Implementability

No additional remedial activities are proposed for this alternative, and therefore, implementability does not apply.

Cost

There are no remedial costs directly associated with this alternative.

4.2.2 Alternative G2 - Air Sparging

4.2.2.1 Description

Air sparging could be implemented as a stand-alone alternative or in conjunction with the BTEX soil contamination alternative. The alternative would generally be comprised of a system of vertical air sparging points and a vapor extraction system that would remediate the overburden groundwater north of the West Nyack Service Building and south of the Hackensack River. This alternative would be designed to meet the groundwater remedial objectives with respect to the overburden and would also provide for some treatment of the BTEX soils, in the event BTEX soils are not removed as another part of the remedy.

Shallow bedrock groundwater would not be directly affected by this alternative. However, TCE the source of which is believed to be upgradient of the site, is one of the primary contaminants in the fractured bedrock groundwater. Any on-site treatment of bedrock groundwater will not result in any significant reduction of TCE in the bedrock and will not influence long-term TCE concentrations within the bedrock groundwater flow regime.

The concentration of the 1,1,1-TCA, which is potentially Site related, in the shallow bedrock groundwater samples was less than the USEPA National Primary Drinking Water Standard of 200 ug/l. Additionally, a water supply survey performed as part of the Phase II report (LMS, March 1992) indicated that there are no known potable groundwater supplies located within two miles downgradient of the Site.

Due to the presence of a low permeability organic silt layer in parts of the area to be treated, there will be a tendency for sparge air to form "bubbles" beneath the low permeability zone and migrate laterally. This lateral migration may result in vapor entering basements or, over the course of the remedial program, the spread of contaminants to peripheral areas of the site and depositing of the contaminants there. The incidental migraton of contaminants by the application of sparging has been observed at other sites and could potentially be reduced through enhancement of the silt layer's permeability using soil gravel columns.

The area containing the groundwater to be remediated consists of approximately 60,000 square feet north of the Site building and south of the river. No air sparging or vapor extraction pilot tests have been performed to provide site-specific data for estimating sparging point and extraction pipe spacing. The relatively permeable nature of the undifferentiated glacial sand and gravel and the fact that it extends 15 to 20 feet or more below the water table, are favorable conditions for air sparging possibly yielding a radius of influence of 10 to 15 feet. Vapor extraction pipes are expected to have a similar zone of influence. Based on this assumption approximately 70 (based on 30 foot centers) to 150 (based on 20 foot centers) air sparging points would be required to provide full coverage of the impacted overburden groundwater.

To capture the volatilized constituents in the air bubbles rising to the surface of the saturated zone, horizontal vapor extraction piping would be placed near the ground surface in shallow, parallel trenches located approximately 20 to 30 feet apart. Horizontal piping is likely to be more effective than vertical vapor extraction points due to the shallow groundwater table (3 to 6 feet below ground surface) and the potential for mounding as a result of in-situ air sparging. The length of required piping is estimated to range between 3,500 to 5,500 feet. Trenches would be necessary to place the piping at such a depth to prevent freezing of condensed water. A layer of gravel would be placed in and above the trenches to provide a continuous layer through which the vacuum created by the vapor extraction system could capture the air produced by the air sparging system.

The entire area would be covered by an asphalt cap (as proposed under the PCB Alternative PCB-S2) which would protect the system and would reduce short circuiting of ambient air into the system. Above ground components would include an air compressor, a vapor extraction system and a vapor phase carbon treatment system. These would be housed in a treatment building to be built in the northern, less active portion of the Site.

As mentioned above, it will be necessary to enhance the permeability of the 3 to 6 foot layer of organic silt between the fill and the underlying undifferentiated sand and gravel. This layer is present across approximately 80 percent of the area proposed to be remediated. It is present at or below the groundwater table and consists of black to brown organic silt with some fine to medium sand and varying amounts of roots, wood and peat. The layer is characteristic of the material deposited in a marshy or frequently flooded area. This layer is likely to have low permeability to water and vapors.

In the event sparging were to be implemented without prior removal of the silt layer under the BTEX alternative and in areas where the silt layer would remain even if the BTEX alternative is implemented, it would be necessary to supplement the vapor extraction controls described above. In addition to horizontal extraction pipes, the following would also be required:

1 Permeability enhancement using Soil Gravel Columns - this would entail drilling or excavating holes through the silt and backfilling with permeable stone.

2 Temporarily pumping and treating shallow groundwater from above the silt layer to allow vapor extraction to remove BTEX in that zone.

3 Installing perimeter vapor extraction wells around the area being treated to guard against lateral migration.

If the selected alternative for the BTEX impacted soils is excavation (BTEX S-3), then the additional air sparging components detailed above would not be required in this area. However, air sparging across the remainder of the site where the organic silt layer was not removed would require implementation of items 1 and 3 as detailed above.

4.2.2.2 Assessment

Overall Protectiveness of Human Health and the Environment

Future ingestion of untreated groundwater would be prevented through on-site groundwater treatment and monitoring. Air sparging frequently causes a slight mounding of the groundwater table which can increase the potential for off-site migration of groundwater constituents. The ongoing removal of VOCs through air sparging and vapor extraction would diminish this potential over time. Current discharge of impacted groundwater to the river does not appear to be having an overall affect on the Hackensack River surface water quality.

Compliance with ARARs

Attainment of groundwater standards across the Site in the overburden flow zone would eventually occur as a result of active in- situ air sparging of the VOCs. Discharge of air from the vapor extraction system would be required to meet state and federal air discharge requirements.

Long-Term Effectiveness and Permanence

VOC concentrations in the overburden flow zone would most likely be reduced to below drinking water standards.

If sparging were implemented without removal of the silt, and if the controls described above were implemented, remediation would occur through several mechanisms: volatilization from the liquid phase, volatilization from soils, extraction and treatment of the shallow groundwater, and biodegradation.

Adequacy of controls: A small percentage of the groundwater plume may not be treated by the air sparging system due to the outward gradient caused by mounding. VOCs not captured by the air sparging/vapor extraction system would be remediated by natural flushing and attenuation including volatilization in the river. Groundwater and surface water monitoring would be performed to evaluate the reduction in groundwater VOC concentrations. Treatment system monitoring would ensure that air discharge meets the discharge requirements.

Reliability of controls: Groundwater and surface water monitoring and treatment system monitoring and maintenance would be performed periodically. During monitoring events, the wells and treatment system would be visually inspected and the results would be evaluated to determine if the system is operating reliably. Maintenance of the wells and treatment system would be performed, as appropriate, based on the recommendations set forth in the monitoring reports. Performance of these controls would continue until ARARs are achieved in Site groundwater, or otherwise waived.

Reduction of Toxicity, Mobility & Volume Through Treatment

Air sparging and vapor extraction would transfer the VOCs from groundwater to carbon thereby reducing the mobility of these compounds. The method of disposal of the spent carbon would determine the amount of ultimate reduction of toxicity and volume of the VOCs.

Short-Term Effectiveness

Due to the presence of the organic silt layer, there is a potential for contaminated groundwater to migrate off-site due to excessive mounding. Installation of the soil gravel columns is expected to reduce this risk. The effectiveness of these columns would be evaluated during the air sparging pilot test. If the soil gravel columns are effective in reducing the lateral migration of impacted groundwater, there would be no significant risks or adverse impacts to the community during implementation of this alternative. Installation of the air sparging/vapor extraction system would not pose a substantial risk to the workers as they would be wearing personal protective equipment (PPE) as necessary.

The time required to install and test the air sparging/vapor extraction system would be approximately four to six months after contractor mobilization to the Site.

Implementability

Ability to construct and operate: Installation of air sparging wells, vapor extraction piping and a treatment system could be readily implemented and tested. Operation and maintenance of the system would be readily implementable.

Reliability: Based on the success of other systems, if the presence of the organic silt layer does not impact the effectiveness of an air sparging system, the proposed system is expected to operate reliably with proper operation, maintenance and monitoring.

Ease of undertaking additional actions: This alternative would require construction of a building to house the vapor extraction system and air compressor. Selection of the building location would require consideration of other potential remedial construction activities and current Site usage.

Ability to monitor: Groundwater and surface water quality and level monitoring would be used to evaluate the effectiveness of the remedy.

Availability of material and services: There are no aspects of this alternative that would require specialty services. There are numerous contractors that could install the air sparging points and vapor extraction system.

Cost

The costs associated with Alternative G2 have been estimated as shown on Table 4-2. A summary of these costs and a comparison with the other alternatives are provided on Table 4-1. The present worth cost of this alternative assuming 5 years of operation ranges between $635,741 and $947,129 The range is based on varying densities of air sparging points, vapor extraction piping and soil gravel columns.

4.2.3 Alternative G3 - Manage Plume with Groundwater Extraction and Treatment System

4.2.3.1 Description

Alternative G3 incorporates the groundwater monitoring and Site deed restrictions and includes installation of groundwater wells or trenches and a water treatment system to manage the groundwater plume. The feasibility of using a cutoff wall to reduce pumping rates and using reinjection wells to increase the efficiency of cleanup were evaluated to determine if they would be appropriate components to add to this alternative. This alternative would also be implemented as part of a vapor extraction system for treatment of soils in the BTEX area. Therefore, implementation of this alternative meets two remedial objective goals.

For the purpose of cost estimating it is assumed that wells would be used rather than trenches. Use of trenches would be further evaluated in the design phase if this alternative is selected for the Site remedy.

Summary of Site Hydrogeology

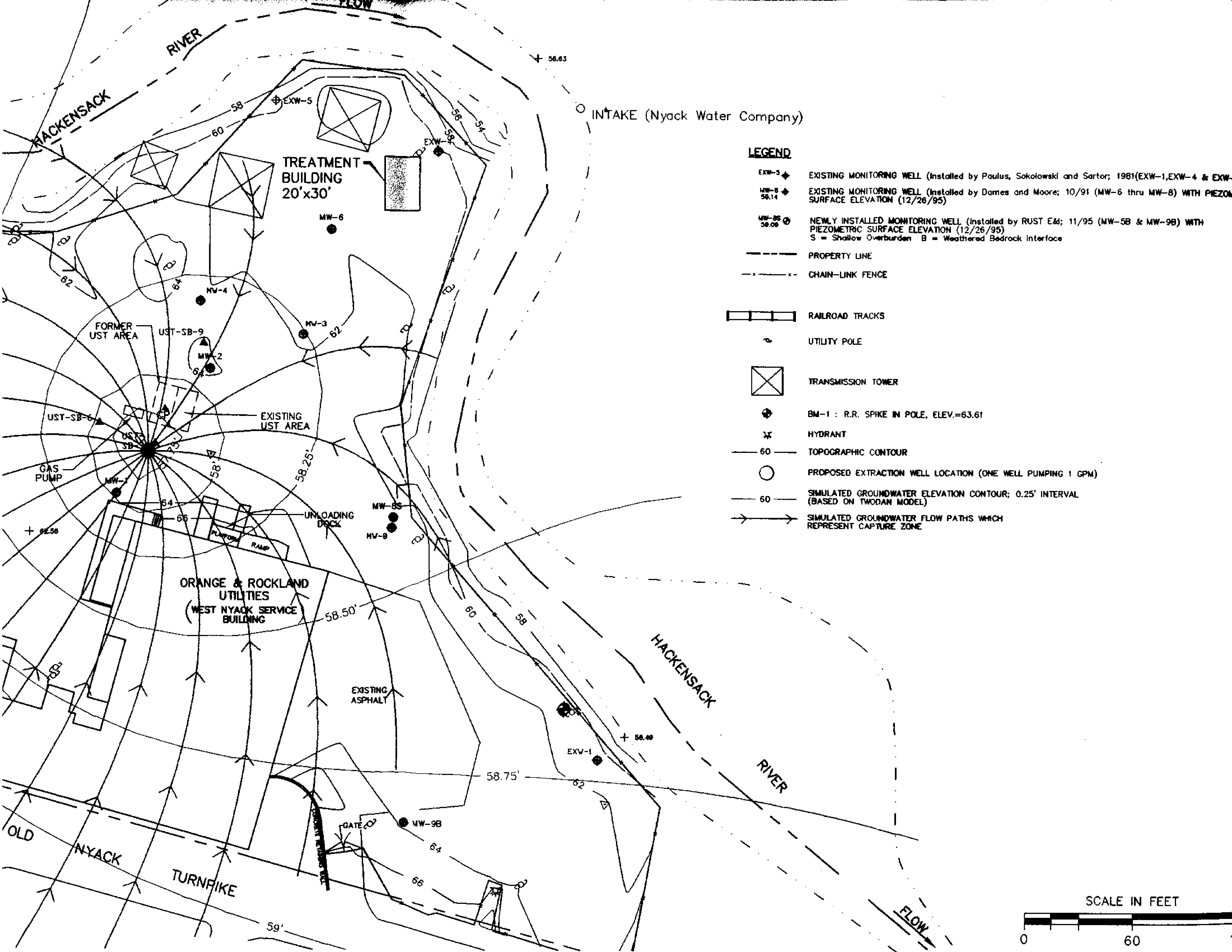
The RI data indicate that impacted groundwater occurs in two water bearing units, overburden and fractured bedrock, underlying the Site. The groundwater in the overburden flows in a northeastern direction across the Site, through undifferentiated sand and gravel with a hydraulic conductivity of approximately 7×10^{-4} cm/sec (2 ft/day), discharging to the Hackensack River. Groundwater in the overburden is separated from groundwater in the underlying fractured bedrock by a potentially discontinuous lower permeability layer composed of glacial till or dense sand and gravel in the lower portions of the undifferentiated sand and gravel unit. No Site groundwater monitoring wells are screened solely in this dense material, but a variation in head between groundwater in wells screened in the overburden and the fractured bedrock indicate that a lower permeability layer is present and acts as a semi-confining layer. This material is assumed to have a hydraulic conductivity of 1×10^{-5} cm/sec (0.03 ft/day) which is approximately two orders of magnitude less than the overlying less dense sand and gravel material. The hydraulic conductivity measured at wells in the fractured (weathered) bedrock was approximately 2×10^{-3} cm/sec (5 ft/day). Near the river a slight upward gradient was measured between the fractured bedrock and the overburden indicating that there is a component of flow up through the "semi-confining layer", probably toward the river. It is assumed that the remaining groundwater in the fractured bedrock flows under the river.

Groundwater Extraction Well System

A preliminary evaluation of various pumping rates at wells at various locations and depths was performed to determine how the groundwater plume would be managed through steady groundwater pumping.

A two-dimensional groundwater flow model, TWODAN, described in Appendix B, was used to predict the number of new wells and well locations to be used in the overburden and/or fractured bedrock. The two hydrogeologic units separated by the semi-confining layer were simulated separately since this modeling program has a limited capability for handling vertical hydrogeologic variability.

