4.2	9.1	0.93	1.5
Benzo(b)fluoranthene	1.1	0.86	0.3	0.61	0.78 - 33	0.86	33	2.1	2.4	1.7	4.8	9.6	0.78	1.2
Benzo(k)fluoranthene	1.1	0.61	0.23	0.43	0.74 - 14	0.61	14	1.2	1.6	1.1	1.8	5.2	0.74	0.98
Benzo(a)pyrene	0.061	0.68	0.24	0.46	0.58 - 27	0.68	27	1.4	1.6	1.4	3.1	7.4	0.79	0.58
Indeno(1,2,3-cd)pyrene	3.2	0.48	0.18	0.27	0.41 - 16	0.48	16	1.7	1.7	1	2	4.1	0.41	0.43
Dibenz(a,h)anthracene	0.014	0.1	0.041	0.072	ND - 5.5	0.072	5.5	0.46	0.52	0.3	0.68	1.5	1.7	ND
Benzo(ghi)perylene	50	0.3	0.091	0.14	0.26 - 8	0.3	8	1.2	0.69	0.6	0.89	2.2	0.38	0.26
Total CPAHs	10	4.17	1.571	3.232	4.35 - 174.5	4.17	174.5	9.96	11.82	8.4	20.18	45	4.35	5.25
Total PAHs	500	7.56	3.031	5.582	8.41 - 446.2	7.56	446.2	16.88	20.9	15.677	44.72	81.06	8.41	13.96

Notes:
NA = Not Analyzed
NL = Not Listed
ND = The material was analyzed for, but not detected at or above the reporting limit.
J = The associated numerical value is an estimated quantity.
(Note 1) NYSDEC TAGM HWR-94-4046 - Determination of Soil Cleanup Objectives and Cleanup Levels (NYSDEC, Jan. 1994).
(Note 2) - Highest concentration detected in the background samples collected in the City of Port Jervis.

Table C-2
Subsurface Soil Results
Port Jervis MGP Site

Identification Sample Depth	SCG (Note 1)	Concentration Range Detected	Frequency Exceeding SCG	TP4 8	TP10 10	TWP-1 14-15.5	TWP-1 16-17	TWP-2 14-15.5	TWP-2 18-19	HA1 5.1	SB4 8.3	SB14 25-26	SB14 73-75	SB15 74-75	SB16 23-25	SB16 53-55	SB17 72-73	SB17 151-153	SB18 39-40	SB18 68-70	SB19 38-40
Compound of Concern																					
BTEX (mg/Kg)																					
Benzene	0.06	ND - 1200	2/76	ND	0.023	ND	ND	ND	ND	ND	**1200**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	1.5	ND - 1700	3/76	ND	ND	ND	ND	ND	ND	ND	**1700**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5.5	ND - 1400	10/76	0.006	0.32	ND	ND	ND	ND	ND	**1400**	0.037	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes (total)	1.2	ND - 1900	12/76	ND	0.26	ND	ND	ND	ND	ND	**1900**	0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total BTEX	10	ND - 6200	10/76	ND	0.6	ND	ND	ND	ND	ND	**6,200**	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
PAHs (mg/Kg)																					
Acenaphthene	50	ND - 1400	9/76	1.8	ND	ND	ND	ND	ND	ND	**1400**	8.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	41	ND - 1200	2/76	1.4	ND	ND	ND	ND	ND	ND	**1200**	0.72	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	ND - 1000	4/76	3.5	0.43	ND	ND	ND	ND	ND	**1000**	1.7	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.224	ND - 500	33/76	**2.2**	**0.29**	ND	ND	ND	ND	0.012	**500**	**1.7**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	0.061	ND - 370	38/76	**2.0**	**0.18**	ND	ND	ND	ND	0.011	**370**	**1.1**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	1.1	ND - 140	22/76	0.78	0.092	0.023	ND	ND	ND	0.01	**140**	0.94	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	50	ND - 130	1/76	1.1	0.14	ND	ND	ND	ND	ND	**130**	0.38	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	1.1	ND - 23	15/76	ND	ND	ND	ND	ND	ND	ND	ND	0.89	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.4	ND - 500	33/76	**2.4**	**0.49**	0.0229	ND	ND	ND	0.012	**500**	**1.9**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	0.014	ND - 8.5	27/76	**0.29**	**0.047**	ND	ND	ND	ND	ND	ND	**0.16**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	50	ND - 93	2/76	1.2	ND	0.0329	0.0243	ND	ND	ND	ND	4.9	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	50	ND - 310	3/76	1.9	0.058	ND	ND	ND	ND	ND	**310**	3	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	3.2	ND - 110	10/76	0.87	0.099	ND	ND	ND	ND	ND	**110**	0.58	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	13	ND - 9000	13/76	0.98	1.1	ND	ND	ND	ND	0.044	**9000**	13	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	50	ND - 3000	13/76	10	2.7	ND	ND	ND	ND	ND	**3000**	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	50	ND - 1400	6/76	5.6	0.58	0.0286	0.0216	ND	ND	0.017	**1400**	7.6	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAHs (mg/Kg)	500	ND - 19,060	8/76	36	6	0.11	ND	ND	ND	0.11	**19,060**	61	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total CPAH (mg/Kg)	NA	ND	**1620**	8.54	1.2	ND	ND	ND	ND	ND	1,620	7.2	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = The material was analyzed for but not detected at, or above, the reporting limit.
Bold value - compound detected in concentration greater than SCG.
(Note 1) - NYSDEC TAGM HWR-94-4046 - Determination of Soil Cleanup Objectives and Cleanup Levels [NYSDEC, Jan. 1994].
NA - Not Applicable

