EXECUTIVE SUMMARY

This Feasibility Study (FS) report has been prepared in accordance with the terms of the Order on Consent, Index No. D2-0001-98-04, agreed to by KeySpan Corporation (KeySpan) and the New York State Department of Environmental Conservation (NYSDEC) regarding the former Clifton Manufactured Gas Plant (MGP) site (the Site). The Site is currently divided into two parcels of land (i.e., 25 Willow Avenue and 40 Willow Avenue). This FS satisfies one of the goals of the Order on Consent, which is to prepare an FS for the 40 Willow Avenue Parcel, Operable Unit 1 (OU-1). OU-1 includes the 40 Willow Avenue Parcel of the Former Clifton MGP Site, an adjacent property located at 66 Willow Avenue and eight (8) privately owned residential properties which front Lynhurst Avenue.

This FS was completed in compliance with the United States Environmental Protection Agency (USEPA), National Oil and Hazardous Substances Pollution Contingency Plan (USEPA, 1994), the USEPA guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA – Interim Final" (USEPA, 1988), the New York State Department of Environmental Conservation (NYSDEC) guidance document entitled "Guidelines for Remedial Investigation/Feasibility Studies, TAGM 4025" (NYSDEC, 1989), and the NYSDEC guidance entitled "Selection of Remedial Actions at Inactive Hazardous Waste Sites, TAGM 4030" (NYSDEC, 1990). These requirements and guidance documents prescribe a step-wise approach to the identification, evaluation, comparison, and recommendation of remedial alternatives.

This FS addresses the presence of source materials (i.e., non-aqueous phase liquids (NAPL)) tar in the subsurface soil within OU-1. The term non-aqueous phase liquid (NAPL) is utilized to describe a fluid that is immiscible is water and tends to remain as a separate undissolved liquid in the subsurface.

E.1 FS APPROACH

The former Clifton MGP Site has been the subject of several investigations, a qualitative human exposure assessment, and an interim remedial measure (IRM) to abate lead in surface soils of adjacent private properties. The Order on Consent governing project activities establishes a risk-based framework for the development and execution of remedies as long as acceptable remedial action objectives (RAOs) are identified and met.

The FS process begins with the establishment of RAOs to address the risks posed by the Site contaminants. General response actions (GRAs) are then developed in order to address the RAOs. Technologies applicable to each GRA are identified and screened; representative process options that pass the initial screening are combined to form remedial alternatives. The remedial alternatives are screened to determine which alternatives are candidates for detailed evaluation, in which each retained alternative is evaluated individually against NYSDEC's seven criteria as stated in the "Guidelines for Remedial Investigation/Feasibility Studies, TAGM 4025"

(NYSDEC, 1989). This is followed by a comparative analysis and the conceptual plan for the preferred remedial alternative.

E.2 SUMMARY OF REMEDIAL INVESTIGATION

The Remedial Investigation (RI) was performed between February 1999 and June 2002 by GEI Consultants, Inc. In addition, an IRM was performed to address the presence of soils impacted by lead-based paint residues. The Draft RI report (GEI Consultants, 2002) concluded the following:

- The on-site OU-1 soils contain various chemical constituents related to the gas manufacturing processes that occurred previously at the Site.
- The overall extent of tar, staining, sheen, odors, and chemical constituents detected in soils was located primarily within, beneath, and immediately adjacent to the former Relief Holder No. 2 on the 40 Willow Avenue Parcel.
- The vertical extent of tar ceased prior to encountering the saprolite (weathered bedrock). The saprolite is located at a depth of approximately 125 feet below grade surface (bgs).
- Tar-related observations were noted at discrete soil intervals south of the former holder area underneath the Lynhurst Avenue properties at depths greater than 24 feet bgs. These deeper tar-related observations are not associated with a potential exposure pathway based on samples of the shallow groundwater in this area that do not exhibit impacts from the deeper tar-related materials.
- Benzene, toluene, ethylbenzene and xylene (BTEX) compounds were the principal volatile organic compounds (VOCs) detected at OU-1 and are the common VOCs associated with tar.
- Semi-volatile organic compounds (SVOCs) were also detected at the Site, with polyaromatic hydrocarbons (PAHs) being the common subset of SVOCs in tar.
- In general, elevated levels of total polyaromatic hydrocarbons (TPAHs), carcinogenic PAHs (CPAHs), and BTEX correlated with the occurrence of observable tar, odor and/or sheen.
- Analytical data from surface soil samples obtained from the Lynhurst Avenue properties noted the presence of lead at elevated concentrations. These soils were addressed and removed during the Interim Remedial Measure (IRM) conducted at the site.
- Migration of NAPL at OU-1 has been shown to be predominately vertical, although there is a horizontal flow component, which results in the migration of free product towards the OU-1 boundaries.