The capture zone predicted using TWODAN, as shown on Figure 2, shows that two wells installed in the overburden, located at and downgradient of the former UST area and each pumped at 3 gpm would capture the primary portion of the overburden plume. Likewise, one extraction well located at the former UST area and pumped at 5 gpm would also capture the primary portion of the overburden plume as shown on Figure B-3 in Appendix B. This would include the groundwater in the vicinity of the overburden wells which contain the highest BTEX and chlorinated organic


INTAKE (Nyack Water Company)
LEGEND
EXISTING MONITORING WELL (Installed by Paulus, Sokolowski and Sartor; 1981(EXW-1,EXW-4 & EXW-
EXISTING MONITORING WELL (Installed by Dames and Moore; 10/91 (MW-6 thru MW-8) WITH PIEZOM
SURFACE ELEVATION (12/26/95)
NEWLY INSTALLED MONITORING WELL (Installed by RUST E&I; 11/95 (MW-5B & MW-9B) WITH
PIEZOMETRIC SURFACE ELEVATION (12/26/95)
S = Shallow Overburden B = Weathered Bedrock Interface
PROPERTY LINE
CHAIN-LINK FENCE
RAILROAD TRACKS
UTILITY POLE
TRANSMISSION TOWER
BM-1 : R.R. SPIKE IN POLE, ELEV.=63.61
HYDRANT
TOPOGRAPHIC CONTOUR
PROPOSED EXTRACTION WELL LOCATION (ONE WELL PUMPING 1 GPM)
SIMULATED GROUNDWATER ELEVATION CONTOUR; 0.25' INTERVAL
(BASED ON TWODAN MODEL)
SIMULATED GROUNDWATER FLOW PATHS WHICH
REPRESENT CAPTURE ZONE
HACKENSACK RIVER
FLOW
TREATMENT BUILDING 20'x30'
EXW-5
EXW-4
EXW-1
MW-6
MW-4
MW-3
MW-2
MW-1
MW-8S
MW-8
MW-9B
FORMER UST AREA
UST-SB-9
UST-SB-6
EXISTING UST AREA
GAS PUMP
UNLOADING DOCK
PLATFORM
RAMP
ORANGE & ROCKLAND UTILITIES (WEST NYACK SERVICE BUILDING)
EXISTING ASPHALT
GATE
58.25'
58.50'
58.75'
59'
OLD NYACK TURNPIKE
SCALE IN FEET
0
60

compound concentrations. These wells include MW-1, MW-2, MW-3, MW-4, EXW-4, and EXW-5. Concentrations detected at MW-8S may not be captured by a well at this location but the extraction well system could be further refined during the design phase if this alternative was selected.

Due to the low horizontal gradient in the fractured bedrock, even though the hydraulic conductivity in this unit is higher than the overburden, a lower pumping rate could be used to reverse the gradient and contain the groundwater plume. Figure 3 shows the capture zone predicted using TWODAN for a well installed in the fractured bedrock, located in the center of the Site, and pumped at 1 gpm. Higher pumping rates would increase the vertical gradient and potentially speed up flushing of the aquifer. Such a well would capture the shallow bedrock groundwater containing chlorinated organic compounds. Alternately, the lowering of head in the overburden unit as a result of pumping could produce sufficient upward gradient to reverse gradients in the fractured bedrock, eliminating the need for a bedrock well. For FS cost estimating purposes, it is assumed that no well is installed in the bedrock.

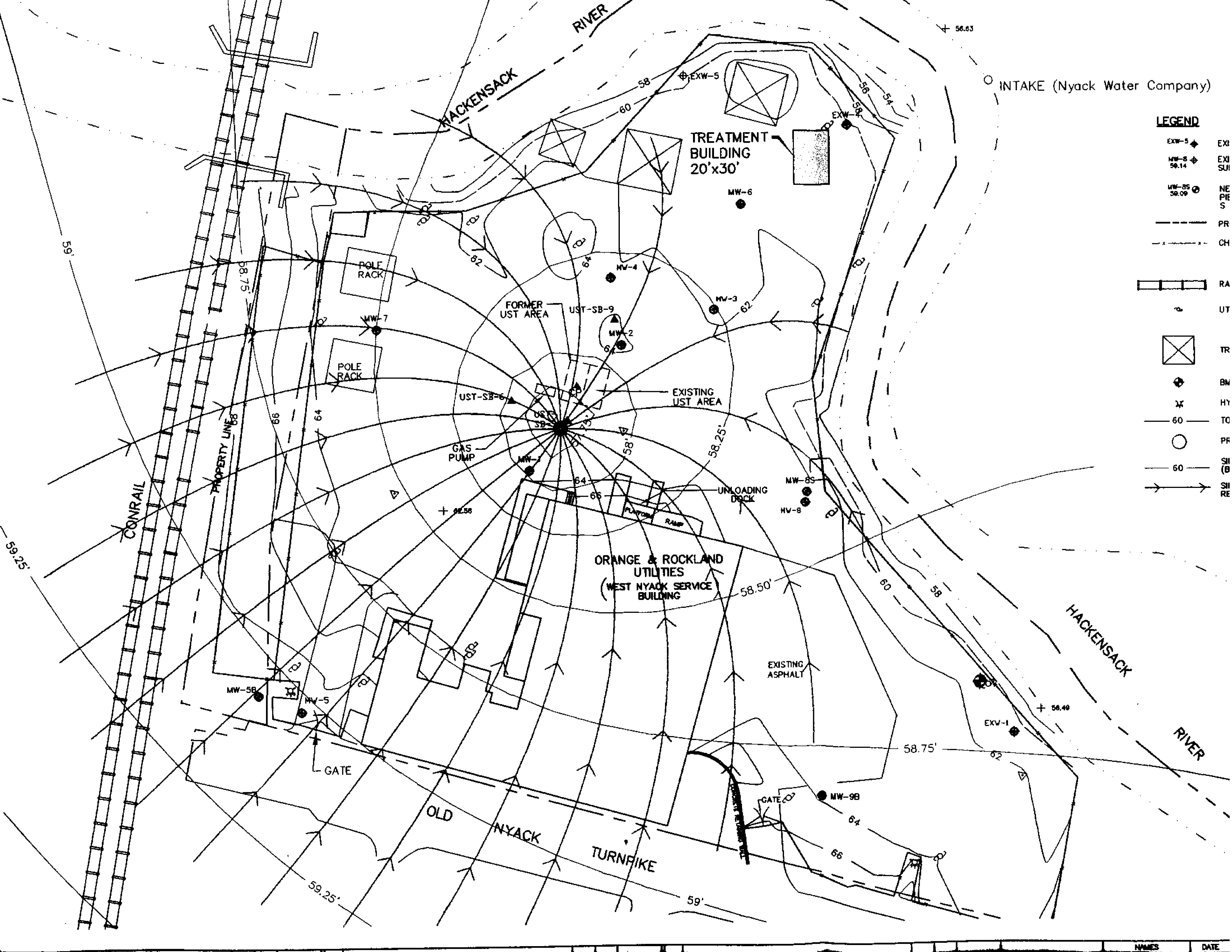
Cutoff Wall Evaluation

Use of a cutoff wall to reduce groundwater pumping rates was further evaluated in terms of effectiveness and implementability in conjunction with estimating extraction well placement and pumping rates. Seepage estimates for flow into a fully contained cutoff wall are provided in Appendix C.

Overburden: Discharge from the river to a pumping well in the overburden was predicted using a TWODAN simulation. The simulation, as shown on Figure B-3, shows the capture zone of one 5 gpm pumping well in the overburden. Data from the TWODAN output indicates that approximately 2 gpm (40%) of that pumping rate is derived from the river and would be negated with the construction of a cutoff wall adjacent to the river and tied into the low permeability layer overlying the bedrock.

Further, a cutoff wall completely encompassing the VOC plume in the overburden, in combination with Site paving (which would lower infiltration) would reduce the pumping rate from the overburden extraction well system to only what is required to remove groundwater which seeps through the cutoff wall, infiltrates through the Site cover (asphalt) and flows from the bedrock through the low permeability layer as a result of the induced upward gradient caused by lowering the head in the overburden. The flow rate into the area contained by the cutoff wall has been estimated to be 1 to 4 gpm, as shown in Appendix C. This flow rate would be highly dependent on the hydraulic conductivity of the glacial till or "low permeability layer" at the base of the undifferentiated sand and gravel. If the overall hydraulic conductivity of this unit is relatively high, the flow from the bedrock would likely be comparable to the predicted flow rate required to capture the groundwater contaminant plume without a cutoff wall. If the hydraulic conductivity is low, the flow into the contained area would likely be approximately 1 gpm which would still require construction of a treatment system.

A treatment system would be required whether or not a cutoff wall was installed. Since treatment system costs for the groundwater flow rates associated with and without a cutoff wall are similar,



INTAKE (Nyack Water Company)
HACKENSACK
RIVER
CONRAIL
PROPERTY LINE
TREATMENT BUILDING 20'x30'
POLE RACK
POLE RACK
FORMER UST AREA
UST-SB-9
UST-SB-6
EXISTING UST AREA
GAS PUMP
UNLOADING DOCK
PLATFORM
RAMP
ORANGE & ROCKLAND UTILITIES (WEST NYACK SERVICE BUILDING
EXISTING ASPHALT
GATE
GATE
OLD NYACK TURNPIKE
EXW-5
EXW-4
MW-6
MW-4
MW-3
MW-2
MW-7
MW-8S
HV-8
MW-5B
MW-5
MW-9B
EXV-1
58.75'
58.25'
58.50'
59.25'
59'
LEGEND
NAMES
DATE

a cutoff wall would add significant costs to a groundwater remedy without substantially reducing long-term treatment costs and is therefore not included in the Alternative G3 conceptual design.

Fractured Bedrock: It is unlikely that the fractured bedrock is hydraulically well connected with the river due to the lower permeability layer overlying the bedrock. Therefore, a cutoff wall adjacent to the river would have little affect on the pumping rates at an extraction well in the fractured bedrock. Cutoff walls are not frequently used to control flow in fractured bedrock due to the lack of a significant confining layer to reduce upward groundwater movement into the treatment zone and complications related to installation.

Driving sheet piles would likely be hampered by the presence of the dense material overlying the bedrock and the potential for the fractured/weathered bedrock to have considerable competence. Installation of a slurry wall would require excavation of approximately 50 feet which could also be complicated by the variability of the competency of the fractured bedrock zone. It would be difficult to determine if the slurry wall was tied into competent rock since identifying the locations of bedrock fractures would not be feasible. A cutoff wall in bedrock will not be further considered for this alternative.

Groundwater and Surface Water Monitoring

To evaluate the performance of pumping on the long term reduction of VOCs in groundwater, monitoring is necessary. For the purpose of the FS, it is assumed that performance monitoring of the pump and treat system would consist of periodic water level monitoring, treatment system influent monitoring, and periodic rounds of water quality monitoring (assumed to be approximately once each year for cost estimating purposes) at selected wells.

Water Treatment System

An air stripper system and not carbon adsorption would be used to treat the recovered groundwater. Since groundwater volumes and VOC concentrations are high carbon canisters would require frequent replacement. Therefore, use of carbon for groundwater treatment prior to discharge is not cost effective. For the purpose of cost estimating it is assumed that the system would include a shallow tray air stripper, blower, and appurtenances. Operation and maintenance of such a system would include monitoring for scaling and turbidity which could cause a build up of sediments in the air stripper trays or associated holding tanks. The trays would require monitoring and cleaning and the holding tanks would likely need to be flushed periodically. Due to the low pumping rate and chemical concentrations, air treatment would not be needed.

Water Treatment System Discharge

Locations for treatment system discharge were evaluated. The discharge locations considered were: 1) to the Hackensack River; and 2) upgradient reinjection/recharge, and 3) to a local POTW. The following is a description of the evaluation of these discharge options.

1 Construction of a discharge structure at the Hackensack River appears to be a viable option in terms of construct-ability. Effluent would be tested to ensure that NYSDEC surface water discharge standards (specified under NYCRR Parts 700-703)

are met. These standards are likely to be more stringent than those for upgradient infiltration for certain parameters. A pre-design study to evaluate the appropriate final location and sizing of the system is included in the cost estimate.

2 Reinjection of treated groundwater is also considered a viable discharge option. Use of suitably located upgradient injection wells, a surface infiltration trench or bed, or a retention basin could induce a higher gradient toward the pumping wells and therefore produce a benefit in both the greater rate of flushing and percentage of capture. Alternately, the increase in water level caused by reinjection would reduce the effectiveness of a soil vapor extraction system if this technology were selected for soil remediation. For the purpose of FS cost estimating, it is assumed that no reinjection wells/trenches are used. Reinjection methods would be reconsidered during remedial design.

3 Discharge to a local POTW is probably not a viable option. POTW's are generally hesitant to accept water from a hazardous waste Site, even after treatment, for reasons relating to liability. If a POTW could accept the volumes of water generated at the Site, the costs associated with discharge monitoring and fees to the POTW would likely out weigh the costs and efforts related to obtaining a NYSDEC surface water discharge or reinjection permit. If this alternative is used in the selected remedy, the local POTW should be contacted to further evaluate this discharge option.

To comply with discharge standards specified in NYCRR Parts 700-703, in addition to monthly influent and effluent sampling at the treatment system would be required. The samples would be analyzed for VOCs plus other specified discharge criteria and a report would be submitted to the state. For the purpose of the FS, it is assumed that no treatment of groundwater other than air stripping would be necessary prior to discharge.

4.2.3.2 Assessment

Overall Protectiveness of Human Health and the Environment

Future ingestion of untreated groundwater would be prevented through on-site groundwater treatment, the deed restriction, and groundwater monitoring. Current discharge of impacted groundwater to the river does not appear to be having an overall affect on the quality of the river.

Compliance with ARARs

Reduction in groundwater VOC concentrations across the Site would eventually occur as a result of active pumping combined with natural flushing, and gradual attenuation and degradation of VOCs as described for Alternative G1. The predicted capture zone for Alternative G3, estimated based on TWODAN simulations (see Appendix B), is shown on Figures 2 and 3.

However, NYSDEC has expressed a concern that this alternative will not adequately address BTEX contamination in the organic silt layer, which is located partially below the groundwater table. There is a concern that due to the high organic carbon content of this layer, the volatile organic contaminants are tightly held to the organic carbon in the organic silt and that they will not be removed by groundwater pump and treat technology in a reasonable time frame. There is also a concern that even after groundwater ARARs are reached, the organic silt layer would potentially act as a source of volatile organics (BTEX and related petroleum compounds) and groundwater concentrations would rise once the pump and treat system was deactivated.

If treated groundwater is discharged to the Hackensack River, the construction of an outfall structure would require substantive compliance with the U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330) under the Clean Water Act, Section 404(b)(1). The US Fish and Wildlife Service would be notified by the Corps of Engineers under the Nationwide Permit Program regarding any potential impact on the river by the proposed discharge. If treated groundwater is reinjected via site wells, substantive compliance with the Nationwide Permit program would not be required.

If treated groundwater is discharged at the Hackensack River, pre-discharge monitoring would be required to comply with the substantive requirements of the NYS Pollution Discharge Elimination System (SPDES) Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges (6 NYCRR 750-757). If treated groundwater is reinjected via Site wells, the activities must also comply with the substantive requirements of the EPA Underground Injection Control (UIC) permit program (40 CFR Part 144). The UIC program requires that the injection activities be conducted in a manner that will not cause a violation of any primary drinking water standard in groundwater. It is likely that effluent standards required for discharge to the river would be more stringent than for reinjection wells due to the consideration of protection to aquatic life. Variances to the effluent standards may be permitted if protection to human health and the environment can be demonstrated.