Table C-2
Subsurface Soil Results
Port Jervis MGP Site

Identification	SCG	MW1S	MW1D	MW2	MW3	MW3	MW3D	MW5	MW6	MW7	MW7	MW8	MW8	MW8	MW9	MW10I	MW10	MW10	MW11	MW11	MW12	MW12	MW13
Sample Depth	(Note 1)	18.7	41.05	15.56	15.95	17.5	146-148	15.35	16-18	25-26	43-45	41-43	41-43	73-75	163-165	23-25	51-53	178-180	23-25	43-45	15-16	34-35	21-23
Compound of Concern																							
BTEX (mg/Kg)																							
Benzene	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	1.5	ND	**5**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5.5	**13**	**150**	ND	2	**13**	ND	**28**	ND	**6.2**	ND	0.061	0.012	ND	ND	ND	ND	ND	0.081	ND	ND	ND	ND
Xylenes (total)	1.2	**14**	**160**	ND	**2.2**	**15**	ND	**32**	ND	**7.7**	ND	0.074	0.011	ND	ND	ND	ND	ND	0.17	ND	ND	ND	ND
Total BTEX	10	**27.0**	**315.0**	ND	4.2	**28.0**	ND	**60.0**	ND	**13.9**	ND	0.1	0.0	ND	ND	ND	ND	ND	0.3	ND	ND	ND	ND
PAHs (mg/Kg)																							
Acenaphthene	50	**62**	**320**	0.048	**130**	**80**	ND	39	ND	17	ND	2	1.2	ND	ND	ND	ND	ND	15	ND	1.6	ND	ND
Acenaphthylene	41	5.8	**56**	1.4	14	9.8	ND	4.4	ND	3.2	ND	0.3	0.18	ND	ND	0.11	ND	ND	1.8	ND	ND	ND	ND
Anthracene	50	27	**160**	0.31	**56**	37	ND	17	ND	9.3	ND	1.3	0.78	ND	ND	ND	ND	ND	5.6	ND	0.58	ND	ND
Benzo(a)anthracene	0.224	**12**	**81**	0.17	**24**	**16**	ND	**7.4**	0.14	**8.7**	ND	**0.87**	**0.53**	ND	ND	0.069	ND	ND	**3.4**	ND	**0.48**	ND	ND
Benzo(a)pyrene	0.061	**9.2**	**84**	**1.6**	**18**	**12**	ND	**6.1**	**0.12**	**7.4**	ND	**0.76**	**0.48**	ND	ND	**0.12**	ND	ND	**2.9**	ND	**0.33**	ND	ND
Benzo(b)fluoranthene	1.1	**4.5**	**35**	0.53	**7.7**	**4.7**	ND	**2.5**	0.11	**4.2**	ND	0.39	0.25	ND	ND	0.076	ND	ND	**1.7**	ND	0.26	ND	ND
Benzo(ghi)perylene	50	3.6	34	5.5	5.8	5	ND	2.7	0.083	5.4	ND	0.18	0.13	ND	0.057	0.4	ND	ND	0.88	ND	0.31	ND	ND
Benzo(k)fluoranthene	1.1	ND	ND	ND	ND	ND	ND	**4.5**	0.12	**5.4**	ND	0.49	0.29	ND	ND	0.081	ND	ND	**1.8**	ND	0.31	ND	ND
Chrysene	0.4	**12**	**96**	**0.46**	**25**	**16**	ND	**8**	0.17	**9.1**	ND	**0.87**	**0.51**	ND	ND	0.086	ND	ND	**3.7**	ND	**0.57**	ND	ND
Dibenz(a,h)anthracene	0.014	ND	**8.5**	**0.66**	ND	**1.4**	ND	ND	ND	**0.78**	ND	**0.062**	ND	ND	ND	ND	ND	ND	**0.27**	ND	ND	ND	ND
Fluoranthene	50	ND	**93**	ND	ND	ND	ND	ND	0.24	23	ND	2	1.2	ND	ND	0.069	ND	ND	6.6	ND	1	ND	ND
Fluorene	50	ND	**93**	ND	21	23	ND	ND	ND	15	ND	1.2	0.66	ND	ND	ND	ND	ND	6.3	ND	1.3	ND	ND
Indeno(1,2,3-cd)pyrene	3.2	3.1	**28**	2.5	**5.1**	**4.2**	ND	2.2	0.11	**4.9**	ND	0.28	0.16	ND	ND	0.19	ND	ND	1.1	ND	0.29	ND	ND
Naphthalene	13	**240**	**1400**	ND	**440**	**250**	ND	**160**	ND	**50**	ND	1.8	1.2	ND	ND	ND	ND	ND	**53**	ND	0.47	ND	ND
Phenanthrene	50	**80**	**480**	0.049	**160**	**100**	ND	**51**	0.17	**56**	ND	5.1	3	ND	ND	ND	ND	ND	19	ND	1.6	ND	ND
Pyrene	50	36	**280**	0.89	**66**	48	ND	21	0.28	30	ND	2.1	1.3	ND	ND	0.17	ND	ND	7.5	ND	1.9	ND	ND
Total PAHs (mg/Kg)	500	495	**3,249**	14	**973**	**607**	ND	326	2	249	ND	20	12	ND	ND	1	ND	ND	131	ND	11	ND	ND
Total CPAH (mg/Kg)	NA	40.8	332	5.9	79.8	54.3	ND	30.7	0.77	40.5	ND	3.7	2.2	ND	ND	0.6	ND	ND	14.9	ND	2.2	ND	ND