In the RI Report, the term NAPL is used to indicate the visual observation of tar-saturated material or soil containing tar blebs or tar lenses. A light NAPL (LNAPL) is a NAPL with a specific gravity less than that of water resulting in a material that would float on water. Conversely, a dense NAPL (DNAPL) is one that has a specific gravity greater than that of water resulting in a NAPL that will sink in water.

E.3 PREVIOUS INTERIM REMEDIAL MEASURES

KeySpan conducted an IRM to address the presence of soils impacted by lead-based paint residues identified during the performance of the RI activities. The objective of the IRM was to mitigate potential risks and eliminate any potential contact by the occupants of the residential dwellings on Lynhurst Avenue. The IRM activities were conducted in accordance with an NYSDEC-approved Work Plan (FWENC, 2002) between September 2002 and September 2003.

The IRM removed surficial soils impacted by lead-based paint residues in the areas to the south and southeast of former Relief Holder No. 2 and along the adjacent Lynhurst Avenue properties. Completion of the IRM has successfully eliminated direct contact exposure pathways and mitigated the risks presented by the previously lead impacted soils.

E.4 QUALITATIVE HUMAN EXPOSURE ASSESSMENT

As part of the RI (GEI Consultants, 2002) a Qualitative Human Exposure Assessment and Fish and Wildlife Impact Analysis was performed by Vanasse Hangen Brustlin, Inc. (VHB). This assessment considered the chemical distribution at the site in terms of potential human exposure and impact(s) to fish and wildlife.

Chemicals of potential concern (COPCs) were identified based on validity of the analytical results, frequency of occurrence, concentrations relative to natural (background) levels, toxicological, physical, and chemical characteristics.

40 Willow Avenue Parcel

The Qualitative Human Exposure Assessment performed during the RI identified that, under future use conditions, absent any remedial measures, exposure to soil and groundwater are potential pathways of concern.

Lynhurst Avenue Properties

After completion of the IRM, no remaining exposure pathways of concern were identified.

E.5 MEDIA OF CONCERN

The findings of the various investigations were analyzed to define those environmental media that are of greatest concern due to the level of contamination and/or potential for risk to the public health and/or the environment. The following media are of concern:

Source Materials. The focus of this FS is the remediation of dense non-aqueous phase liquids (DNAPL) source materials within the OU-1 area. The results of investigations performed to date have demonstrated that, by far, the majority of potential source material in OU-1 is located within, beneath and in the immediate vicinity of Former Relief Holder No. 2. The NAPL

present at the site originated from former Relief Holder No. 2 and has migrated downward through the underlying permeable fill and soils. Some indications of lateral migration of NAPL to the south away from the 40 Willow Avenue Parcel has been documented at depths of approximately 40 to 50 feet bgs. These areas are presented on Figures E-1 and E-2. As compared to the amount of tar related material observed remaining beneath the former holder area, the materials that have migrated represent a minor fraction of the remaining potential source materials on-site. Furthermore, the location of this NAPL at a great depth under residential structures combined with the limited amount of material observed significantly diminishes the practicality of addressing its presence.