Long-Term Effectiveness and Permanence

Residual risk: The groundwater treatment system would effectively reduce VOC concentrations in recovered groundwater to below drinking water standards. Deed restrictions would prevent ingestion of untreated water as related to future use of the Site. However, as previously discussed, NYSDEC has concerns over the effectiveness of this technology due to the presence of the organic silt layer.

Adequacy of controls: Alternative G3 endeavors to obtain 100 percent capture of the VOC plume through optimum well placement. Groundwater and surface water monitoring would provide a long-term mechanism for determining if the Site groundwater plume is migrating toward the river. Treatment system monitoring would ensure that effluent meets drinking water quality and discharge standards. Periodic groundwater and surface water monitoring and treatment system influent monitoring would provide a basis for evaluating groundwater quality enhancements. However, as previously discussed, NYSDEC has concerns over the effectiveness of this technology due to the presence of the organic silt layer.

Reliability of controls: Groundwater, surface water, treatment system and discharge monitoring would be performed periodically. During monitoring events, the wells and treatment system would be visually inspected and the results would be evaluated to determine if these long-term controls are operating reliably. Maintenance of the wells and treatment system would be performed based on the recommendations included in the monitoring reports.

Short-Term Effectiveness

There would be no significant risks or adverse impacts to the community during implementation of this alternative. It is anticipated that air emissions associated with the air stripper would be within acceptable levels. Assembling an air stripping system and installing wells would not pose a substantial risk to workers as they would be wearing personal protective equipment (PPE) as necessary, during the implementation of this alternative. Implementation of Alternative G3 would pose no adverse impacts to the environment since pumping should have little affect on the overall volume of the river and its habitat.

The time required to install and test recovery wells, mobilize a treatment system and prepare the system for operation would be approximately four to six months after contractor mobilization to the Site.

Implementability

Ability to construct and operate: New extraction wells, a treatment system, injection wells, or an outfall structure could be readily installed and tested. Operation and maintenance of the new system would be readily implementable.

Reliability: Many examples of similar systems have proven success records. Based on the success of other systems the proposed system is expected to operate reliably with proper operation, maintenance and monitoring.

Ease of undertaking additional actions: This alternative would require construction of a building to house the air stripper system. Selection of the building location would require consideration of other potential remedial construction activities and current Site usage.

Ability to monitor: Groundwater and surface water quality and level monitoring would be used to evaluate the effectiveness of the remedy.

Availability of material and services: There are no aspects of this alternative that would require specialty services. There are numerous contractors that could install wells and construct the treatment and discharge system.

Cost

The estimated costs are shown on Table 4-3 . A summary of these costs and a comparison with the other alternatives are provided on Table 4-1. Operation and maintenance of the existing system is expected to continue until ARARs are achieved, which is assumed to be 25 years. The present worth costs are based on an assumption of 25 years of operation and maintenance. The total capital costs are approximately $148,200 and the estimated direct and indirect expenses are $124,700. The estimated annual operation and maintenance costs are $81,800. The present worth cost is $1,015,402. However, these costs assume that the system could be deactivated after 25 years of operation. If, as believed by NYSDEC, the presence of the organic silt layer would preclude reaching acceptable groundwater BTEX concentrations then the system would have to be operated for a longer period of time and costs would increase.

4.2.4 Alternative G4 - Groundwater and Hackensack River Surface Water Monitoring and Deed Restriction.

4.2.4.1 Description

This alternative would consist of the collection and analysis of overburden groundwater and Hackensack River surface water samples on a quarterly basis and a deed restriction on the on-site use of groundwater. Alternative G4 would not be implemented as a stand alone alternative. This alternative would be implemented in conjunction with soil alternative BTEX-S3. Alternative BTEX-S3 consists of source removal of BTEX impacted soils by excavation and off-site treatment and or disposal. Alternative G4 would be used to monitor the effectiveness of the BTEX source removals and to document that there is no Site related impact on Hackensack River surface water quality.

Samples would be collected on a quarterly basis and analyzed for volatile organics. At the end of two years, the data would be evaluated to determine the effectiveness of the source removal remedial action and the need, if any, for additional monitoring or remedial action.

The groundwater samples would be collected from the existing on-site monitoring wells. However, the BTEX-S3 alternative would result in the removal of two existing overburden wells. One additional overburden monitoring well would be installed at the Site boundary adjacent to the Hackensack River, between existing well MW-8S and EXW-4.

4.2.4.2 Assessment

Overall Protectiveness of Human Health and the Environment

Future on-site use of untreated groundwater would be prevented through a deed restriction. The groundwater and surface water monitoring would be implemented along with BTEX source removal remedial alternative, which would eliminate these compounds as on-going sources of groundwater contamination. Existing surface water data indicate that the Site has not had an impact on Hackensack River surface water quality. The groundwater and surface water monitoring program will monitor the effectiveness of the source removal and ensure that the does not impact Hackensack River water quality.

Compliance with ARARs

Attainment of petroleum related volatile organic (BTEX) groundwater standards in the overburden flow zone would eventually occur across the Site as a result of the BTEX source removal that would be conducted in conjunction with alternative G4. Chlorinated volatile organics would not be directly addressed by this combination of alternatives. However, no on-site continuing source of chlorinated volatile compounds that are considered to be potentially site related (primarily 1,1,1-TCA) was identified. Also, the source of TCE, one of the primary chlorinated volatile organics detected in the overburden groundwater, is believed to originate upgradient of the Site. Therefore any on-site remedial action to address chlorinated volatile organics would not attain ARARs with respect to TCE.

Long-Term Effectiveness and Permanence

The BTEX source removal that would be performed prior to initiation of alternative G4, would ensure long-term protection of groundwater and surface water quality. The groundwater and surface water monitoring associated with alternative G4 would be used to document the effectiveness of the source removal. The surface water monitoring will ensure that there is no degradation of Hackensack River surface water quality from Site derived chemical compounds. The current surface water data indicate that the Site has not impacted the Hackensack River water quality.

Adequacy of controls: The groundwater and surface water monitoring program will be capable of monitoring the effectiveness of the BTEX source removal remedial action. The surface water monitoring will be an effective method of evaluating Hackensack River water with respect to Site related compounds.

Reliability of controls: The sampling and analytical methods that will be utilized in the collection and analysis of groundwater and surface water are standard well documented procedures. These procedures are proven technologies and will adequately provide reliable data on groundwater and surface water quality.

Reduction of Toxicity, Mobility & Volume Through Treatment

Alternative G4 will not result in any reduction in contaminant toxicity, mobility or volume. However, alternative G4 is the groundwater and surface water monitoring program associated with BTEX source removal. The BTEX source removal alternative will result in a reduction in the on-site volume of BTEX compounds. If BTEX impacted soil is treated off-site via thermal desorption or other acceptable technologies, there would be a permanent reduction in the toxicity, mobility and volume of BTEX compounds.

Short-Term Effectiveness

There are no short-term impacts to human health and the environment associated with the groundwater and surface water monitoring. Sampling personnel would follow standard health and safety procedures during sample collection and installation of the one additional monitoring well. There would be no impacts to the residents adjacent to the Site. Any impacts related to the BTEX source removal alternative are discussed in the in the respective alternative assessment sections of this report.

Implementability

Ability to construct and operate: Installation of the additional monitoring well and, collection and analysis of groundwater and surface samples would be readily implementable.

Reliability: Monitoring well installation technology is a thoroughly proven and accepted. Groundwater and surface samples will be collected and analyzed following documented and proven procedures.

Ability to monitor: Standard laboratory and field QA/QC procedures will be used to verify the validity of the groundwater and surface water analytical data.

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes clean up objectives for PCBs of 1.0 ppm from 0 to 2 feet below the surface and 10 ppm at depths greater than 2 feet. Federal TSCA policy establishes requirements for PCB levels at 25 ppm for restricted access areas and 10 ppm for unrestricted access areas.

The Site exhibits PCB concentrations equal to or greater than these guidelines and clean up objectives. Therefore, the objectives would not be satisfied under the No Action Alternative, since no removal or treatment of PCB impacted soil is proposed under this alternative.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is moderately high since future Site usage and access is not controlled under the No Action Alternative.

Adequacy of controls: No controls would be implemented for this alternative.

Reliability of controls: No controls would be implemented for this alternative.

Reduction of Toxicity, Mobility, and Volume Through Treatment

The No Action Alternative would not reduce the toxicity, mobility, or volume of the PCBs in the soil at the ORU Site.

Short-Term Effectiveness

Since no action would be taken to disturb the contaminated soil under this alternative, implementation would not pose any short-term risks to workers, the community, or the environment as a result of construction activities.

Implementability

No construction or operation would be required to implement the No Action Alternative. No treatment would be performed, and therefore, no permits or approvals are necessary.

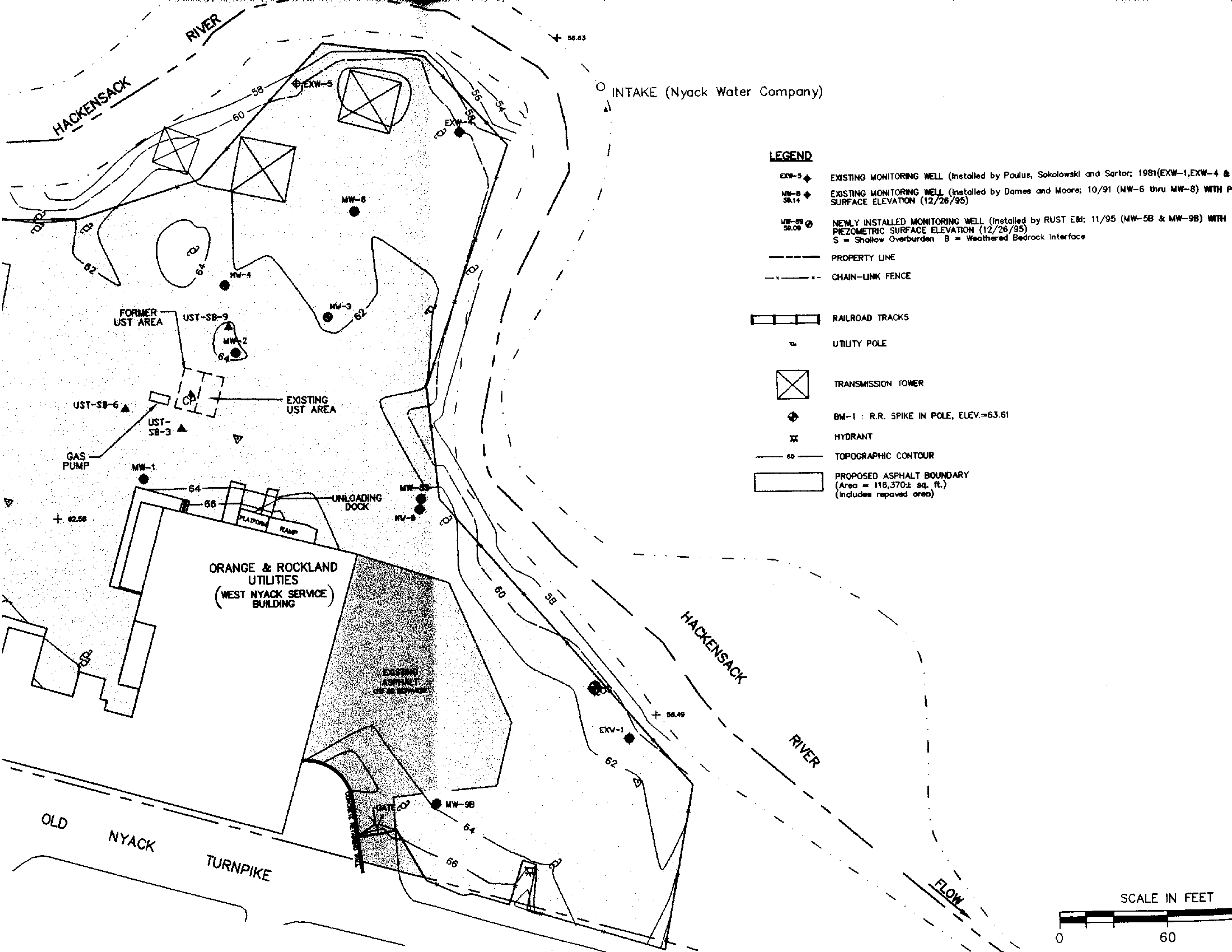
Cost

There are no costs directly associated with this alternative.

4.3.2 Alternative PCB-S2 - Excavation, Disposal, Asphalt Cap, and Institutional Controls

4.3.2.1 Description

Under this alternative, soils with PCB concentrations greater than 10 ppm would be excavated and transported off-site for disposal and an asphalt cap would be placed over the entire ORU Site. Refer to Figure 4 for the delineation of the area to be covered by asphalt. The surface would be prepared with a 12 inch structural sub-base layer, a 3 inch binder course, and a 1.5 inch asphalt wearing surface, which will result in approximately 16.5 inches of clean material above any soils with residual low level PCB concentrations. The asphalt surface design would also incorporate an