Notes:
ND = The material was analyzed for but not detected at, or above, the reporting limit.
Bold value - compound detected in concentration greater than SCG.
(Note 1) - NYSDEC TAGM HWR-94-4046 - Determination of Soil Cleanup Objectives and Cleanup Levels [NYSDEC, Jan. 1994].
NA - Not Applicable

Table C-2
Subsurface Soil Results
Port Jervis MGP Site

Identification	SCG	MW-14S	MW-14S	MW-15S	MW-15S	MW-16S	MW-16S	MW-17S	MW-17S	MW-19S	MW-19S	DP1	DP2	DP3	DP5	DP6	DP7	DP8	DP9	DP10
Sample Depth	(Note 1)	12-13	20-20.8	14-15	22-22.2	16-17	20-20.2	10-11.5	22-22.3	10-11.3	16-17	10.5-11.5	18-19	19-20	5-6	19-20	22-23	12-14	6-8	12-14
Compound of Concern																				
BTEX (mg/Kg)																				
Benzene	0.06	ND	ND	ND	0.0263	ND	ND	ND	ND	ND	ND	ND	ND	ND	**140**	ND	ND	ND	ND	ND
Toluene	1.5	0.0012	ND	ND	0.0352	ND	ND	ND	ND	ND	ND	ND	ND	ND	**180**	ND	ND	ND	ND	ND
Ethylbenzene	5.5	ND	ND	**9.62**	2.17	ND	ND	ND	ND	ND	ND	ND	1.9	**10**	**160**	**11**	ND	ND	ND	ND
Xylenes (total)	1.2	ND	ND	**4.14**	**1.26**	ND	ND	ND	ND	ND	ND	ND	ND	**24**	**130**	**11**	ND	ND	ND	ND
Total BTEX	10	ND	ND	**13.8**	3.5	ND	ND	ND	ND	ND	ND	ND	1.9	**34.0**	**610.0**	**22.0**	ND	ND	ND	ND
PAHs (mg/Kg)																				
Acenaphthene	50	ND	ND	**73.6**	2.43	ND	0.0721	ND	6.5	ND	ND	3.7	**180**	**75**	**120**	37	21	0.042	ND	0.26
Acenaphthylene	41	ND	ND	2.77	0.357	0.0312	0.0714	ND	1.85	ND	ND	0.43	13	9.6	9.7	3.9	3.3	0.66	1.5	5.8
Anthracene	50	ND	ND	29	1.84	ND	0.0609	ND	10.2	ND	ND	1.9	**65**	28	34	13	14	0.2	0.57	2.4
Benzo(a)anthracene	0.224	ND	ND	**15.5**	**1.31**	0.03	0.117	ND	**7.02**	0.0477	ND	**1.2**	**44**	**22**	**24**	**6.9**	**8.4**	**0.83**	**0.8**	**3.7**
Benzo(a)pyrene	0.061	ND	ND	**9.91**	**1.19**	0.0274	**0.11**	ND	**5.74**	0.0395	ND	**0.8**	**35**	**20**	**21**	**5.1**	**6**	**1.6**	**2.7**	**6.9**
Benzo(b)fluoranthene	1.1	ND	ND	**5.53**	0.653	ND	ND	ND	**3.5**	0.0461	ND	0.72	**18**	**10**	**12**	**2.4**	**2.9**	**1.9**	**2.2**	**5.1**
Benzo(ghi)perylene	50	ND	ND	4.22	0.61	0.0259	0.152	ND	3.21	ND	ND	0.63	17	10	6.8	1.7	2.4	1.8	1.9	4.5
Benzo(k)fluoranthene	1.1	ND	ND	**3.96**	0.805	0.0215	ND	ND	**3.08**	0.0179	ND	0.73	**23**	**13**	**12**	**3.1**	**3.8**	**1.2**	**1.5**	**3.2**
Chrysene	0.4	ND	ND	**10.1**	**1.2**	0.0264	0.104	ND	**6.25**	0.0489	ND	**1.4**	**47**	**23**	**24**	**7.3**	**8.9**	**1.3**	**2.3**	**4.5**
Dibenz(a,h)anthracene	0.014	ND	ND	**1.05**	**0.13**	ND	ND	ND	**0.64**	ND	ND	**0.15**	**5.7**	**3**	**2.8**	**0.63**	**1**	**0.35**	**0.5**	**1.5**
Fluoranthene	50	ND	ND	28.9	2.72	0.0439	0.175	ND	14.2	0.0569	ND	3.6	**90**	44	43	13	15	1.5	2.3	5.4
Fluorene	50	ND	ND	37.3	1.76	ND	ND	ND	8.37	ND	ND	3.6	**72**	33	47	16	14	0.2	0.088	0.98
Indeno(1,2,3-cd)pyrene	3.2	ND	ND	**3.32**	0.506	ND	ND	ND	2.56	ND	ND	0.69	**20**	**11**	**8.5**	2	3	2.1	2.5	**6.8**
Naphthalene	13	ND	ND	**140**	0.401	ND	ND	ND	ND	ND	ND	6.2	**460**	**180**	**800**	**81**	5.8	0.21	1	0.73
Phenanthrene	50	ND	ND	**95.5**	6.31	ND	0.14	ND	33.4	ND	ND	11	**220**	**100**	**170**	**51**	**53**	1.5	1.6	4.5
Pyrene	50	ND	ND	40.6	3.65	0.0527	0.251	ND	18	0.051	ND	3.7	**120**	**59**	**68**	21	24	4.4	3.2	7.9
Total PAHs (mg/Kg)	500	ND	ND	**501**	26	0.259	1.3	ND	125	ND	ND	40	**1,430**	**641**	**1,403**	265	187	20	25	64
Total CPAH (mg/Kg)	NA	ND	ND	49.4	5.7	0.14	0.32	ND	25.3	ND	ND	59	193	102	104	27	34	9.98	12.5	31.7