The remedial alternatives considered in this FS for OU-1 will address the remaining significant NAPL source areas located within, beneath and in the immediate vicinity of former Relief Holder No. 2 on the 40 Willow Avenue Parcel.

Soil. The investigations performed previously at OU-1 show that soil, especially subsurface soil, is contaminated by substances common to the operations of MGP sites. Therefore, it is a medium of concern requiring appropriate management.

E.6 CONTAMINANTS OF POTENTIAL CONCERN

Based on the findings of the RI, several chemicals were identified as being of concern due to their potential associated risks or hazards. These contaminants of potential concern include BTEX, which are constituents of gasoline; SVOCs, predominately present in the form of PAHs, which are constituents of common road asphalt and inorganic compounds, mostly metals.

E.7 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) have been developed for the purpose of evaluating the applicability of remedial technologies and the effectiveness of remedial alternatives.

The following four risk-based RAOs are deemed appropriate for Site remediation at OU-1:

1. Eliminate, to the extent practical, direct contact with surface and subsurface soil contaminants at concentrations exceeding SCGs;
2. Eliminate, to the extent practical, ingestion of surface and subsurface soil contaminants at concentrations exceeding SCGs;
3. Eliminate, to the extent practical, migration of DNAPL in the subsurface soil; and,
4. Prevent, to the extent practical, groundwater contact with source materials.

E.8 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

In order to develop feasible alternatives that address the established RAOs, potentially applicable technologies were identified and screened. Technologies were categorized into General Response Actions (GRAs). The results of the technology screening are presented in Table E-1, which lists the potentially applicable technologies and process options retained for alternative development.

TABLE E-1
RETAINED TECHNOLOGIES AND PROCESS OPTIONS

General Response Actions	Remedial Technology Types	Process Options	Retained Process Options
No Action	Site Reviews	Site Reviews	✓
Limited Action	Access Restrictions	Access Restrictions	✓
	Institutional Controls	Deed Restrictions	✓
		Health and Safety Plan	✓
	Monitoring	Monitoring and Site Reviews	✓
Containment	Capping	Soil	✓
		Clay	✓
		Asphalt	✓
		Multi-Media /Engineered	✓
	Barrier Walls	Sheet Piling	✓
		Slurry Walls	✓
		Grout Curtain	✓
Removal / Treatment/ Disposal	Removal	Excavation	✓
		Steam stripping (DUS)	✓
		NAPL Collection and Extraction	✓
	In situ Treatment	Soil Vapor Extraction	
		Soil Flushing / Washing	
		Stabilization / Solidification	✓
		Biodegradation	✓
		Chemical Oxidation	✓
	Ex situ Treatment	Recycling / Reuse	✓
		Stabilization / Solidification	✓
		Thermal Desorption	✓
		Incineration	✓
		Vitrification	
		Phytoremediation	
		Biodegradation	
		Soil Flushing / Washing	
		Soil Vapor Extraction	
	Disposal	On-site Reuse	✓
		On-site Landfill	
		Off-site Disposal	✓

E.9 DEVELOPMENT, EVALUATION, AND COMPARISON OF REMEDIAL ALTERNATIVES

Remedial alternatives were developed by combining the retained process options listed in Table ES-1. The No Action alternative was included as a baseline for comparing other alternatives. Assembling alternatives required an assessment and understanding of significant differences between technologies. By evaluating the differences between technologies, it was possible to select the best candidates for alternative evaluation, comparison, and cost estimating. A total of four alternatives were assembled by various combinations of the options being considered:

- Alternative S-1: No Action
- Alternative S-2: Containment via Vertical Barriers and Capping
- Alternative S-2A: Containment via Vertical Barriers, Capping and Holder Removal
- Alternative S-3: Removal of Soils Containing Source Materials
- Alternative S-4: *In situ* Stabilization/Solidification of Source Materials

Alternative S-1: No Action is the statutory No Action alternative, providing a basis of comparison for all other alternatives. The No Action alternative includes no remedial activities at OU-1. Five-year reviews would be performed to assess any changes in the risk to human health and the environment posed by the Site.