INTAKE (Nyack Water Company)
LEGEND
EXISTING MONITORING WELL (Installed by Paulus, Sokolowski and Sartor; 1981(EXW-1,EXW-4 &
EXISTING MONITORING WELL (Installed by Dames and Moore; 10/91 (MW-6 thru MW-8) WITH P
SURFACE ELEVATION (12/26/95)
NEWLY INSTALLED MONITORING WELL (Installed by RUST E&I; 11/95 (MW-5B & MW-9B) WITH
PIEZOMETRIC SURFACE ELEVATION (12/26/95)
S = Shallow Overburden B = Weathered Bedrock Interface
PROPERTY LINE
CHAIN-LINK FENCE
RAILROAD TRACKS
UTILITY POLE
TRANSMISSION TOWER
BM-1 : R.R. SPIKE IN POLE, ELEV.=63.61
HYDRANT
TOPOGRAPHIC CONTOUR
PROPOSED ASPHALT BOUNDARY
(Area = 116,370± sq. ft.)
(includes repaved area)
HACKENSACK RIVER
FLOW
ORANGE & ROCKLAND UTILITIES
(WEST NYACK SERVICE BUILDING)
OLD NYACK TURNPIKE
FORMER UST AREA
EXISTING UST AREA
GAS PUMP
UNLOADING DOCK
PLATFORM
RAMP
UST-SB-9
UST-SB-6
UST-SB-3
MW-1
MW-2
MW-3
MW-4
MW-6
MW-8
MW-9B
EXW-5
EXV-1
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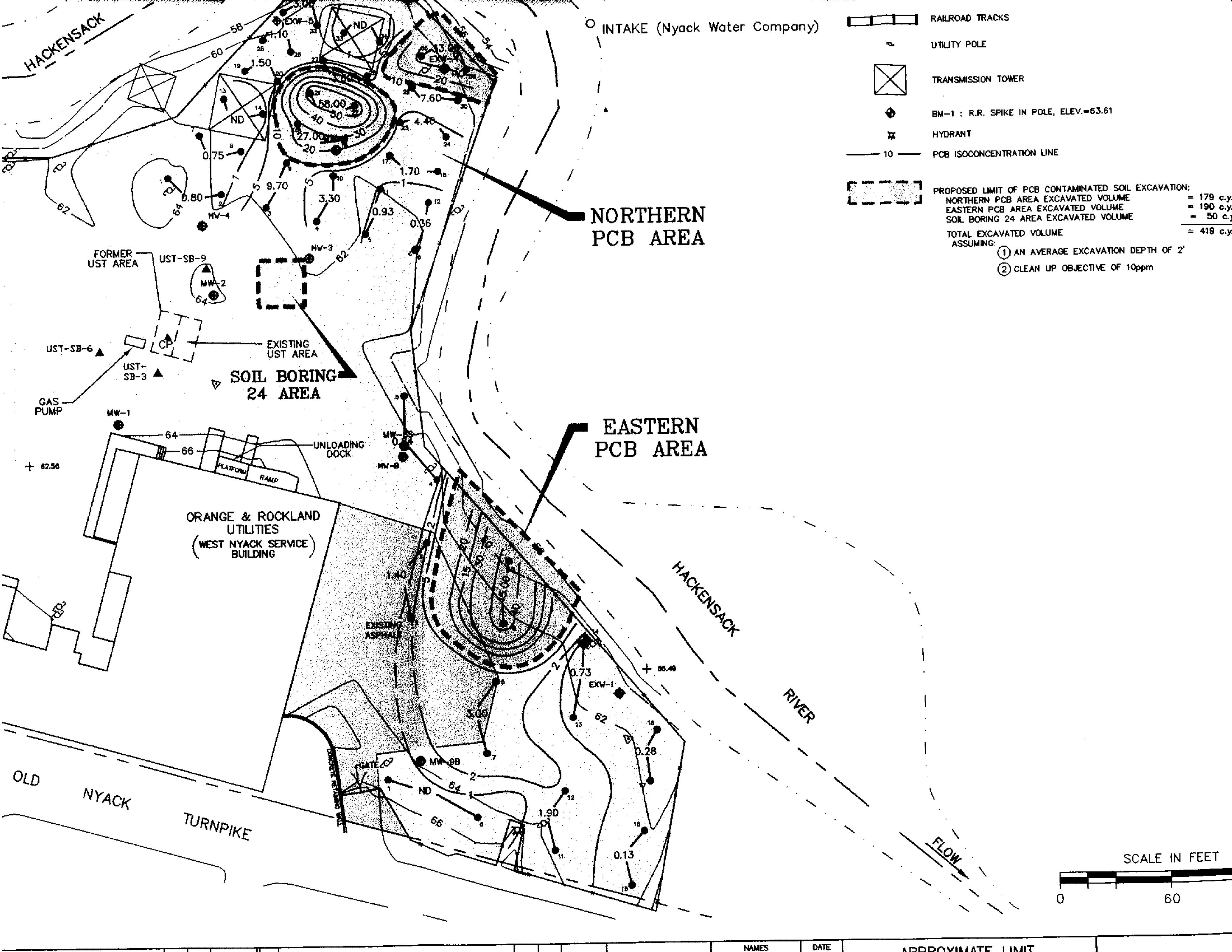

INTAKE (Nyack Water Company)
RAILROAD TRACKS
UTILITY POLE
TRANSMISSION TOWER
BM-1 : R.R. SPIKE IN POLE, ELEV.=63.61
HYDRANT
10 PCB ISOCONCENTRATION LINE
PROPOSED LIMIT OF PCB CONTAMINATED SOIL EXCAVATION:
NORTHERN PCB AREA EXCAVATED VOLUME = 179 c.y.
EASTERN PCB AREA EXCAVATED VOLUME = 190 c.y.
SOIL BORING 24 AREA EXCAVATED VOLUME = 50 c.y.
TOTAL EXCAVATED VOLUME = 419 c.y.
ASSUMING:
(1) AN AVERAGE EXCAVATION DEPTH OF 2'
(2) CLEAN UP OBJECTIVE OF 10ppm
NORTHERN PCB AREA
EASTERN PCB AREA
SOIL BORING 24 AREA
HACKENSACK
HACKENSACK RIVER
FLOW
FORMER UST AREA
UST-SB-9
MW-2
EXISTING UST AREA
UST-SB-6
UST-SB-3
GAS PUMP
MW-1
MW-3
MW-4
MW-8
MW-9B
EXW-1
EXW-5
UNLOADING DOCK
PLATFORM
RAMP
ORANGE & ROCKLAND UTILITIES (WEST NYACK SERVICE BUILDING)
EXISTING ASPHALT
CONCRETE RETAINING WALL
GATE
OLD NYACK TURNPIKE
SCALE IN FEET
0
60
NAMES
DATE
APPROXIMATE LIMIT

oil/water separator to provide a detention period for run-off water prior to release to the municipal storm sewer system.

Institutional controls would be implemented since low level PCB-contaminated soil would remain in place. The areas containing PCB concentrations greater than 10 ppm represent a total volume of approximately 419 cy. Refer to Figure 5 for the delineation of these areas. Before transport off-site, the soil materials would be analyzed as necessary for acceptance at a TSCA and RCRA approved facility. The excavated areas would then be backfilled with clean fill material, compacted, and paved.

This alternative includes long-term monitoring and maintenance to ensure cap integrity is preserved. Since this alternative relies partly on isolation of low level PCB contamination, cap demarcation and deed restrictions would be required to prevent any future damage to the cap.

4.3.2.2 Assessment

Overall Protection of Human Health and the Environment

Capping would effectively isolate contaminated soils and prevent exposure to affected on-site soils. An asphalt cap is an effective infiltration barrier and would eliminate the potential for erosion and transport of contaminated sediments to the Hackensack River. Capping would prevent uptake of constituents in vegetation and/or exposure to soil, thereby reducing risks to higher order receptors in the food chain.

Compliance with ARARs

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes clean up objectives for PCBs of 1.0 ppm from 0 to 2 feet below the surface and 10 ppm at depths greater than 2 feet. Federal TSCA policy establishes requirements for PCB levels at 25 ppm for restricted access areas and 10 ppm for unrestricted access areas. Removal of soils in excess of 10 ppm will meet the Federal TSCA cleanup criteria of 25 ppm and the NYSDEC sub-surface (greater than 2 feet deep) cleanup criteria of 10 ppm.

As previously mentioned, the ORU site will be capped. The cap will consist of a 12 inch structural sub-base, a 3 inch binder course and 1.5 inches of asphalt, resulting in approximately 16.5 inches of clean material over the top of the existing land surface. This 16.5 inch cap of clean material would eliminate exposure to the original Site surface soils. Therefore, this alternative is as protective of human health and the environment as the NYSDEC recommended surface soil (top two feet) cleanup objective of 1 ppm.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is low. The affected soils would be adequately contained and isolated in place below the cap. Assuming that the cap is performing properly, the risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils is mitigated effectively. Migration of PCBs below the cap would be negligible since infiltration of precipitation is prevented by the asphalt cap and drainage controls would aid to prevent erosion around the cap. As the affected soils are not treated, a failure or breach of the cap would result in the reoccurrence of health-based or ecological risks. Appropriate land use restrictions would be implemented to assure that the cap is not breached.

Adequacy of controls: An asphalt cap should, in all probability, achieve its performance requirement of preventing direct contact to future potential receptors. Implementation of and compliance with land use restrictions and long-term maintenance obligations would aid in preserving cap integrity and limiting exposure. Long-term maintenance activities including annual visual inspection of the cap and crack and surface repair would ensure cap integrity.

Reliability of controls: With proper construction and long-term monitoring and maintenance, the asphalt cap would provide a highly reliable isolation barrier to potential future receptors. Deed restrictions would limit access to the area, and therefore, aid in preventing accidental damage to the cap. It is anticipated that with proper maintenance, the cap should last indefinitely.

Reduction of Toxicity, Mobility and Volume Through Treatment

As the affected soils are not treated, there is no reduction in the toxicity. The volume of contaminants on site would be reduce by excavation and removal of soils with concentrations above 10 ppm. However, the asphalt cap would reduce the mobility of constituents from soil.

Short-Term Effectiveness

Since actions would be taken not to disturb the affected soils during placement of the asphalt cap, implementation would pose minimal risks to workers, the community and the environment. Air monitoring for PCBs and use of personal protective equipment would mitigate risk to workers during excavation activities.

Implementability

Ability to Construct and Operate: All components of this alternative utilize relatively common construction equipment and materials. The cap could be constructed with little or no difficulty.

Reliability:

Installation of an asphalt cap would provide a high degree of reliability provided long term maintenance activities and deed restrictions are implemented. This alternative involves proven technologies and utilizes common construction materials and procedures.

Availability of Materials and Service:

All equipment and materials are available locally and have been demonstrated sufficiently for the purpose for which they are intended. Implementation of this alternative would be accomplished in approximately 4 weeks. Implementation of deed restrictions would require coordination with Rockland County.

Cost

The costs associated with Alternative PCB-S2 have been estimated as shown on Table 4-7. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-6. The total capital costs and expenses for PCB-S2 are $457,356. The annual operation and maintenance costs are $15,000. The present worth costs, based on 30 years of operation and maintenance are $598,759.

4.3.3 Alternative PCB-S3 - Excavation, Off-Site Disposal

4.3.3.1 Description

This alternative involves excavation and off-site disposal of surface soils containing PCBs in the contaminated areas to the east and north of the ORU service building. Surface soils containing PCB concentrations greater than 1 ppm would be excavated to a depth of 2 feet. These areas represent a volume of approximately 3,000 cy. Subsurface soils (i.e. soils at a depth greater than 2 feet below the surface) containing PCB concentrations greater than 10 ppm would be excavated. These areas are isolated to soil boring SB-24 and represent a volume of approximately 50 cy. The total volume to be excavated is approximately 3,050 cy. Refer to Figure 5 for the delineation of these areas. Before transport off-site, the soil materials would be analyzed as necessary for acceptance at a TSCA and RCRA approved facility. The excavated areas would then be backfilled with clean fill material and compacted.

4.3.3.2 Assessment

Overall Protection of Human Health and the Environment

This alternative would provide a high level of protection to human health and the environment. Potential risks resulting from exposure to PCBs would be eliminated under this alternative. Clean up objectives for PCBs would be met since the PCB-containing soils would be permanently removed from the Site. After removal from the Site, PCB-contaminated soils would be disposed of in a secure landfill, subject to regular monitoring and maintenance requirements.

Compliance with ARARs

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes clean up objectives for PCBs of 1.0 ppm from 0 to 2 feet below the surface and 10 ppm at depths greater than 2 feet. Federal TSCA policy establishes requirements for PCB levels at 25 ppm for restricted access areas and 10 ppm for unrestricted access areas. The Site exhibits PCB concentrations equal to or greater than these guidelines and clean up objectives. Clean up objectives would be satisfied under this alternative since contaminated soil would be permanently removed from the Site.

TBCs and ARARs considered with the implementation of this alternative include RCRA, OSHA and the New York State hazardous waste regulations. Excavation of PCB-containing soils is subject to OSHA health and safety standards. Transportation of contaminated materials to a TSDF is subject to various RCRA regulations for transport and monitoring.

Long-Term Effectiveness and Permanence

Residual risk: The risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils is mitigated effectively by removal of the affected soil. Disposal of affected soils in an off-site TSCA approved landfill effectively isolates the constituents from potential receptors.

Adequacy of controls: Off-site RCRA and TSCA permitted landfill facilities should, in all probability, achieve their performance requirement of preventing direct contact to any receptors. There would be no long-term management or deed restrictions placed on the Site in regard to this alternative for soils, since risks to human health and the environment would be sufficiently mitigated and all contaminated soil would have been removed.

Reliability of controls: No on-site controls would be required because the contamination would be removed. It is anticipated that the off-site disposal facility could function properly for an indefinite period of time, assuming proper maintenance.

Reduction of Toxicity, Mobility and Volume Through Treatment

The toxicity of the materials being excavated and removed is not reduced, however, reduction in contaminant mobility is achieved by encapsulation of the material within a controlled landfill environment.

Short-Term Effectiveness

There would be minimal Site impact to the community during the implementation of this alternative, since access is limited. Fugitive dust would be controlled using engineering measures. Traffic increases due to transportation of soil would have minimal impact on the community as this is a one time occurrence with an approximate duration of five weeks.

Workers involved with the soil excavation and transport and disposal activities could be exposed to the risks associated with dermal contact with contaminated soil and inhalation of soil dust particulates. Risks would be mitigated by properly outfitting workers with appropriate personal protection equipment, following proper industrial hygiene procedures, using controlled excavations, and monitoring air quality during soil excavation activities. All work associated safety practices would be outlined in a Health and Safety Plan, including a description of the control measures that would be implemented at the Site. The Health and Safety Plan would be reviewed by the NYSDEC.

Implementability

Ability to Construct and Operate: All components of Alternative PCB-S3 utilize relatively common construction equipment and materials. Soil excavation and removal utilizes routine construction procedures. It may be necessary to obtain a hazardous waste generator USEPA Identification number. Soil shipments considered hazardous must be manifested and transported by a permitted hazardous waste transporter.

Reliability: All aspects of this alternative would be highly reliable in achieving the remedial action objectives as it involves proven technologies. All components of Alternative PCB-S3 utilize common construction materials and procedures, and routine sampling procedures and analyses.

Availability of Materials and Services: There are no aspects of this alternative that would require specialty services. All equipment and materials are available locally and have been demonstrated sufficiently for the purpose for which they are intended. One nearby TSCA regulated facility has been identified as potentially capable of receiving such waste. It is anticipated, once the contractor is mobilized to the Site, that excavation, confirmatory sampling, transport and backfilling activities would be completed within a five week time frame.

Cost

The costs associated with Alternative PCB-S3 have been estimated as shown on Table 4-7. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-5. The estimated total costs associated with this alternative are $1,483,000.

4.4 BTEX-CONTAMINATED SOIL ALTERNATIVES ANALYSIS

This detailed analysis evaluates the soil alternatives that passed the initial alternatives screening in Section 3.0 relative to the seven evaluation criteria. It focuses upon the relative performance of each alternative. The soil remedial alternatives that are evaluated in the detailed analysis are as follows:

- ➢ Alternative BTEX-S1: No Action
- ➢ Alternative BTEX-S2: Dual Groundwater/Vapor Extraction
- ➢ Alternative BTEX-S3: Excavation and Disposal
- ➢ Alternative BTEX-S4: Biosparging

4.4.1 Alternative BTEX-S1- No Action

4.4.1.1 Description

This No Action Alternative assumes that no action would be taken to control, remove, or monitor the contaminated areas at the Site The BTEX-contaminated areas in the former UST area, north of the ORU service building would be left in place. The existing fence around the perimeter of the Site would continue to restrict access.

4.4.1.2 Assessment

Overall Protection of Human Health and the Environment

The Site is enclosed by a perimeter boundary fence, and therefore, has restricted entry and minimal occupation. The risk of direct contact with contaminated soil is mainly by Site personnel, utility workers, and construction workers. This alternative would not reduce existing on-site risks. Although access to the Site is currently controlled and limited by way of the perimeter fence, there is no guarantee that these controls would be maintained. Should the land usage be changed or the Site be developed, the human health and ecological risks would be increased.