Notes:
ND = The material was analyzed for but not detected at, or above, the reporting limit.
Bold value - compound detected in concentration greater than SCG.
(Note 1) - NYSDEC TAGM HWR-94-4046 - Determination of Soil Cleanup Objectives and Cleanup Levels [NYSDEC, Jan. 1994].
NA - Not Applicable

Table C-2
Subsurface Soil Results
Port Jervis MGP Site

Identification	SCG	DP13	DP14	DP15	DP16	DP17	DP18	RBB1	RBB1	RBB2	RBB2	RBB3	RBB3	RBB4	RBB4	RBB4	RBB5	RBB5
Sample Depth	(Note 1)	14-16	22-23	18.5-19.5	16-18	15-16	16-17	3.3-4.3	13-14	3.8-4.8	12-13	3-4	12-14	3.8-4.8	19-20	32-34	3.5-4.5	12-13
Compound of Concern																		
BTEX (mg/Kg)																		
Benzene	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5.5	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes (total)	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total BTEX	10	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PAHs (mg/Kg)																		
Acenaphthene	50	12	11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.3	ND	ND	ND	ND
Acenaphthylene	41	1.8	1.4	ND	ND	0.62	ND	0.06	ND	0.48	ND	0.27	ND	0.35	ND	ND	0.21	ND
Anthracene	50	3.1	4.2	ND	ND	ND	ND	0.039	ND	0.008	ND	0.13	ND	0.89	ND	ND	0.12	ND
Benzo(a)anthracene	0.224	**2.4**	**3.3**	ND	ND	ND	ND	**0.23**	ND	**0.41**	0.05	**0.89**	ND	**1.8**	ND	ND	**0.53**	ND
Benzo(a)pyrene	0.061	**1.4**	**2.2**	ND	ND	**0.94**	ND	**0.27**	ND	**0.31**	ND	**1.2**	ND	**1.4**	ND	ND	**0.78**	ND
Benzo(b)fluoranthene	1.1	0.84	**1.4**	ND	ND	0.9	ND	0.28	ND	0.35	0.04	**1.2**	ND	**1.6**	ND	ND	0.71	ND
Benzo(ghi)perylene	50	ND	0.61	ND	ND	0.76	0.063	0.35	ND	0.21	ND	1.1	ND	0.7	ND	ND	0.72	ND
Benzo(k)fluoranthene	1.1	**1.3**	**1.6**	ND	ND	0.51	ND	0.1	ND	0.16	ND	0.48	ND	0.6	ND	ND	0.26	ND
Chrysene	0.4	**2.7**	**3.6**	ND	ND	**0.6**	ND	0.2	ND	0.36	0.04	**1**	ND	**1.6**	ND	ND	**0.59**	ND
Dibenz(a,h)anthracene	0.014	ND	**0.27**	ND	ND	ND	ND	**0.05**	ND	**0.062**	ND	**0.2**	ND	**0.2**	ND	ND	**0.15**	ND
Fluoranthene	50	4.7	6.5	ND	ND	ND	ND	ND	ND	0.6	0.07	0.8	ND	5.3	ND	ND	0.52	ND
Fluorene	50	7.2	6.4	ND	ND	ND	ND	0.34	ND	ND	ND	0.05	ND	0.6	ND	ND	0.43	ND
Indeno(1,2,3-cd)pyrene	3.2	0.77	0.97	ND	ND	1	ND	0.31	ND	0.24	ND	1.1	ND	0.9	ND	ND	0.66	ND
Naphthalene	13	13	5.2	ND	ND	ND	ND	ND	ND	ND	ND	0.05	ND	0.6	ND	ND	0.14	ND
Phenanthrene	50	20	23	ND	ND	ND	ND	0.13	ND	0.3	ND	0.3	ND	6.2	ND	ND	0.18	ND
Pyrene	50	7.6	9.5	ND	ND	4.7	ND	1	ND	0.63	0.09	1.5	ND	4.8	ND	ND	0.63	ND
Total PAHs (mg/Kg)	500	79	81	ND	ND	10	0.063	2.9	ND	3.7	0.313	10	ND	28	ND	ND	6	ND
Total CPAH (mg/Kg)	NA	9.4	13.3	ND	ND	3.9	ND	1.4	ND	1.9	0.138	6	ND	8	ND	ND	3	ND