Alternative S-2: Containment via Vertical Barriers and Capping consists of surface and subsurface containment mechanisms, thereby encapsulating the product source areas and inhibiting contact between impacted soil within the barrier and groundwater outside the barrier. The subsurface containment wall would be keyed into the saprolite layer to isolate the product source and prevent DNAPL migration. The limited amount of DNAPL observed beyond and south of the proposed containment barrier will be hydraulically disconnected and isolated from the parent source area located beneath the former holder area. As such, the limited amount of DNAPL will be inhibited from further migration. For the purpose of developing the containment alternative, a jet grout curtain was identified as a representative vertical barrier process option. The portions of OU-1 not currently surfaced with pavement (i.e., the holder area) would be subject to excavation activities consisting of the removal of the top one foot of materials. These materials would be removed to install a suitable subgrade (i.e., six inches of compacted clean stone) and an engineered cap, covering an area of approximately one-half of an acre. These soils, and any excess soil-grout mixture which may develop at the top of the grout injection area, would be transported off-site for subsequent treatment and disposal. Additionally, these remedial alternatives include the installation of wells within the containment cell for the passive recovery of DNAPL as well as the monitoring of groundwater level measurements and hydraulic heads for comparison to these values outside of the containment cell to demonstrate the efficacy of the hydraulic integrity of the groundwater system. Further, this alternative also incorporates Institutional Controls.

Alternative S-2A: ***Containment via Vertical Barriers, Capping and Holder Removal*** consists of all of the elements of Alternative S-2, including surface and subsurface containment remedies,

capping, passive recovery wells and institutional controls. In addition, this alternative includes the removal of the foundation structure associated with former Relief Holder No. 2, the contents of the holder and impacted soils located in the immediate area of the holder foundation structure that will need to be excavated to facilitate safe, efficient and complete removal of the holder foundation structure. The removal of the holder structure addresses the historic source of the media of concern. In order to avoid adverse impacts to the integrity of the proposed containment cell, the sequencing of the alternative would proceed with the removal of the holder structure foundation followed by the installation of the containment cell. The excavation of soils would proceed to a depth corresponding with the bottom of the holder foundation structure (i.e., approximately 18 feet bgs. A shoring system would be installed to secure the integrity of the excavation walls. Once completed, the excavation would be backfilled with certified clean fill imported from an off-site source and the site would be restored to a grade approximately one foot below pre-disturbance grade to facilitate the installation of the cap system. Soils, construction debris (holder foundation materials) and excess soil-grout mixture which may develop at the top of the injection area, would be transported off-site for subsequent treatment and disposal. Blending of excavated materials would be performed on-site to reduce moisture content and improve characteristics as required by off-site treatment facilities.

Alternative S-3: Removal of Soils Containing Source Materials consists of excavating soils containing source materials. The excavation of soils would proceed to a depth of 80 feet bgs in the areas underneath and immediately surrounding former Relief Holder No. 2. A 30-inch thick reinforced concrete slurry wall with intermittent internal and corner bracing would be installed concurrent with excavation. Once completed, the excavation would be backfilled with certified clean fill imported from an off-site source and the site would be restored to pre-disturbance grade. The restoration activities would include installing a six (6) inch layer of topsoil and the establishment of permanent vegetative cover over all disturbed areas. Soils removed during the excavation activities would be transported off-site for subsequent treatment and disposal (an estimated 81,000 tons). The contents of former Relief Holder No. 2, as well as the holder structure itself, would also be removed. Blending of excavated materials would be performed on-site to reduce moisture content and improve characteristics as required by off-site treatment facilities. Due to residual contamination at depths below surface grade above soil SCGs that would remain after the implementation of this remedial alternative, it will be necessary to employ Institutional/Engineering Controls such as deed restrictions on future use of the land, maintenance of Site access restrictions (e.g., fencing, lockable gates), a health and safety plan, public education and awareness programs, long-term monitoring, and five-year site reviews.