Potential off-site migration pathways of BTEX compounds include leaching and migration through groundwater movement and via sediment erosion and transport to the Hackensack River. Benzene, toluene, and other Site related VOCs are considered to be highly to moderately mobile. Xylene and ethylbenzene are slightly less mobile and are more likely to sorb to the soil. A risk associated with the potential migration of these constituents exists and is relative to leachability and surface erosion.

Compliance with ARARs

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes soil clean up objectives for BTEX compounds of 0.06, 1.5, 5.5, and 1.2 ppm respectively. The Site currently exhibits soil concentrations above these objectives. Since no remedial action is proposed under this alternative, these objectives would not be met.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is moderately high since migration pathways have been identified and future Site usage and access is not controlled under the No Action Alternative.

Adequacy of controls: The adequacy of this alternative in reducing concentrations through natural attenuation would not be determined since monitoring is not included as part of this alternative.

Reliability of controls: No controls would be implemented for this alternative.

Reduction of Toxicity, Mobility, and Volume Through Treatment

No reduction in toxicity, mobility, or volume would occur other than through natural degradation and attenuation.

Short-Term Effectiveness

Since no action would be taken to disturb the contaminated soil under this alternative, implementation would not pose any short-term risks to workers, the community, or the environment as a result of construction activities.

Implementability

No construction or operation would be required to implement the No Action Alternative. No treatment would be performed, and therefore, no permits or approvals are necessary.

Cost

There are no costs directly associated with this alternative.

4.4.2 Alternative BTEX-S2 - Dual groundwater/Vapor Extraction

4.4.2.1 Description

This alternative would involve the installation of a soil vapor extraction (SVE) system and groundwater extraction well(s). The SVE system would be designed to remove vapors from the interstitial spaces of the soil in the vadose zone. The extraction well(s) would be designed to depress the water table enough so that a vacuum could be applied to remove the vapors in the vadose zone without extracting water.

Preliminary groundwater modeling of the overburden hydrogeologic system has indicated that the groundwater table could be sufficiently depressed, thus increasing the effectiveness of the SVE system. A 5 gpm well located in the vicinity of the former UST area could be utilized, or the installation of additional wells may be considered to further enhance groundwater depression. Groundwater would be treated and discharged as described in Section 4.2 of this report.

A pilot study was not performed to evaluate the effectiveness of a vapor extraction system. The RI indicates that the majority of BTEX contaminated soil is located within 0 to 14 feet below ground surface. The soil in this zone is described as fill (consisting of reworked native soil, road stone, brick, angular gravel and in some areas asphalt) overlying an apparently naturally occurring layer of organic silt. Potential non-homogeneities in the fill, and the organic silt layer could reduce the effectiveness of the SVE system. It is possible that the BTEX compounds would be sorbed to the organic carbon fraction of the organic layer and would not readily desorb into the air phase and therefore would not be removed by the SVE system.

The existing UST would have to be removed and replaced prior to installation of the SVE system. A pre-design pilot study would be performed to evaluate the zone of influence of a vapor extraction point to determine the quantity and placement for optimum VOC removal.

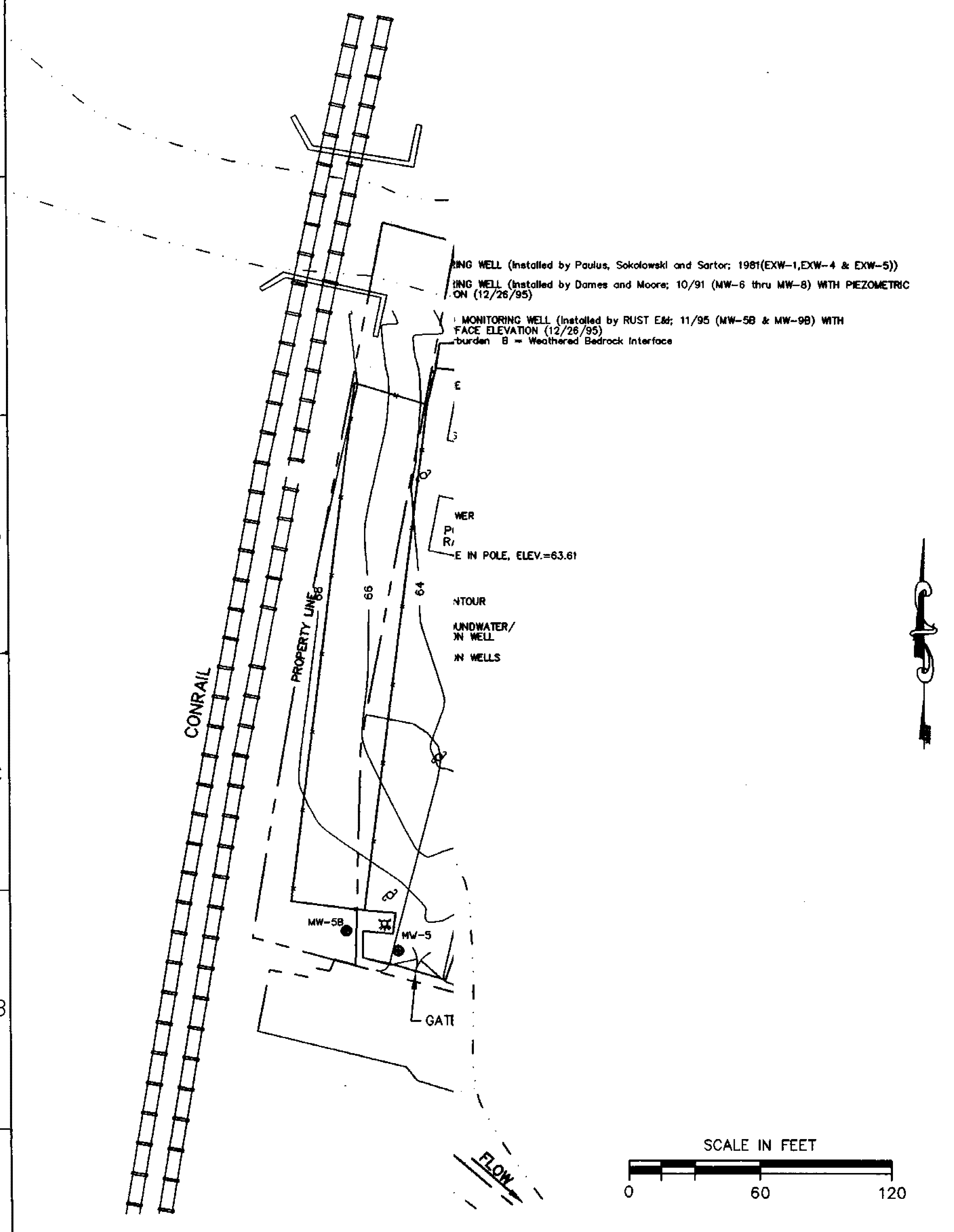
It is assumed that the soil vapor would require treatment. Although, upon further investigation, it may be determined that the concentrations are within the NYSDEC air guidance limits. The vapors would be treated using vapor phase granular activated carbon housed in the treatment building.

For cost estimating purposes, it is assumed that vapor would be drawn from a dual extraction well located in the center of the former UST area and from 10 additional surrounding points. Refer to Figure 6 for a typical system layout.

4.4.2.2 Assessment

Overall Protection of Human Health and the Environment

This alternative would provide a high level of protection to human health and the environment. Potential risks resulting from exposure to or ingestion of BTEX compounds would be eliminated under this alternative through on-site treatment of both the unsaturated zone impacted soils and the groundwater in the saturated zone. Soil clean up objectives for BTEX and other site-related VOCs would be met since treatment would permanently remove VOCs from the soil.



NO.	REVISIONS	MADE	CHK	DATE

IATE DUAL GROUNDWATER
VAPOR EXTRACTION
SYSTEM LAYOUT

AND ROCKLAND UTILITIES, INC.
EST NYACK, NEW YORK

RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NUMBER 38301.300
DATE 11/06/96
RUST DWG NUMBER 38301-19
FILE NUMBER
CLIENT DWG NUMBER FIG. 6
SHEET NUMBER
CAD FILE NAME: 3830-19

Compliance with ARARs

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes soil clean up objectives for BTEX compounds of 0.06, 1.5, 5.5, and 1.2 ppm respectively. The Site currently exhibits soil concentrations above these objectives, however, through on site soil treatment these objectives would be satisfied. Additionally, ARARs for groundwater would be met through active pumping and treatment of groundwater. However, as discussed in Section 4.2.3.2, NYSDEC has expressed a concern with respect to the effectiveness of the groundwater pump and treat alternative. These same concerns apply with respect to this alternative, in that soil vapor extraction of the organic silt layer located in the unsaturated zone may not be effective without enhancing the permeability of this zone.

Long-Term Effectiveness and Permanence

Residual risk: The risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils is mitigated effectively by on site soil treatment. Assuming SVE is effective for the type of soils present at the Site, remediation would ultimately achieve soil and groundwater clean up objectives and reduce residual risk over time. It is assumed that the SVE system would be operated for a period of five years. To effectively treat groundwater for BTEX it would be necessary to continue groundwater pump and treat at least for an additional 20 years.

Adequacy of controls: This alternative would effectively reduce BTEX concentrations in the soil and long-term monitoring would be implemented to evaluate the system performance. As previously discussed there is some concern with respect to the long-term effectivness of the groundwater pump and treat alternative, and the SVE alternative without enhancement of the permeability of the organic silt layer.

Reliability of controls: Maintenance and monitoring of wells and the treatment system would be performed to determine that they are operating reliably. An Operations, Maintenance, and Monitoring manual would be provided.

Reduction of Toxicity, Mobility and Volume Through Treatment

The mobility of the contaminants would be reduced by plume containment through groundwater extraction. Treatment of the soil through vapor extraction would greatly reduce the toxicity and volume of BTEX compounds over time. As previously discussed there is some concern with respect to the long-term effectivness of the groundwater pump and treat alternative due to the sorptive capacity of the organic silt layer, and the SVE alternative without enhancement of the permeability of the organic silt layer.

Short-Term Effectiveness

There would be minimal impact to the community during the implementation of this alternative, since Site access is limited. It is assumed that vapors extracted from the soil will be treated utilizing vapor phase granular activated carbon.

Workers involved with the construction activities could be exposed to the risks associated with dermal contact with contaminated soil and inhalation of soil dust particulates. Risks would be mitigated by properly outfitting workers with appropriate personal protection equipment, following proper industrial hygiene procedures, and monitoring air quality during construction activities. All work associated safety practices would be outlined in a Health and Safety Plan, including a description of the control measures that would be implemented at the Site. The Health and Safety Plan would be reviewed by the NYSDEC.

Implementability

Ability to Construct and Operate: The installation of groundwater extraction and vapor wells, and the construction of a treatment system for Alternative BTEX-S2 utilize relatively common construction equipment and materials. Construction and Operations and Maintenance associated with this alternative could be successfully implemented.

Reliability: All aspects of this alternative involve proven technologies and all components of Alternative BTEX-S2 utilize common construction materials and procedures, and routine sampling procedures and analyses. All equipment and materials are available locally and have been demonstrated sufficiently for the purpose for which they are intended. However, a pilot test would be required to evaluate the effectiveness of vapor extraction at this particular site. The shallow groundwater table and non-homogeneous soils at the Site may limit the effectiveness of this technology.

Availability of Materials and Services: There are no aspects of this alternative that would require specialty services. There are numerous contractors that could install the wells and construct the treatment system and building. Once the contractor is mobilized to the Site it is anticipated that installation of the wells and construction of the treatment system within 4 months.

Cost

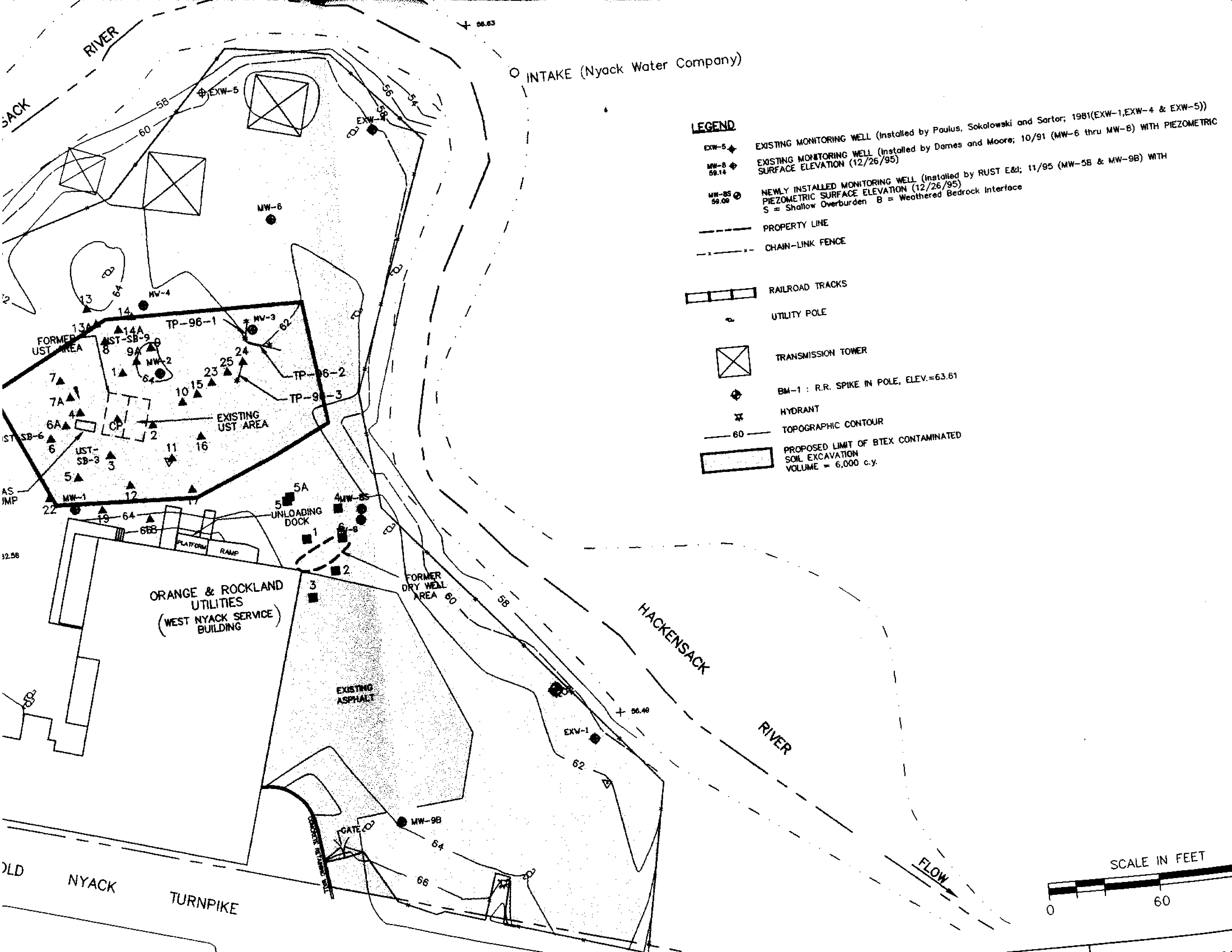
The costs associated with Alternative BTEX-S2 have been estimated as shown on Table 4-9. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-8. Costs for the groundwater pump and treat system are not included since an estimate for this alternative has been previously calculated. The estimated total capital costs and expenses for this alternative are $146,300. The estimated annual operation and maintenance costs are $34,500. The estimated present worth value based on 5 years is $277,082

4.4.3 Alternative BTEX-S3 - Excavation and Off-Site Disposal

4.4.3.1 Description

This alternative involves excavation and off-site disposal of the BTEX impacted soil. Soil exhibiting total xylene concentrations greater than the NYSDEC recommended soil cleanup objective of 1.2 ppm would be excavated and treated and/or disposed of off-site. The volume of excavated material is based on the RI boring program. Figure 7 depicts the linear extent of impacted soils and Drawing 1 delineates the vertical extent of impacted soils.