Notes:
ND = The material was analyzed for but not detected at, or above, the reporting limit.
Bold value - compound detected in concentration greater than SCG.
(Note 1) - NYSDEC TAGM HWR-94-4046 - Determination of Soil Cleanup Objectives and Cleanup Levels [NYSDEC, Jan. 1994].
NA - Not Applicable

Appendix C
Table C-3
Groundwater Summary Table

Sample Designation / Date Sampled	NYSDEC Standard Value (Note 1)	Concentration Range Detected	Frequency Exceeding SCG	MW1D 11/4/04	MW2 11/4/04	MW3D 11/4/04	MW3S 11/4/04	MW5 11/4/04	MW6 11/4/04	MW9D 11/5/04	MW10S 11/3/04	MW10I 11/4/04	MW100I 11/4/04 Duplicate MW10I	MW10D 11/4/04	MW11 11/5/04
Volatile Organic Compounds (ug/Kg)															
Benzene	1 s	ND - 150	9/33	**150**	**19**	ND	**32**	**64**	ND	ND	ND	**2**	**2**	ND	**1.3**
Ethylbenzene	5 s	ND - 540	9/33	**510**	**68**	ND	**140**	**540**	ND	ND	ND	ND	ND	ND	**8.1**
Toluene	5 s	ND - 16	3/33	**16**	2.4	ND	**5.7**	**14**	ND	ND	ND	ND	ND	ND	ND
Xylenes (total)	5 s	ND - 310	11/33	**270**	**56**	ND	**120**	**310**	ND	ND	ND	**22**	**23**	ND	**7.7**
Total BTEX (ug/Kg)	NL	ND - 946	NA	946	145.4	-	297.7	928	-	-	-	24	25	-	17.1
PAH Compounds (ug/Kg)															
2-Methylnaphthalene	NL	ND - 170	NA	170	ND	ND	34	24	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	20 g	ND - 170	11/33	**170**	**30**	ND	**79**	**69**	ND	ND	ND	**61**	**75**	ND	13
Acenaphthylene	NL	ND - 17	NA	17	6	ND	11	ND	ND	ND	ND	11	13	ND	ND
Anthracene	50 g	ND - 1.9	0/33	14	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	1.5
Benzo(a)anthracene	0.002 g	ND	0/33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND - 0.99	1/33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002 g	ND	0/33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	NL	ND - 1.7	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002 g	ND	0/33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.002 g	ND	0/33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	NL	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	50 g	ND - 4.2	0/33	4.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7
Fluorene	50 g	ND - 53	1/33	**53**	7.2	ND	26	31	ND	ND	ND	3.1	1.1	ND	3.8
Indeno(1,2,3-cd)pyrene	0.002 g	ND - 1.1	1/33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10 g	ND - 3100	8/33	**3100**	**66**	3	**940**	**1000**	ND	ND	ND	**31**	**47**	1	**13**
Phenanthrene	50 g	ND - 75	1/33	**75**	3.1	ND	38	47	ND	ND	ND	ND	ND	ND	4.9
Pyrene	50 g	ND - 3.9	0/33	3.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7
Total PAHs	NL	ND - 3607	NA	3607.1	112.3	3	1128	1171	-	-	-	103	137.2	1	39.6
Total CPAHs	NL	ND - 2.09	NA	-	-	-	-	-	-	-	-	-	-	-	-

Sample Designation / Date Sampled	MW12 11/5/04	MW13 11/5/04	MW14S 11/4/04	MW15S 11/5/04	MW16S 11/5/04	MW17I 11/3/04	MW17S 11/4/04	MW18I 11/3/04	MW19S 11/3/04	TW1 9/17/04	TW1 11/4/04	TW2 9/17/04	TW2 11/4/04	TW3(10) 11/3/04	TW3(20) 11/3/04	TW3(30) 11/3/04	TW4 9/17/04	TW4 11/3/04	TW40 11/3/04 Duplicate TW4	TW5 9/17/04	TW5 11/3/04
Volatile Organic Compounds (ug/Kg)																					
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**22**	**7.3**	ND	12	9.8	9.3	ND	ND
Ethylbenzene	ND	ND	ND	**330**	ND	ND	ND	ND	ND	ND	ND	ND	ND	**26**	**14**	ND	**43**	2.7	2.3	ND	ND
Toluene	ND	ND	ND	3.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes (total)	ND	ND	ND	**200**	ND	ND	ND	ND	ND	ND	ND	ND	ND	**24**	**6.4**	ND	**4.6**	3.1	2.8	ND	ND
Total BTEX (ug/Kg)	-	-	-	533.7	-	-	-	-	-	-	-	-	-	72	27.7	-	59.6	15.6	14.4	-	-
PAH Compounds (ug/Kg)																					
2-Methylnaphthalene	ND	ND	ND	52	ND	1.2	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	86	ND	5	1.5	ND	ND	ND	ND	ND	1.7	**58**	**30**	ND	**47**	**35**	**28**	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	9.5	4.9	11	ND	2.3	1.7	1.6	ND	ND
Anthracene	ND	ND	ND	ND	ND	1.3	1.9	ND	ND	ND	ND	ND	9.5	2.3	ND	ND	1.8	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	**0.99**	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	ND	ND	ND	ND	ND	ND	1.7	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	1.3	3.3	2	ND	ND	ND	ND	9.5	ND	ND	ND	1.7	1.8	1.7	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	ND	9.5	6.7	2.3	ND	13	1.7	1.4	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	**1.1**	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	**1800**	ND	ND	ND	ND	ND	ND	ND	ND	9.5	2.5	ND	ND	3.7	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	36	ND	ND	1.8	ND	ND	ND	ND	ND	9.5	8.8	1.3	ND	8	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	1.5	3.9	1.8	ND	ND	ND	ND	9.5	ND	ND	ND	2.1	2	1.9	ND	ND
Total PAHs	-	-	-	1974	-	10.3	19.39	3.8	-	-	-	-	1.7	83.2	44.6	-	79.6	42.2	34.6	-	-
Total CPAHs	-	-	-	-	-	-	2.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table D-1
Soil and Groundwater
Chemical-Specific SCGs and TBCs