Alternative S-4: In situ Stabilization/Solidification of Source Materials consists of *in situ* stabilization/solidification, in tandem with an engineered cap and Institutional Controls. These remedial activities would include *in situ* stabilization/solidification of the source materials within, beneath, and around Relief Holder No. 2, as well as the area surrounding soil boring SB-22. *In situ* stabilization/solidification would create a stable cement type matrix in which the product source is trapped and becomes immobile, thus preventing product migration. Since the foundation structure associated with former Relief Holder No. 2 would not be removed, this alternative would include stabilization/solidification of the materials underneath the holder by

penetrating the foundation base. Further, stabilization/solidification of the contents of the holder foundation structure would also be performed as part of this remedial alternative. In addition to the stabilization of the product source materials, an engineered cap would be installed to inhibit exposure to contaminants and restrict stormwater infiltration into the source area. The portions of the Site not currently surfaced with pavement (i.e., the Holder Area) would be subject to excavation activities consisting of the removal of the top one foot of materials. These materials would be removed to install a suitable subgrade (i.e., six inches of compacted clean stone) and the engineered cap. Disposal of any excess soil-grout mixture, which may develop at the top of the injection area, as well as soils removed to establish the engineered cap system, would also be required. As with the other remedial alternatives (with the exception of Alternative S-1: No Action), due to residual contamination above soil SCGs that would remain at depths below surface grade after the implementation of this remedial alternative, it will be necessary to employ Institutional Controls.

Initial Screening of Remedial Alternatives. These alternatives were initially screened based on effectiveness, implementability, and cost. All of the alternatives were retained for detailed evaluation.

Comparison of Remedial Alternatives. The following sections present a brief comparison of the alternatives using the seven criteria required by NYSDEC to evaluate remedial alternatives. The five (5) alternatives retained for detailed evaluation were:

- Alternative S-1: No Action
- Alternative S-2: Containment via Vertical Barriers and Capping
- Alternative S-2A: Containment via Vertical Barriers, Capping and Holder Removal
- Alternative S-3: Removal of Soil Containing Source Materials
- Alternative S-4: *In situ* Stabilization/Solidification of Source Materials

E.9.1 Overall Protection of Human Health and the Environment

Alternative S-1 is the least protective, since it does not contain, remove, or treat contaminants or reduce the risk of exposure, nor does it achieve any of the established RAOs. Alternative S-2 prevents human exposure risks by the use of an engineered capping system and prevents the source material (product) from coming into contact with the surrounding groundwater and continuing to migrate off-site, thereby achieving all of the RAOs. Groundwater monitoring wells, installed in the NAPL zone, will be utilized to passively recover NAPL from within the containment cell as well as to collect groundwater level and head information. This information will be utilized to compare groundwater characteristics within and outside of the containment cell to demonstrate that the containment wall is achieving the goal of containing NAPL. Alternative S-2A would be more protective than Alternative S-2 as a small portion of the source materials and impacted soils would be removed. This alternative would also employ the use of groundwater monitoring wells for passive NAPL recovery and groundwater level monitoring. Alternative S-3 is the most protective of human health exposure risks by removing all soil containing source materials, thereby preventing source materials (product) from coming into

contact with the surrounding groundwater and migrating off-site. The implementation of Alternative S-3 achieves all of the RAOs. Alternative S-4 is also protective of human health risks, since it controls and treats the product source by binding and immobilizing the source material in a chemically/physically fixated matrix, while the engineered cap prevents human exposure to the stabilized/solidified source materials. Alternative S-4 achieves all of the established RAOs for OU-1. Additionally, protection would be achieved over time via the implementation of Alternatives S-2, S-2A, S-3 and S-4 as saturated zone contaminants outside of the vertical barrier perimeter, the removed source area and/or the chemically fixated matrix would be reduced via natural attenuation.