It is estimated that approximately 6,000 cy of affected soil in both the unsaturated and saturated zone in the vicinity of the former UST would be excavated and removed for off-site treatment and/or disposal. The volume of soil to be removed was estimated based on the average depth of the soils



INTAKE (Nyack Water Company)
LEGEND
EXW-5 EXISTING MONITORING WELL (Installed by Paulus, Sokolowski and Sartor; 1981(EXW-1,EXW-4 & EXW-5))
MW-8 59.14 EXISTING MONITORING WELL (Installed by Dames and Moore; 10/91 (MW-6 thru MW-8) WITH PIEZOMETRIC SURFACE ELEVATION (12/26/95)
MW-8S 59.09 NEWLY INSTALLED MONITORING WELL (Installed by RUST E&I; 11/95 (MW-5B & MW-9B) WITH PIEZOMETRIC SURFACE ELEVATION (12/26/95)
S = Shallow Overburden B = Weathered Bedrock Interface
PROPERTY LINE
CHAIN-LINK FENCE
RAILROAD TRACKS
UTILITY POLE
TRANSMISSION TOWER
BM-1 : R.R. SPIKE IN POLE, ELEV.=63.61
HYDRANT
60 TOPOGRAPHIC CONTOUR
PROPOSED LIMIT OF BTEX CONTAMINATED SOIL EXCAVATION VOLUME = 6,000 c.y.
HACKENSACK RIVER
FLOW
SCALE IN FEET
0
60
ORANGE & ROCKLAND UTILITIES (WEST NYACK SERVICE BUILDING)
OLD NYACK TURNPIKE
FORMER UST AREA
EXISTING UST AREA
FORMER DRY WELL AREA
UNLOADING DOCK
PLATFORM
RAMP
EXISTING ASPHALT
GATE
CONCRETE RETAINING WALL
TP-96-1
TP-96-2
TP-96-3
MW-1
MW-2
MW-3
MW-4
MW-6
MW-8S
MW-9B
EXW-1
EXW-4
EXW-5
UST-SB-3
UST-SB-6
UST-SB-9
GAS PUMP

exhibiting total xylene concentrations at or above 1.2 ppm, which ranges from existing grade to a maximum depth of 14 feet below grade. For the purpose of calculating the volume of excavated soil, it was assumed that the average depth was 10 feet over an area approximately 16,200 square feet.

The limits of the areas to be excavated would be refined, if necessary, during excavation activities. Excavated areas would be backfilled with clean fill material and graded to blend with surrounding areas. The excavated soil would be transported to an appropriate off-site facility for treatment and/or disposal.

It is estimated that the contamination has migrated toward the service building but has not migrated beneath the foundation. Therefore, soil would be excavated and sheet-piling would be used as necessary to maintain the excavation and protect the integrity of the building foundation.

It would be necessary to remove the existing UST to implement this alternative. The excavated area would be backfilled with a clean fill material and compacted. Additionally, the Site would be paved in conjunction with the selected PCB remedial alternative.

This alternative would include a groundwater and surface water monitoring program. Groundwater and surface water monitoring would be performed to evaluate the effect of source removal and capping the Site on groundwater volatile organic concentrations. At the end of a two year period the groundwater and surface water data would be evaluated to determine if additional groundwater monitoring and/or treatment was required.

4.4.3.2 Assessment

Overall Protection of Human Health and the Environment

This alternative would provide a high level of protection to human health and the environment. Potential risks resulting from exposure to BTEX compounds in soils would be eliminated under this alternative. The BTEX contaminated soils would be treated and/or disposed of off-site at a NYSDEC approved facility. Although this alternative would address the BTEX source area, it would not address existing BTEX impacted groundwater. However, with removal of the BTEX source and capping of the Site, natural attenuation and biodegradation will over time result in a reduction in groundwater BTEX concentrations. This alternative would not address the chlorinated hydrocarbons detected in Site groundwater.

Compliance with ARARs

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes soil clean up objectives for BTEX compounds of 0.06, 1.5, 5.5, and 1.2 ppm respectively. This alternative proposes excavation of all soils which exhibit total xylene concentrations above the recommend soil cleanup objective of 1.2 ppm. Although it is potentially possible that some soils exhibiting benzene, toluene and ethylbenzene above the respective recommended soil cleanup objectives (0.06, 1.5 and 5.5 ppm, respectively) would remain, the most significantly impacted soils will have been removed. The significant source material would be removed and the recommended soil cleanup objectives would be satisfied to a significant extent.

Long-term groundwater and surface water monitoring would be performed to evaluate the effect of source removal and capping the Site on groundwater volatile organic concentrations. At the end of a two year period the groundwater and surface water data would be evaluated to determine if additional groundwater treatment was required.

Long-Term Effectiveness and Permanence

Residual risk: The risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils are mitigated effectively by removal of the affected soil and asphalt pavement of the Site. Off-site treatment and/or disposal of affected soils in an off-site industrial landfill effectively isolates the constituents from potential receptors, and also greatly reduces contaminant mobility.

Adequacy of controls: Off-site treatment or disposal at a landfill facility will prevent direct contact to any receptors. Groundwater monitoring would be performed for a period of two yeas to determine if the BTEX source removal was effective in reducing groundwater concentrations. After two years the data will be evaluated to determine if additional groundwater monitoring or remediation is required.

Reliability of controls: No on-site controls would be required because the BTEX impacted soil would be removed. It is anticipated that an off-site disposal facility could function properly for an indefinite period of time, assuming proper maintenance.

Reduction of Toxicity, Mobility and Volume Through Treatment

The toxicity of the materials being excavated and removed would be reduced if treated off-site but would not be reduced by landfill disposal. However, reduction in contaminant mobility is achieved by encapsulation of the material within a controlled landfill environment.

Short-Term Effectiveness

There would be minimal impact to the community during the implementation of this alternative, since Site access is limited. Fugitive dust would be controlled using engineering measures. Traffic increases due to transportation of soil would have minimal impact on the community as this is a one time occurrence with an approximate duration of 8.5 weeks.

Workers involved with the soil excavation, transport, and disposal activities could be exposed to the risks associated with dermal contact with contaminated soil and inhalation of soil dust particulates. Risks would be mitigated by properly outfitting workers with appropriate personal protection equipment, following proper industrial hygiene procedures, using controlled excavations, and monitoring air quality during soil excavation activities. Groundwater encountered during the excavation would be placed in portable tanks and treated via carbon absorption. All work associated safety practices would be outlined in a Health and Safety Plan, including a description of the control measures that would be implemented at the Site. The Health and Safety Plan would be reviewed by the NYSDEC.

Implementability

Ability to Construct and Operate: All components of Alternative BTEX-S3 utilize relatively common construction equipment and materials. Soil excavation and removal utilizes routine construction procedures. It may not be necessary to obtain a hazardous waste generator USEPA Identification number under the exemption of the Federal Code of Regulations CFR 40 § 261.4 and 6NYCRR Part 371.

Reliability: All aspects of this alternative would be highly reliable in achieving the remedial action objectives as it involves proven technologies. All components of Alternative BTEX-S3 utilize common construction materials and procedures, and routine sampling procedures and analyses.

Availability of Materials and Services: There are no aspects of this alternative that would require specialty services. All equipment and materials are available locally and have been demonstrated sufficiently for the purpose for which they are intended. Nearby industrial/commercial facilities have been identified as potentially capable of receiving such waste. It is anticipated, once the contractor is mobilized to the Site, that excavation, confirmatory sampling, transport and backfilling activities would be completed within a 8.5 week time frame.

Cost

The costs associated with Alternative BTEX-S3 have been estimated as shown on Table 4-10. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-8. The estimated costs for this alternative are $879,900. There are no operation and maintenance costs associated with alternative BTEX-S3.

4.4.4 Alternative BTEX-S4 - Biosparging

4.4.4.1 Description

This alternative would involve a system of injection wells to introduce oxygen rich air below the subsurface in both the unsaturated and saturated zone to enhance biodegradation, and to a lesser extent, volatilization of petroleum hydrocarbons. A SVE system would be utilized to extract vapors induced by the sparging action. Finally, an asphalt cap would be placed over the contaminated area and the remainder of the Site. Observation wells would be used to monitor the effectiveness of the system.

The system would include two injection wells designed to deliver air into the subsurface at a low pressure and flow rate utilizing a blower or compressor. The injection wells would be designed to enhance biodegradation and to a lesser extent, volatilization. The wells would be strategically placed so that the entire contaminant plume lies within the influence of the wells. The method of vapor extraction would consist of horizontal perforated PVC pipe placed at the ground surface but below an asphalt cap. The costs for the asphalt cap are not included in this alternative since they are part of Alternative PCB-S2.

Due to the presence of a low permeability organic silt layer in parts of the area to be treated, there will be a tendency for sparge air to form "bubbles" beneath the low permeability zone and migrate laterally. This lateral migration may result in vapor entering basements or, over the course of the remedial program, spread contaminants to peripheral areas of the site. The incidental migration of contaminants by application of sparging has been observed at other sites. Also the organic silt layer would act as a barrier to increasing oxygen levels within the organic silt layer and therefore, biodegradation would be inhibited.

This alternative would most likely not result in a significant degradation of chlorinated compounds in the overburden or bedrock groundwater since the chlorinated compounds are less amenable to aerobic biodegradation. Chlorinated compounds can be bio-degraded by facultative anaerobic bacteria. However, existing site data indicates that there is minimal biodegradation of the chlorinated compounds occurring at the Site. This is confirmed by the general absence of vinyl chloride in groundwater.

4.4.3.2 Assessment

Overall Protection of Human Health and the Environment

This alternative would provide a high level of protection to human health and the environment. Potential risks resulting from exposure to BTEX compounds would be eliminated under this alternative. Clean up objectives for BTEX compounds would be met since the contaminated soils would be treated on site and constituents permanently removed from the soil over an extended period of time (estimated at five years). However, as previously discussed this alternative will not have a significant impact on the overburden or shallow bedrock chlorinated volatile organic concentrations.

Compliance with ARARs

The NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 proposes soil clean up objectives for BTEX compounds of 0.06, 1.5, 5.5, and 1.2 ppm respectively. The Site currently exhibits contamination levels above these objectives. The biosparging technology has the potential to meet groundwater ARARs for BTEX compounds in the overburden flow zone. However, as previously discussed, the presence of the organic silt layer would impact the effectiveness of this alternative. This alternative does not address chlorinated volatile organics in either the overburden or shallow bedrock flow zones; chlorinated organics are not readily biodegraded in the aerobic conditions associated with biosparging.

Long-Term Effectiveness and Permanence

Residual risk: The risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils with respect to BTEX compounds would be mitigated by biosparging providing the organic silt layer does not substantially interfere. Remediation would ultimately achieve soil clean up goals and overburden flow zone BTEX groundwater ARARs, and reduce residual risk overtime.

Adequacy of controls:

This alternative would effectively reduce BTEX compounds in the soil and the overburden groundwater flow zone provided the organic silt layer does not significantly impair the effectiveness of the system. Long term monitoring would be implemented to evaluate the system performance.

Reliability of controls: Maintenance and monitoring of wells and the treatment system would be performed to determine that they are operating reliably. An Operations, Maintenance, and Monitoring manual would be provided.

Reduction of Toxicity, Mobility and Volume Through Treatment

Through on-site treatment, the toxicity, mobility, and volume of BTEX compounds on site would be effectively reduced, assuming that the organic silt layer does not impact the effectiveness of the biosparging and continue to act as a source of groundwater contamination. The asphalt cap would effectively prevent off-site migration and human and environmental contact.

Short-Term Effectiveness

There would be minimal impact to the community during the implementation of this alternative, since the Site is isolated and access is limited. Vapors extracted from the soil will be treated utilizing vapor phase granular activated carbon.

Workers involved with construction activities could be exposed to the risks associated with dermal contact with contaminated soil and inhalation of soil dust particulates. Risks would be mitigated by properly outfitting workers with appropriate personal protection equipment, following proper industrial hygiene procedures, using controlled excavations, and monitoring air quality. All work associated safety practices would be outlined in a Health and Safety Plan, including a description of the control measures that would be implemented at the Site. The Health and Safety Plan would be reviewed by the State.

Implementability

Ability to Construct and Operate: The installation of point wells and monitoring wells for Alternative BTEX-S4 utilize relatively common construction equipment and materials. Construction and Operations and Maintenance associated with this alternative could be successfully implemented. However, the low permeability organic silt layer in parts of the area to be treated, could cause a tendency for sparge air to form "bubbles" beneath the low permeability zone and migrate laterally. This lateral migration may result in vapor entering basements or, over the course of the remedial program, spread contaminants to peripheral areas of the site. Also the organic silt layer would act as a barrier to increasing oxygen levels within the organic silt layer and therefore, biodegradation would be inhibited.

This alternative would not result in a significant degradation of chlorinated compounds in the overburden or bedrock groundwater since the chlorinated compounds are less amenable to aerobic biodegradation. Chlorinated compounds can be bio-degraded by facultative anaerobic bacteria. However, existing site data indicates that there is minimal biodegradation of the chlorinated compounds occurring at the Site. This is confirmed by the general absence of vinyl chloride in groundwater. Improving on-site conditions to enhance the anaerobic degradation of the chlorinated volatile organics is not considered feasible.

Reliability: All aspects of this alternative would be highly reliable in achieving the remedial action objectives as it involves proven technologies. All components utilize common construction materials and procedures, and routine sampling procedures and analyses. However, the effectiveness of biosparging in the BTEX area at this particular site would require further evaluation via pilot testing. The shallow groundwater table and the organic silt layer present at the Site may limit the effectiveness of this technology.

Availability of Materials and Services: There are no aspects of this alternative that would require specialty services. All equipment and materials are available locally and have been demonstrated sufficiently for the purpose for which they are intended. It is anticipated, once the contractor is mobilized to the Site, that construction activities would be completed within 12 weeks.

Cost

The costs associated with Alternative BTEX-S4 have been estimated as shown on Table 4-11. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-7. Costs for annual operation and maintenance would be incurred for a period of five years and the present worth values are based on operation for five years. The estimated capital, expenses and annual operation and maintenance costs are $77,000, $130,800 and $60,000, respectively. The estimated present worth cost is $435,247.