Port Jervis MGP Site

MEDIA	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Soil	NYSDEC Soil Cleanup Objectives	NYSDEC HWR-94-TAGM 4046	Establishes soil screening-level objectives based on residential land use and protection of groundwater quality.	SCG	Specified screening-level goals may be applicable in determining site-specific soil objectives.
Groundwater	NYSDEC Groundwater Objectives	NYSDEC, Division of Water, TOGS (1.1.1) - 6 NYCRR 703.5	Establishes guidance or standard values for groundwater quality objectives.	SCG	May be applicable in determining site-specific groundwater objectives.
Surface Water	NYSDEC Surface Water Objectives	NYSDEC, Division of Water, TOGS (1.1.1) - 6 NYCRR 703.5	Establishes guidance or standard values for surface water quality objectives.	SCG	May be applicable for determining site-specific surface water objectives and objectives for groundwater impacts to surface water. Class A surface water objectives are applicable.

SCG - Standards, Criteria, and Guidance

TBC - Other Criteria To Be Considered

Table D-2
Soil and Groundwater
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Water Treatment Discharge	New York State Regulations on the State Pollution Discharge Elimination System (SPDES)	6 NYCRR Parts 750-758	State Pollution Discharge Elimination System Permitting Requirements	SCG	Partially applicable for remedial activities involving direct discharge back into the Delaware River.
	New York State Water Classifications and Quality Standards	6 NYCRR Parts 701, 702, 704	Defines surface water classifications and ambient water quality standards which are the basis for the SPDES effluent limitations	SCG	The Delaware River is classified as a Class A surface water body.
	NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1	Compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in NYSDEC programs (i.e., SPDES)	TBC	These standards and guidance values are applicable in establishing discharge limitations to surface waters.
	Clean Water Act	Section 401	Water Quality Certification	SCG	Potentially Applicable
Waste Management	Solid Waste Management Facility	6 NYCRR 360	Includes solid waste disposal requirements	SCG	Applicable for soil removal
	Waste Transporter Permits	6 NYCRR 364	Requires that wastes be transported by permitted waste haulers	SCG	Applicable for soil removal