E.9.2 Compliance with New York SCGs

Alternative S-1 does not trigger action-specific or location-specific SCGs, and it does not comply with chemical-specific SCGs. Alternatives S-2, S-2A, S-3 and S-4 can be accomplished in accordance with action- and location-specific SCGs. Chemical-specific SCGs may be achieved via Alternatives S-2 and S-2A, since the source material would be encapsulated and/or partially removed utilizing passive NAPL recovery or by removal of the holder foundation structure and its contents (Alternative S-2A) within the vertical and horizontal barriers. Chemical-specific SCGs would be achieved via Alternative S-3, as the source materials would be removed from the Holder Area. Chemical-specific SCGs would be achieved via Alternative S-4, since the stabilized cementitious mass does not leach any free product into the surrounding subsurface soils. The four alternatives (i.e., S-2, S-2A, S-3 and S-4) do not inherently comply with the SCGs since soil contaminants in excess of the SCGs would still be physically present on-site at depths below surface grade; however, all four alternatives are protective of human health and the environment on OU-1 and natural attenuation mechanisms would reduce saturated zone contamination in the surrounding area.

E.9.3 Long-Term Effectiveness and Permanence

Alternative S-1 would not be effective, since it would not reduce, control, or adequately manage human health risks. Alternatives S-2 and S-2A are both effective at reducing risks, since human exposure would be prevented by the cap and impacts to the environment surrounding OU-1 would be reduced via subsurface vertical barriers. Alternative S-2A provides more effectiveness at reducing risks than Alternative S-2 due to the partial removal of source materials that would occur during the excavation of the holder foundation structure, the contents of same as well as impacted soils that are necessary to be removed to facilitate safe, efficient and complete removal of the holder structure. Residual source materials are also encapsulated within the contained area. Long-term operation and maintenance (O&M) and quality control (QC) measures, as well as land use restrictions, would be required to ensure the effectiveness of these alternatives. Alternatives S-2 and S-2A would require proper grout mix design and controls during installation to ensure the adequacy of the vertical barriers. Maintenance measures would be required to ensure the integrity of the engineered cap, and the reliability of management controls. Alternative S-3 is effective at reducing risks as the soil containing source materials would be

removed from the Site. Alternative S-3 would not require O&M and QC measures. Alternative S-4 is effective at reducing risks via source material immobilization, since the free product would be locked in a cementitious mass. Alternative S-4 would also require O&M and QC measures to ensure the adequacy and reliability of the stabilized matrix. Long-term monitoring would be required for each of the remedial alternatives to ensure that conditions do not worsen beyond the contained/stabilized or excavated areas, since soils exceeding TAGM cleanup levels would still physically remain on-site.

E.9.4 Reduction of Toxicity, Mobility, and Volume

Alternative S-1 offers no reduction in toxicity, mobility, or volume at all, since no treatment would be performed. Alternatives S-2 and S-2A offer reductions in mobility due to the vertical barriers and the engineered cap. Further, both of these remedial alternatives offer a partial reduction in toxicity and volume within OU-1 utilizing passive NAPL recovery or, in the case of Alternative S-2A, the removal of the holder foundation structure and its contents. Encapsulating OU-1 sources will also create an environment conducive to natural attenuation of contaminants in surrounding saturated soils. Alternative S-3 reduces toxicity, mobility and volume of contaminants by removing the soil containing source materials. Alternative S-4 reduces the mobility of the contaminants, since the source material would be locked in the grout matrix. However, Alternative S-4 would not reduce the toxicity or volume, since contaminants would still remain on-site. Alternatives S-2, S-2A, and S-4 significantly reduce product mobility and human exposure, thereby achieving all of the established RAOs. Alternative S-3 eliminates product mobility and human exposure, thereby achieving all of the established RAOs.