4.5 COMPARISON OF GROUNDWATER ALTERNATIVES

This analysis provides a comparative assessment of the groundwater alternatives to evaluate the relative performance of each in relation to the specific evaluation criteria. The results of the individual analyses (Section 4.2) are used to determine which alternative best satisfies the evaluation criteria. The purpose is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced can be identified.

Consistent with the 1988 USEPA guidance for conducting an RI/FS under CERCLA, the overall protection of human health and the environment is a threshold criterion that an alternative must meet to be selected as a proposed remedy. Compliance with ARARs is also a threshold criterion, unless a waiver is involved. The five primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume of waste; short-term effectiveness; implementability; and present worth of capital and operating costs. The comparative analysis focuses mainly on those aspects of the alternatives that are unique for each.

4.5.1 Overall Protection of Human Health and the Environment

This criterion evaluates how well each of the alternatives protects human health and the environment, and how each alternative is consistent with the groundwater Remedial Action Objectives.

Alternative G1, the No Action Alternative, is the least protective of human health and the environment as it does not prevent ingestion of untreated groundwater and it provides no means of monitoring the distribution or migration of VOCs in groundwater. Alternatives G2, G3 and G4 are equally as protective of human health with regard to future ingestion of untreated groundwater on the Site, which would be prevented through deed restrictions. Under Alternative G2 there is a short-term increased potential for off-site migration of VOCs resulting from the outward gradient created by air-sparging induced mounding.

Future downgradient use of untreated fractured bedrock groundwater with chlorinated hydrocarbon concentrations above the NYSDEC groundwaters would not be prevented by Alternatives G2 and G4. However, there are no known groundwater potable water supplies located downgradient of the Site within two miles. Additionally, the source of TCE, which is the principle chlorinated volatile organic detected in the fractured bedrock, is believed to originate upgradient and off the Site. Therefore, any on-site treatment of volatile organics in the fractured bedrock would not result in the long-term permanent reduction of groundwater TCE concentrations.

Alternative G3 would be most protective of the environment since the VOCs in groundwater would be contained on-site and removed through pumping and treating the groundwater. Alternative G3 would be protective of human health and the environment and would meet the Remedial Action Objectives. Additionally, alternative G3 would be used as part of the treatment process for the BTEX soil vapor extraction alternative (BTEX-S2). However, the NYSDEC has expressed a concern with respect to the long-term effectiveness of alternative G3 because of the sorptive capacity of the organic silt layer. Additionally, alternative G3 would not eliminate TCE concentrations in the bedrock flow regime since the source of TCE is believed to be located upgradient of the ORU Site, therefore the advantage of alternative G3 over alternatives G2 and G4 is negated.

4.5.2 Compliance with ARARs

This criterion is used to assess how successful an alternative is in attaining action-, location- and chemical-specific ARARs and as such, is consistent with the Remedial Action Objectives for groundwater.

It is anticipated that given adequate time, each of the alternatives would meet chemical-specific ARARs. Under Alternative G1 the time to achieve ARARs in both the overburden and fractured bedrock flow regimes is dependent entirely on natural attenuation and degradation of VOC concentrations. These natural processes would include dilution, dispersion, adsorption, and other physical, chemical and biological phenomena occurring in the water bearing unit and volatilization occurring at the river groundwater discharge points. Alternative G3 would achieve ARARS in a shorter time frame than Alternative G1, because of the flushing action associated with the Alternative G3 groundwater pump and treat system. The time to achieve ARARs in the overburden via Alternative G2 would likely be the shortest of the four alternatives due to active volatilization and treatment of the vapors.

Similar to Alternative G1, Alternative G4 would rely on natural attenuation and degradation to ultimately reduce groundwater/soil volatile organic concentrations. However, Alternative G4 would only be implemented in conjunction with a BTEX source removal remedial action, which would eliminate the source of BTEX and hasten the natural reduction in groundwater BTEX concentrations.

Alternative G1, G2 and G4 do not involve active treatment of groundwater in the fractured bedrock flow zone. Alternative G3 addresses groundwater in the fractured bedrock due to capture caused by active pumping. However, the TCE detected in the bedrock monitoring wells is believed to be related to an upgradient off-site source. Therefore, alternative G3 does not represent a remedy for reducing TCE concentrations in the fractured bedrock to concentrations that would be compliant with the groundwater standard. Since the fractured bedrock contamination will not be completely addressed by alternative G3 there is no advantage over alternative G2 and G4 and the additional cost associated with the G3 alternative may not be warranted.

No location-specific ARARs are applicable to Alternatives G1, G2 or G4 because no discharge of treated water is associated with these alternatives. If, under Alternatives G3, treated groundwater is discharged in the Hackensack River, the construction of an outfall structure would require substantive compliance with the Nationwide Program under the Clean Water Act. If excess treated groundwater is reinfected via site wells, substantive compliance with this Program would not be required.

No action-specific ARARs are applicable to Alternatives G1 and G4 because no discharge of excess treated water is associated with these alternatives. For Alternative G2, the air emissions from the SVE system would have to meet the NYSDEC Air Guide-1guidelines for the control of toxic ambient air contaminants. If, under Alternative G3, excess treated groundwater is discharged in the Hackensack River, SPDES requirements would apply. If excess treated groundwater is reinjected via Site wells, substantive compliance with the UIC Program may be required in addition to compliance with SPDES permit requirements. It is likely that effluent standards required for discharge to the river would be more stringent than for reinjection wells due to the consideration of protection to aquatic life. Variances to the effluent standards may be permitted if protection of human health and the environment can be demonstrated.

4.5.3 Long-Term Effectiveness and Permanence

This criterion is used to evaluate the residual long-term risks posed by the Site and the long-term adequacy and reliability of controls.

Alternative G1 is neither effective nor permanent because it would not prevent ingestion of impacted groundwater and it provides no mechanism for monitoring reduction of VOCs over time. Alternatives G2, G3 and G4 are equal with respect to long-term effectiveness and permanence of BTEX in the overburden since each prevents ingestion of on-site untreated groundwater via deed restrictions and each includes provisions for monitoring the reduction of VOCs over time. Alternative G3 provides the added benefit of actively remediating the chlorinated volatile organics in the fractured bedrock zone through the groundwater extraction and treatment system which captures and removes the impacted overburden and fractured bedrock groundwater, thereby, eliminating the potential for off-site migration of untreated groundwater that could occur under Alternatives G2 and G4. However, as previously stated, alternative G3 will not result in eliminating TCE in the fractured bedrock since the source is believed to be located upgradient and off of the ORU facility. Therefore, the advantage of this alternative over alternatives G2 and G4 is negated.

4.5.4 Reduction of Toxicity, Mobility & Volume Through Treatment

This criterion is used to evaluate how well the alternative satisfies the regulatory preference towards treatment. The USEPA prefers a remedy that eliminates significant site threats through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of the total volume of contaminated media.

Alternative G1 would reduce the toxicity, mobility or volume of the VOCs in groundwater through natural attenuation and degradation. Alternative G2 would reduce the volume via active treatment of groundwater in the overburden flow zone. However, Alternative G2 would not include active treatment of impacted groundwater in the fractured bedrock flow zone. Alternative G3 would reduce the mobility and volume of a significant portion of the groundwater containing VOCs through pumping and on-site treatment. This alternative would not result in removing TCE as a fractured bedrock zone contaminant since the TCE source is believed to be located off-site and not related to the ORU facility.

Alternative G4 would be combined with a BTEX source removal program. The BTEX impacted soil would be removed from the Site and treated and/or landfilled. This would result in a permanent reduction in the volume of BTEX impacted soils on-site. If the soil was treated (i.e., via soil roasting) there would be a permanent reduction in toxicity and mobility.

4.5.5 Short-Term Effectiveness

This criterion is used to evaluate how effective an alternative is in mitigating immediate site hazards, and to determine whether implementation of the remedial action would result in risks to the community, workers or the environment.

Alternative G1 does not pose any short-term risks since they require no remedial construction. Alternative G2 involves the installation of air sparging points and soil vapor extraction trenches which could pose short-term risks associated with potential direct contact with impacted groundwater and soil. Other short-term risks with Alternative G2 include the potential for uncontrolled release of vapors that may migrate laterally and pose the potential for off-site migration of VOCs due to air sparging related mounding. Alternative G3 includes installation of pumping wells or trenches which could pose short-term risks associated with potential direct contact with impacted soil or water.

Alternative G4 involves groundwater and surface water monitoring which do not pose any short-term risks. However, this alternative would be combined with a BTEX source removal remedial action which would involve on-site excavation activities and transport of BTEX impacted soils from the Site.

The minor risks associated with Alternatives G2,G3 and indirectly G4, could be easily controlled with proper construction, and health and safety practices.

4.5.6 Implementability

This criterion is used to evaluate the ease with which an alternative can be constructed, operated, monitored, maintained, or upgraded, if necessary.

Alternatives G1 would not require any construction, operation or monitoring, therefore implementability does not apply. The installation of the air sparging points and the soil vapor extraction system under Alternative G2 would not require any specialized equipment or contractor and could be implemented using common construction practices. Under Alternative G3 installation of new recovery wells and construction of a treatment system and discharge system would require no specialty equipment or contractors and could be implemented using common construction practices. Alternative G4 would not require and specialized equipment or services. The well installation and groundwater and surface water monitoring proposed by Alternative G4 utilize established common technologies.

4.5.7 Costs

This criterion is used to evaluate all costs and cost uncertainties associated with implementing and maintaining the remedial alternatives. Table 4-1 is a summary of the costs for each of the groundwater alternatives.

Alternative G4 would have significantly lower costs than both Alternative G2 and G3. However, alternative G4 would not be implemented without a BTEX source removal remedial action which would make the costs associated with Alternative G4 equivalent to the high end of the costs associated with Alternative G2 and slightly lower than Alternative G3.

4.6 COMPARISON OF PCB SOIL ALTERNATIVES

This analysis provides a comparative assessment of the PCB soil alternatives to evaluate the relative performance of each in relation to the specific evaluation criteria. The results of the individual analyses (Section 4.3) are used in this evaluation to determine which alternative best satisfies the evaluation criteria. The purpose is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced can be identified. The comparative analysis focuses mainly on those aspects of the alternatives that are unique for each.

4.6.1 Overall Protection of Human Health and the Environment

For all alternatives, the perimeter fence provides some measure of protection of human health and the environment by limiting access to the ORU Site. Of the three remedial alternatives evaluated, Alternative PCB-S1, the No Action Alternative, is the least protective of human health and the environment as it does not prevent exposure or further reduce potential risks to human heath and the environment. Alternative PCB-S2 (Excavation, disposal, asphalt cover and institutional controls) is significantly better than Alternative PCB-S1 in that it would remove soils with PCB concentrations above 10 ppm, effectively isolate remaining contaminated soils and greatly limit the potential for exposure. Soils with PCB concentrations greater than 10 ppm would be excavated and then transported off-site for disposal at a permitted waste facility. It would also serve to lower the potential for future risks to human health by limiting land use at areas around the ORU service building.

The overall protection of human health and the environment for Alternative PCB-S2 is high compared to Alternatives PCB-S1. Alternative PCB-S3 is not significantly more protective of human health and the environment than alternative PCB-S2. Alternative PCB-S3 would effectively remove the contaminated soils and eliminate the potential for exposure. The contaminated soils would be excavated and then transported off-site for disposal in a permitted waste facility.

4.6.2 Compliance with ARARs

Under Alternative PCB-S1, the No Action Alternative, compliance with ARARs would not be satisfied because contaminated soil would not be treated or removed.

Alternative PCB-S2 would meet the Federal TSCA ARAR for restricted access sites, which is clean up of soils with PCB concentrations in excess of 25 ppm and the NYSDEC soil clean up objective of 10 ppm for subsurface soils.

As previously mentioned, the ORU site will be capped. The cap will consist of a 12 inch structural sub-base, a 3 inch binder course and 1.5 inches of asphalt, resulting in approximately 16.5 inches of clean material over the top of the existing land surface. This 16.5 inch cap of clean material would eliminate exposure to the original Site surface soils. Therefore, this alternative is as protective of human health and the environment as the NYSDEC recommended surface soil (top two feet) cleanup objective of 1 ppm. Alternative PCB-S2 would effectively contain and isolate remaining soils under the asphalt cap.

Alternative PCB-S3 would satisfy the NYSDEC ARARs of 1 ppm for surface soils and 10 ppm for subsurface soils by excavation and removal of surface soils with PCB concentrations above 1 ppm and subsurface soils with concentrations in excess of 10 ppm.

4.6.3 Long-Term Effectiveness and Permanence

This criterion is used to evaluate the residual long term risks posed by the Site and the long term adequacy and reliability of the controls.

Alternative PCB-S1, the No Action Alternative, is neither effective nor permanent because there remains a long-term risk from exposure to contaminated soils. Alternative PCB-S2 is significantly more effective in reducing long term residual risks since the soils with concentrations above 10 ppm would be removed and remaining soil would be isolated under an asphalt cap. However, because this alternative relies on isolation rather than removal, cap demarcation and maintenance would be required to ensure cap integrity. Under Alternative PCB-S3 long term residual risks due to exposure to contaminated soils above 1 ppm would be eliminated. Off-site disposal would effectively and permanently remove the soil from the Site.

4.6.4 Reduction of Toxicity, Mobility and Volume Through Treatment

Alternative PCB- S1 does not involve any type of treatment or removal for affected soils at the Site and therefore would not reduce the toxicity, mobility or volume of affected soils. Alternative PCB-S2 involves removal of soils with PCB concentrations above 10 ppm and installation of an asphalt cap over the remaining soils and therefore, there would be a reduction in contaminant volume. Contaminant mobility, primarily by water erosion, would also be greatly reduced. Alternative PCB-S3 provides the greatest reduction in the volume of Site contaminants by removal of affected soils above 1 ppm to a secure landfill facility. Reduction in mobility of contaminants would be achieved by encapsulation in a secure landfill. Toxicity of the contaminated soil is not reduced since the soil will not be treated.

4.6.5 Short-Term Effectiveness

No short-term impacts to human health or the environment would result from Alternative PCB-S1 since no construction, treatment, removal, or transport of affected soils would take place. Alternatives PCB-S2 and PCB-S3 also pose only minimal risk to the community, since off-site transport of affected soils would be limited to a one time occurrence for a short duration. Properly fitting workers with personal protective equipment during excavation, transport, and disposal mitigate exposure risks.

4.6.6 Implementability

Alternative PCB- S1 is readily implementable since no construction or Site activities are part of this alternative. Both Alternatives PCB-S2 and PCB-S3 could be implemented with little or no difficulty using readily available materials, equipment, and construction practices.

4.6.7 Cost

Table 4-5 provides a summary of the costs for each of the soil alternatives. Alternative PCB-S2 which provides a level of protection basically equivalent to alternative PCB-S3, is considerably more cost effective than alternative PCB-S3.

4.7 COMPARISON OF BTEX SOIL ALTERNATIVES

This analysis provides a comparative assessment of the BTEX soil alternatives to evaluate the relative performance of each in relation to the specific evaluation criteria. The results of the individual analyses (Section 4.4) are used in this evaluation to determine which alternative best satisfies the evaluation criteria. The purpose is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced can be identified. The comparative analysis focuses mainly on those aspects of the alternatives that are unique for each.