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Hazardous Waste	Identification and Listing of Hazardous Waste	6 NYCRR 371	Outlines criteria determining whether solid waste is hazardous and subject to regulations under 6 NYCRR Parts 370-376	SCG	Excavated soil will need to be analyzed and determined if it is classified as hazardous.
	Hazardous waste manifest system and related standards for generators, transporters, and facilities.	6 NYCRR 372; 40 CFE 263	Must be met when hazardous waste is being disposed of off-site	SCG	If the soil is classified as hazardous, it will need to be transported following these regulations.
MGP-Impacted Soil	Management of soil and sediment impacted with coal tar from Manufactured Gas Plants	NYSDEC TAGM 4060 and NYSDEC TAGM 4061	This guidance outlines the criteria for MGP coal tar waste. Soils and sediment only exhibiting the toxicity characteristic for benzene (D018) may be conditionally excluded from the requirements of 6 NYCRR Parts 370-374 and 376 when they are destined for permanent thermal treatment	SCG	Applicable for off-site treatment and disposal.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Generation, Management, and Treatment of Hazardous Waste	**Federal:** Resource Conservation and Recovery Act (RCRA) Subtitle C – Hazardous Waste Management				
	Identification and Listing of Hazardous Wastes	40 CFR Part 261	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 40 CFR Parts 260-266	SCG	These regulations do not set clean-up standards, but would apply to the classification of all MGP-impacted soils and residual waste streams generated during activities such as on-site thermal treatment.
	Hazardous Waste Determinations	40 CFR Part 262.11	Generators must characterize their wastes to determine if the waste is hazardous by listing (40 CFR 261, Subpart D), by characteristic (40 CFR 261, Subpart C), or excluded from regulation (40 CFR 261.4)	SCG	Neither coal tars nor petroleum-based residuals are listed hazardous wastes but may be hazardous by characteristic (particularly for benzene toxicity).
	Manifesting	40 CFR 262, Subpart B	Generators must prepare a Hazardous Waste Manifest (EPA form 8700-22) for all off-site shipments of hazardous waste to disposal or treatment facilities	SCG	Will apply to all off-site shipments of RCRA/NYSDEC hazardous wastes.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Generation, Management, and Treatment of Hazardous Waste (Cont'd.)	Recordkeeping	40 CFR 262.40	Generators must retain copies of all hazardous waste manifests used for off-site disposal	SCG	Generators must retain copies of waste manifests for a minimum period of three years after shipment date.
	Labeling and Marking	40 CFR 262, Subpart C	Specifies EPA marking, labeling, and container requirements for off-site disposal of hazardous waste	SCG	Pre-transportation requirements for off-site shipments of hazardous wastes.
	Accumulation Limitations	40 CFR Part 262.34	Allows generators of hazardous waste to store and treat hazardous waste at the generation site for up to 90 days in tanks, containers, and containment buildings without having to obtain a RCRA hazardous waste permit	SCG	Hazardous wastes may be stored for up to 90 days on site without the need for a storage permit unless NYSDEC waives the 90-day limit as an administrative requirement. Requirement will likely apply to coal tar or purifier wastes that contain little or no soil and treatment residuals that are characteristically hazardous.
	Standards for Owners/Operators of Hazardous Waste Treatment, Storage, Disposal (TSD) Facilities	40 CFR Part 264/265 Subpart B	General requirements for owners/ operators of TSD facilities including general waste analysis and compatibility, notices and inspection requirements, location and construction standards, and security	SCG	These subpart standards would be applicable to the on-site management of hazardous waste soils and sediments in tanks, containers, or containment buildings.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Generation, Management, and Treatment of Hazardous Waste (Cont'd.)	Closure and Post-Closure	Subpart G	Establishes closure and post-closure requirements for hazardous waste treatment and storage units	SCG	These regulations are potentially applicable for remediation activities that would involve the construction of upland hazardous waste management facilities.
	Container Management	Subpart I	Hazardous waste stored in containers must comply with management requirements, including types of containers used, waste compatibility, and inspection requirements	SCG	Applicable to storage and/or treatment of hazardous wastes in containers on site.
	Tank Systems	Subpart J	Tank Systems for the treatment or storage of hazardous wastes are to be designed and operated in a manner to prevent releases to the environment	SCG	Applicable for the tank treatment and/or storage of all site-generated wastes classified as hazardous.
	Containment Buildings	Subpart DD	Containment buildings must be designed, constructed, and operated to meet regulatory performance standards	SCG	Standards applicable to the construction of containment buildings used to treat and/or store hazardous waste.
	Siting of Industrial Hazardous Waste Facilities	6 NYCRR Part 361	Establishes procedures for selecting appropriate sites for hazardous waste facilities	SCG	These regulations are potentially applicable for remediation activities that would involve the construction of upland hazardous waste management facilities.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Generation, Management, and Treatment of Hazardous Waste (Cont'd.)	NYSDEC Division of Hazardous Substances Regulation				
	Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 372-376	SCG	These regulations do not set clean-up standards, but would apply during the on-site management of excavated hazardous waste soils and the upland management of excavated sediments and residual waste streams generated during remedial activities.
	New York State Hazardous Waste Management Facility Regulations	6 NYCRR Part 370, 373, 372	Establishes New York State's USEPA equivalent hazardous waste management program. Includes regulations for hazardous waste facility construction, operation, and closure, and standards for hazardous waste generation, manifesting, and transport	SCG	(See RCRA Hazardous Waste Management Regulations. 40 CFR Parts 263 and 264/265 under Federal SCGs listed in this table.)
	Management of Soils impacted with Coal Tar from Former Manufactured Gas Plants Policy	NYSDEC Division of Environmental Remediation, Technology Section	Addresses management of MGP-contaminated soils within defined Areas of Contamination (AOCs) and allows for consolidation of such soils under specified circumstances without triggering LDR requirements	TBC	Provisions are consistent with USEPA Area of Contamination (AOC) policy. The provisions will be referenced in developing and evaluating MGP-impacted soil remediation alternatives.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Off-site Management of Non-hazardous Waste	RCRA Subtitle D	42 U S C Section 6901 et seq.	State and local governments, in accordance with EPA's guidance, are the primary planning, regulating, and implementing entities for the management of non-hazardous solid waste, such as household garbage and non-hazardous industrial solid waste	SCG	May be applicable if the soil is removed from site.
	Criteria for Classification of Solid Waste Disposal Facilities	40 CFR Part 257	Minimum criteria for siting, construction, operation, and closure of solid waste disposal facilities	SCG	Requirements potentially applicable to the onsite disposal of excavated soil and associated waste streams
	New York State Solid Waste Management Facility Regulations	6 NYCRR Part 360, 364	Establishes New York State's USEPA equivalent solid waste management program. Includes regulations governing construction, operation, and closure of solid waste disposal facilities.	SCG	These regulations are potentially applicable to remediation activities involving the upland management and disposal of non-hazardous wastes. Coal tars and petroleum-based site residuals must be identified as solid and/or hazardous waste in order to determine applicability of waste management requirements.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Off-site Management of Hazardous Waste	RCRA Subtitle C	40 U S C Section 6901 et seq.			
	Standards for Capping	40 CFR Part 264/265	Regulations governing placement of caps or similar barriers over hazardous waste and requirements for installation, permeability, maintenance of cover, elimination of free liquids or solidification, run-on/run-off damage control, and post-closure use of property	SCG	Requirements potentially applicable to the upland disposal of hazardous waste, excavated sediments, and associated residual waste streams.
	Surface Requirements	Subpart K			
	Waste Piles	Subpart L			
	Landfills	Subpart N			