E.9.5 Short-Term Effectiveness

There would be no potential risks to workers or the public during implementation of Alternative S-1, since no on-site activities or construction would be performed. The short-term effectiveness of Alternative S-2 would be moderate, since vertical barrier and cap construction would produce some disturbance of OU-1 contaminants at the surface as a result of construction activities, but would not significantly impact heavier contamination in the subsurface. Alternative S-2A would provide similar short-term effectiveness to Alternative S-2 but would impact a larger quantity of heavier contamination in the subsurface. Risks to workers and the public would be minimal and would be mitigated through appropriate health and safety procedures and engineering controls. Alternative S-3 would provide the least short-term effectiveness of the remedial alternatives being considered. This alternative would disturb source materials and the heavier contaminants within the surface and the subsurface at OU-1. Logistical issues involving the size of the site, the large equipment to be utilized, and, the significant number of processes that will be occurring at the site during the implementation of Alternative S-3 result in significant impacts to the surrounding environment and the neighboring community (i.e., noise, odors, dust, traffic). Alternative S-4 would have a lower short-term effectiveness than Alternatives S-2 and S-2A, since *in situ* stabilization/solidification is a larger, more complex operation than encapsulation. Risks to workers and the public would be minimized through appropriate health and safety procedures and engineering controls. Alternatives S-2, S-2A, and S-4 would include an ongoing

construction monitoring program, consisting of perimeter wells, that would be used to assess the near-field effects in the subsurface during the implementation of the remedy. Alternative S-1 does not take any time to implement. The time to implement Alternative S-2, thereby achieving RAOs, is approximately four months; the time to implement Alternative S-2A and achieve the RAOs is approximately eight months. The time to implement Alternative S-3 and achieve the RAOs is approximately 12 months. The estimated time to complete Alternative S-4 and achieve the RAOs is approximately12 months.

E.9.6 Implementability

Technical Feasibility: All of the alternatives evaluated are technically feasible. Alternative S-1 is the easiest to implement, since no remediation activity is employed in this alternative. Alternative S-2 can be implemented, since it involves vertical barriers and an engineered capping system, which are proven and commercially available technologies. However, implementing Alternative S-2 may incur some difficulties due to the limited space for staging activities and may involve the disposal of excess soil-grout material in limited quantities, which may develop at the top of the injection area. Supplementing Alternative S-2 with the holder foundation structure removal in Alternative S-2A presents additional implementability issues including space constraints, the need for an engineering controlled environment, blending and other processes associated with excavation activities. Alternative S-3 is also implementable but presents a host of constructability and logistical challenges including, but not limited to, the following:

- the need to utilize large excavating equipment (i.e., a crane equipped with a 180 foot boom and a clam shell bucket);
- the small size of OU-1 and the spatial concerns for processes associated with the excavation activities (i.e., areas for concrete slurry preparation, staging areas, stockpiling areas, areas of blending and stabilizing activities, areas for the pre-treatment of groundwater generated from dewatering activities, etc.) would require use of portions of OU-2 and would result in impacts to the existing occupant's business;
- the use of Willow Avenue for truck/construction traffic, between OU-1 and OU-2, may require the closure of this street and will impact the surrounding community;
- the need to protect the surrounding community from impacts from noise, dust and odors as the construction of an engineered controlled environment (i.e., a temporary tent structure) is not feasible due to the large size of the equipment necessary to excavate to a depth of 80 feet bgs.
- traffic impacts due to the large volume of delivery and transport trucks as well as construction vehicles that will be entering and exiting the site in support of the excavation activities.

Similarly, Alternative S-4 would also have to be implemented in a very limited space for mobilization and staging, as well as for managing the disposal of excess grout material as a result of "bulking" during *in situ* stabilization/solidification. Alternatives S-2 and S-4 would present similar constructability and logistics challenges. These issues would be increased during the