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Air Emissions from a Point Source	Clean Air Act (CAA)				
	New Source Review (NSR) and Prevention of Significant Deterioration (PSD) Requirements	40 CFR Part 52	New sources or modifications which emit greater than the defined threshold for listed pollutants must perform ambient impact analysis and install controls which meet best available control technology (BACT)	SCG	These regulations are potentially applicable and would require a comparison of potential emissions from the remedial activity to the emission thresholds for NSR.
	National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61; 40 CFR Part 63	Source-specific regulations which establish emissions standards for hazardous air pollutants (HAPs)	SCG	NESHAPs may be applicable if emissions from remediation activities exceed the thresholds for compliance.
	New Source Performance Standards (NSPS)	40 CFR Part 6	Source-specific regulations which establish testing, control monitoring, and reporting requirements for new emission sources	SCG	NSPS could be relevant and appropriate if steam-generating equipment, thermal desorption units, or other regulated new sources were to be used off site.
	New York State Air Pollution Control Regulations	6 NYCRR Parts 120, 200-203, 207, 211, 211, 212, 219, Air Guide-1	Establishes emissions standards for new sources of air pollutants and specific contaminants	SCG	Requirements would be applicable to remediation alternatives that result in emissions of air contaminants, including particulate matter.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Air Emissions from a Point Source (Cont'd.)	New York State Ambient Air Quality Standards	6 NYCRR Part 257	Establishes state ambient air quality standards and guidelines for protection of public health	SCG	May be applicable in evaluating air impacts during remediation activities. Establishes short-term exposure action limits for occupational exposure.
	Fugitive dust suppression and particulate monitoring	NYSDEC TAGM 4031	Fugitive dust suppression and particulate monitoring during source area remedial activities	SCG	For implementation under a site health and safety plan during remedial activities.
	Community Air Monitoring Plan (CAMP)	NYSDOH	Air Quality Requirements	SCG	For implementation under a site health and safety plan during remedial activities.
Land Disposal of Hazardous Waste	RCRA Subtitle C				
	Land Disposal Restrictions (LDRs)	40 CFR Part 268	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes Universal Treatment Standards (UTSs) to which hazardous wastes must be treated to prior to land disposal. Phase IV rule revision establishes Alternate Treatment Standards for Soils containing hazardous wastes.	SCG	Petroleum-based residuals are subject to LDRs, including UTSs. Wastes exhibiting a hazardous characteristic would need to be treated to meet UTS for all hazardous constituents present in the residuals prior to any upland disposal. Characteristically hazardous soils can be treated to meet the UTS standards or to meet the alternative treatment standards for RCRA hazardous soils.

Table D-2
Soil and Groundwater (Continued)
Action-Specific SCGs and TBCs
Port Jervis MGP Site

ACTION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Characteristic Hazardous Waste Soil Management	MGP Site Remediation Strategy	MGP Site Remediation Strategy MGP Subcommittee, Edison Electric Institute (EEI, 1993)	Strategy document intended to facilitate responsible parties undertaking the source removal of heavily contaminated organic residues and contaminated soils at MGP sites in a manner that is consistent with the RCRA hazardous waste program. The remediation strategy is based on the fact that RCRA hazardous materials may be blended on site and de-characterized prior to off-site transport and disposed of at a permitted facility. It covers relevant on-site activities including characterization, excavation, accumulation and treatment in 90-day units, and off-site transportation.	TBC	The remediation strategy applies only to the management of excavated solid materials that are hazardous by characteristic. The strategy does not supersede existing regulations, it is not intended to be the presumptive remedy under CERCLA, nor can it serve as a shield against enforcement under RCRA or any other statute. The strategy should be implemented taking into account site-specific circumstances. It would not necessarily be appropriate or practical at all sites.

Table D-3
Soil and Groundwater
Location-Specific SCGs and TBCs
Port Jervis MGP Site

LOCATION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Entire Site	Orange County	General regulations	County transportation and site use regulations	TBC	Requirements of County and City would be applicable to all remediation alternatives, especially those requiring transportation.
	City of Port Jervis	General ordinances	City regulations regarding transportation, noise, etc.	TBC	
Floodplains	Executive Order 11988- Floodplain Management	40 CFR 6, Subpart A; 40 CFR 6.302	Activities taking place within flood plains must be done to avoid adverse impacts and preserve the beneficial values in floodplains	SCG	Activities may occur within the floodplain of the Delaware River
	Floodplain Management Regulations	6 NYCRR Part 500	Establishes floodplain management requirements	SCG	Activities may occur within the floodplain of the Delaware River
	100-year flood plain regulations	Federal Emergency Management Agency	Administers floodplain management requirements	SCG	Activities may occur within the floodplain of the Delaware River
Wetlands/Waters of the U.S.	Executive Order 11990- Protection of Wetlands	40 CFR Part 6 Subpart A	Activities taking place within wetlands must be done to avoid adverse impacts	SCG	No jurisdictional wetlands at site. Not applicable.
Critical Habitat	Endangered Species Act and Fish and Wildlife Coordination Act	16 USC 661; 16 USC 1531	Actions must be taken to conserve critical habitat in areas where there are endangered or threatened species	SCG	Potential threat to endangered or threatened species from site-related impacts is low.

Table D-3
Soil and Groundwater (Continued)
Location-Specific SCGs and TBCs
Port Jervis MGP Site

LOCATION	REQUIREMENTS	CITATION	DESCRIPTION	SCG or TBC	COMMENT
Historic Preservation	New York State Department of Parks, Recreation, and Historic Preservation	Historic Preservation Act	Establishes requirements for the identification and preservation of historic and cultural resources	SCG	Would be applicable to the management of historic or archeological artifacts identified on the site. A No Findings determination is required prior to excavation.