implementation of Alternative S-2A due to the addition of the holder foundation structure removal activities (i.e., construction of the engineered controlled environment, additional space for stockpiling, staging, blending, treatment of groundwater, etc.) Alternative S-3 would also produce these challenges but on a significantly larger scale. Since there is limited space on-site for mobilization, staging, and blending activities, site areas beyond OU-1 could be utilized during implementation of the remedial alternatives. Potential subsurface structures on-site could create obstacles during remediation, since Alternatives S-2, S-2A, S-3 and S-4 consist of intrusive subsurface remediation at depths of 125 feet bgs for Alternatives S-2 and S-2A and 80 feet bgs for Alternatives S-3 and S-4. However, the equipment used for the implementation of these alternatives can be used to drill, bore and/or remove these subsurface structures (e.g., concrete pads, tank foundations, etc.). Treatability/bench studies would be needed to implement jet grout injection for Alternatives S-2, S-2A and S-4. Alternatives S-2 and S-2A would also require precision surveying, and other construction QC methods to verify the verticality and continuity of the adjacent overlapping grout columns/intersecting jet grout panels.

Administrative Feasibility: All of the alternatives evaluated are administratively feasible. Alternatives S-2, S-2A and S-4 have the same levels of administrative feasibility, while Alternative S-3 has significantly more administrative requirements, and S-1, because it requires "no action" has significantly less. The key administrative requirements for S-2, S-2A and S-4 are coordination and communication with stakeholders; the community and regulatory agencies; the procurement of permits and approvals; and, transportation coordination due to traffic patterns that may potentially be disrupted. S-3 has the same requirements, but more intensive because of the additional activities required. Long-term institutional management (e.g., monitoring, reporting, public coordination) would be associated with all of the alternatives.

Availability of Services and Materials: Services and materials are available for all alternatives. Alternative S-1 requires no services or materials, except for those related to periodic Site reviews. Alternatives S-2 and S-2A require grout-injection services. Alternatives S-2A and S-3 require excavation services. Alternative S-4 requires *in* situ stabilization/solidification services, which are commercially available from multiple vendors. Alternatives S-2, S-2A and S-4 require engineered capping services and materials that are also commercially available.

E.9.7 Cost

No capital or O&M costs are associated with Alternative S-1; the costs incurred from the five-year reviews are considered. The Net Present Value (NPV) of Alternative S-1 is $55,700. The NPV of Alternative S-2 is $4,011,000; the NPV of Alternative S-2A is $13,028,000. The NPV of Alternative 3 is $28,495,000. The NPV of Alternative S-4 is $15,607,000. A summary of the cost estimate is presented in Table E-2.

TABLE E-2
SUMMARY OF COST ESTIMATE

	Capital Cost	Annual O&M Cost	NPV of Five-Year Review	Total NPV
Alternative S-1: No Action	$ 0	$ 0	$ 55,700	$ 55,700
Alternative S-2: Containment via Vertical Barriers and Capping	$ 3,179,000	$ 8,800	$ 55,700	$ 4,011,000
Alternative S-2A: Containment via Vertical Barriers, Capping and Holder Removal	$ 12,196,000	$ 8,800	$ 55,700	$ 13,028,000
Alternative S-3: Removal of Soils Containing Source Materials	$ 27,782,000	$ 1,000	$ 55,700	$ 28,495,000
Alternative S-4: *In situ* Stabilization/ Solidification of Source Materials	$ 14,774,000	$ 8,800	$ 55,700	$ 15,607,000

E.10 SELECTION OF PREFERRED REMEDIAL ACTION ALTERNATIVE

Alternative S-2 is preferred as the most feasible alternative for OU-1, since it achieves all of the RAOs that were established for OU-1, can be implemented effectively with reasonable effort, moderate but only short-term disruption to community activities and at an acceptable cost. The overall Conceptual Plan consists of Alternative S-2 and the common elements. Remedial construction for Alternative S-2 would include the following phases:

1. Installation of the Grout Curtain
2. Construction of the Engineered Cap
3. O&M
4. Institutional Controls

The capital cost for implementation of the preferred remedial alternative (Alternative S-2) is estimated at $3,179,000. The total annual O&M (not including periodic reviews) is estimated to be $8,800. The net present value based on a 30-year period and a five percent discount rate is $4,011,000, including 5-year reviews.