4.7.1 Overall Protection of Human Health and the Environment

For all alternatives, the perimeter fence provides some measure of protection of human health and the environment by limiting access to the ORU Site. Of the four remedial alternatives evaluated, Alternative BTEX-S1, the No Action Alternative, is the least protective of human health and the environment as it does not prevent exposure or further reduce potential risks to human health and the environment.

Alternative BTEX-S2 (Dual Phase Groundwater/Vapor Extraction) is significantly better than Alternative BTEX-S1 in that it would effectively depress the water table, extract the vapors from the soil, and pump and treat groundwater. However there is a concern that the organic silt layer would reduce the efficiency of alternative BTEX-S2 and that this alternative would potentially not meet the remedial objective of treatment of BTEX impacted soils and groundwater. The overall protection of human health and the environment for Alternative BTEX-S2 is high compared to Alternative BTEX-S1.

Alternative BTEX-S3 (Excavation of BTEX Impacted Soils) would result in protection of human health and the environment through off-site treatment and/or disposal of contaminated soil. BTEX impacted soil would be removed via excavation. This remedial action would be accomplished in a much shorter period of time than Alternative BTEX-S2 or BTEX-S4.

As with Alternative BTEX-S2, Alternative BTEX-S4, biosparging, would provide a high level of protection over an extended period of time. Alternative BTEX-S4 would treat via biodegradation the BTEX impacted groundwater and subsurface soils. However, similar to BTEX-S2, the presence of the organic silt layer would potentially reduce the effectiveness of this alternative.

4.7.2 Compliance with ARARs

Under Alternative BTEX-S1, the No Action Alternative, compliance with ARARs would not be satisfied since contaminated soil would not be treated or removed. Clean up of BTEX impacted soil via Alternatives BTEX-S2, BTEX-S3, and BTEX-S4 would be achieved. Under Alternative BTEX-S2 and BTEX-S4, ARARs for both soils and overburden groundwater would most likely be met, although there is a concern about the effectiveness of these two procedures due to the presence of the organic silt layer.

Under Alternative BTEX-S3, BTEX impacted soils with total xylene concentrations greater than 1.2 ppm would be removed and treated an/or disposed of off-site. The ARAR for total xylene, which would result in the removal of essentially the most significant volume of BTEX impacted soil, would be achieved. This alternative would remove the large majority of the BTEX source area.

4.7.3 Long-Term Effectiveness and Permanence

This criterion is used to evaluate the residual long-term risks posed by the Site and the long term adequacy and reliability of the controls.

Alternative BTEX-S1, the No Action Alternative, is neither effective nor permanent because of the residual long-term risks due to potential exposure to contaminated soils. Alternatives BTEX-S2, BTEX-S3 and BTEX-S4 are more effective in reducing long term residual risks since the contaminated soil would be treated or removed during the remediation period. Alternatives BTEX -S2 and BTEX-S4 would require operation and maintenance since these alternatives rely on treatment rather than removal. Alternative BTEX-S3 is effective as it eliminates residual risks and provides long term effectiveness and permanence that would be achieved in a shorter period of time.

4.7.4 Reduction of Toxicity, Mobility and Volume Through Treatment

Alternative BTEX- S1 does not involve any type of treatment or removal for affected soils at the Site and therefore, would not reduce the toxicity, mobility or volume of affected soils.

Alternative BTEX-S2 involves groundwater and vapor extraction, therefore, toxicity and volume of contaminated soil are reduced through vapor extraction and the volume and mobility of impacted groundwater (both BTEX and chlorinated VOCs) is reduced by groundwater extraction. However, the presence of the organic silt layer could potentially interfere with the effectiveness of this alternative, even with the installation of soil gravel columns to increase the permeability of this layer.

Alternative BTEX-S3 effectively reduces the mobility and volume of the BTEX impacted soils since the affected soil is permanently removed from the Site. Toxicity would be reduced if the soil was treated prior to disposal. This alternative is specifically targeted to BTEX impacted soils and would not address chlorinated volatile organics in the overburden or shallow bedrock groundwater.

Alternative BTEX-S4 would reduce the toxicity, mobility, and the volume of contamination associated with BTEX impacted soils and groundwater. Similar to Alternative BTEX-S2, the presence of the organic silt layer could potentially interfere with the effectiveness of this alternative, even with the installation of soil gravel columns to increase the permeability of this layer. This alternative would most likely not result in a significant reduction in the volume, toxicity or mobility of chlorinated compounds in the groundwater. Chlorinated compounds are less amenable to aerobic biodegradation, but can be bio-degraded by facultative anaerobic bacteria. However, existing site data indicates that there is minimal biodegradation of the chlorinated compounds occurring at the Site. This is confirmed by the general absence of vinyl chloride in groundwater.

4.7.5 Short-Term Effectiveness

No short-term impacts to human health or the environment would result from Alternative BTEX-S1 since no construction, treatment, removal, or transport of affected soils would take place. Under Alternative BTEX-S2, BTEX-S3, and BTEX-S4 risks to the community would be minimal.

Although Alternative BTEX-S3 would require off-site transport of impacted soils, the remedial effort would be of limited duration. Risks associated with construction activities would be mitigated by properly outfitting workers with appropriate personal protection equipment, following proper industrial hygiene procedures, and monitoring air quality during remedial activities.

4.7.6 Implementability

Alternative BTEX-S1 is readily implementable since no construction or Site activities are part of this alternative. Alternatives BTEX-S2, BTEX-S3, and BTEX-S4 could be implemented with little or no difficulty using readily available materials, equipment, and construction practices. However, implementation of Alternatives BTEX-S2 and BTEX-S4 would require pilot testing to evaluate the effectiveness of the system with existing Site conditions and the impact of the organic silt layer on these technologies.

4.7.7 Cost

Table 4-8 provides a summary of the costs for each of the soil alternatives. The costs associated with alternative BTEX-S2 would appear to be lower than both Alternative BTEX-S3 and BTEX-S4, however, this remedial alternative would not be implemented as a stand alone alternative, but in conjunction with a groundwater pump and treat alternative (G2). Therefore, the BTEX-S2 alternative would not be more cost effective than the BTEX-S3 or BTEX-S4 options.

Although Alternative BTEX-S4 would be implemented as a stand alone option and would appear to be the most cost effective, the effectiveness of this option has been questioned due to the presence of the organic silt layer.

The cost associated with Alternative BTEX-S3 appears higher than either BTEX-S2 or BTEX-S4. However, unlike Alternative BTEX-S2, the BTEX-S3 remedial action would not be associated with a high cost groundwater pump and treat remedial action. The BTEX-S3 remedial action would result in the excavation and off-site treatment and/or disposal of contaminated soil and unlike Alternative BTEX-S4, the organic silt layer would not have an impact on the effectiveness of this the BTEX -S3 remedial alternative.

4.8 RECOMMENDED ALTERNATIVES

This section presents the recommended alternatives for remediation at the ORU Site. Recommended remedial alternatives are presented for PCB impacted soils, BTEX impacted soils, and groundwater. The recommended alternatives were selected based on the results of the RI and the evaluation conducted in this FS.

4.8.1 PCB Impacted Soils

The recommended remedial alternative for PCB impacted soils is Alternative PCB-S2, Excavation, Disposal, Asphalt Cover, and Institutional Controls. This recommendation is based on the criteria evaluated in this FS.

The RI identified two areas of the Site with surface soil PCB concentrations that exceed the NYSDEC ARARs of 1 ppm and one isolated area that exhibited sub-surface soil concentrations greater than the NYSDEC ARARs of 10 ppm. Three isolated areas exhibited soil PCB concentrations that exceeded the federal cleanup criteria of 25 ppm for restricted access areas. The FS identifies remedial action objectives, screens selected remedial technologies and evaluates the technologies that passed the screening process.

The evaluation concludes that Alternative PCB-S2, which consists of limited excavation and disposal, asphalt pavement and institutional controls would be effective in achieving the remedial action objectives. This alternative would be protective of human health and the environment as it would meet federal ARARs by removing soils exhibiting PCB concentrations greater than 10 ppm. Protection would also be provided by installation of an asphalt cap across the Site. The asphalt cap would consist of twelve inches of a structural sub-base, three inches of a binder course, and a one and a half inch wearing course. Therefore, this alternative will be as protective of human health as the NYSDEC 1 ppm surface soil cleanup objective. The asphalt cap will act as an effective barrier to erosion and transport of contaminated soils to the Hackensack River and therefore, is protective of aquatic life.

This alternative would provide a long-term, effective remediation. Since the highly impacted soils would be removed from the site, the risk to receptor, both current and future would be eliminated. Institutional controls would ensure that the cap is maintained and exposure limited. Contaminant mobility is also limited by installation of the asphalt cap.

Although this alternative would not result in a reduction in toxicity of the material, a reduction in contaminant mobility is achieved by removal of the highly impacted soils from the site and encapsulation in a secure landfill.

This alternative would have minimal impact on the community during implementation. Fugitive dusts would be controlled and perimeter air monitoring would be performed. Traffic increases due to trucking would be minimal since this is a one-time occurrence and would be completed within an approximately five week time period.

This alternative would be readily implemented. Excavation and capping use readily available technology and materials. Deed restrictions would be filed with the property deed at the county courthouse and would insure that use of the Site is restricted.

The cost associated with this alternative is greater than the no action Alternative, PCB-S1. However, the PCB-S1 alternative would not meet the remedial objectives. The $15,000 annual operation and maintenance cost associated with alternative PCB-S2 would be continued indefinitely, but the total present worth cost of $598,759 is considerably less than the total present worth cost of $1,483,000 for Alternative PCB-S3.

Alternative PCB-S3 consists of excavation of surface soils exhibiting concentrations above 1 ppm and sub-surface soils with concentrations above 10 ppm. By removing PCB impacted soils with concentrations in excess of 10 ppm and isolating remaining soils with almost two feet of clean material (Asphalt Cap), Alternative PCB-S2 is as protective of human health and the environment as Alternative PCB-S3. Therefore, Alternative PCB-S2 is a more cost effective remedial alternative.

4.8.2 BTEX Soil Alternatives

The recommended alternative for BTEX soils is alternative BTEX-S3, excavation and disposal. This alternative was selected based on the evaluation criteria presented in this FS report.

The RI identified that unsaturated soils in the vicinity of the former leaking underground storage tank exhibit BTEX concentrations that exceed the NYSDEC ARARs and represent an active source of potential groundwater contamination. The RI also indicated that overburden groundwater at the Site exhibits BTEX concentrations that exceed the NYSDEC groundwater standards.

Alternative BTEX-S3 will effectively achieve the remedial action objectives for the BTEX impacted soils. The impacted BTEX soil would be removed from the site for treatment and/or disposal. This will result in the significant elimination of the BTEX source material. This alternative includes quarterly monitoring of groundwater and Hackensack River surface water for volatile organics for a period of two years to evaluate the effectiveness of the source removal. At the end of a two year period the groundwater and surface water data would be evaluated to determine if continued groundwater monitoring and/or treatment was required.

Although alternatives BTEX-S2 and BTEX-S4 have lower costs than alternative BTEX-S3, the subsurface organic silt layer could potentially impact the effectiveness of these alternatives. Alternative BTEX-S2 would also require groundwater extraction and treatment because of the high groundwater table, which would negate its cost advantage over alternative BTEX-S3.

Alternative BTEX-S3 does not address the chlorinated volatile organics in the overburden groundwater or the fractured bedrock. The source of TCE, which is one of the primary chlorinated volatile organic compounds detected in groundwater, is believed to be from upgradient and off the Site. Therefore, treatment of fractured bedrock groundwater for chlorinated volatile organics will not result in attainment of ARARs.

4.8.3 Groundwater

The selected remedial alternative for groundwater is Alternative G4. This alternative consists of long-term groundwater and surface water monitoring and would be implemented in conjunction with soil Alternative BTEX-S3 which consists of BTEX source removal. Alternative G4 includes implementation of a deed restriction which would prevent ingestion of untreated groundwater at the Site.

The RI investigation revealed that overburden groundwater exhibits concentrations of BTEX compounds and chlorinated volatile organics that exceed the NYSDEC groundwater standards. It is anticipated that removal of the BTEX source (alternative BTEX-S3) and asphalt capping of the Site, will result in natural attenuation of the groundwater volatile organic BTEX concentrations. Additionally, the Hackensack surface water analytical data indicates that Hackensack River surface water quality has not been impacted with respect to either BTEX or chlorinated volatile organic compounds, even though overburden groundwater from the Site does discharge to the Hackensack River. The most recent Hackensack River surface water analytical data (December 1996) are provided in Appendix D.

Although both overburden and fractured bedrock groundwater exhibit chlorinated hydrocarbon concentrations that exceed groundwater standards, the source of TCE, which is one of the primary chlorinated volatile organic hydrocarbons detected in groundwater, is believed to be from upgradient and off the Site. Therefore, treatment of groundwater for chlorinated volatile organics will not result in attainment of ARARs.

The G4 quarterly groundwater monitoring alternative will be implemented in conjunction with the BTEX-S3 remedial alternative, and will be used to monitor the effectiveness of the BTEX source removal. At the end of two years of quarterly monitoring, the data will be evaluated to determine if additional groundwater monitoring or treatment is required.

It is not anticipated that additional groundwater treatment will be required. The BTEX source removal remedial action will result in elimination of BTEX impacted soil as a threat to groundwater. Although chlorinated compound were detected in groundwater above the NYSDEC groundwater standard, no on-site source was identified. Also, there is no known potable use of groundwater within two miles downgradient of the Site. Hackensack River surface water analytical data indicate that the surface water quality has not been impacted. However, if it is determined that additional treatment of groundwater is warranted, the selected treatment alternative is Alternative G2.

The detailed analysis of the air sparging alternative indicated that the organic layer present below the water table across the northern section of the Site, would most likely severely restrict the performance of an air sparging system and possibly result in excessive groundwater mounding. Therefore, gravel soil columns would be installed to increase the permeability of the organic silt layer which was not removed as part of the BTEX-S3 alternative. A pilot test would be performed to evaluate the effectiveness of the gravel soil columns and the air sparging alternative prior to implementation.

Although air sparging is not likely to be effective in fractured bedrock, the primary contaminant in the fractured bedrock is TCE and the source of TCE is believed to be upgradient and off the Site.

Therefore, any treatment of the bedrock groundwater at the site would be ineffective unless the upgradient source is identified and remediated.

The overall present net worth costs associated with Alternative G2 are lower than alternative GW3. The only advantage alternative GW3 has over G2 is that groundwater in both the overburden and fractured bedrock would be captured and treated. However, as previously discussed the TCE detected in the fracturated bedrock is believed to be from a source upgradient and off the Site and pumping and treating groundwater from the fractured bedrock at the Site would not impact the long-term fractured bedrock TCE concentrations. Therefore, Alternative G2 would be implemented if additional groundwater treatment was required.

TABLE 4-1

Summary of Estimated Costs for Groundwater Alternatives
Orange and Rockland Utilities, Inc.

COSTS	Alternative G1	Alternative G2	Alternative G3	Alternative G4
	No Action	Air Sparging	Groundwater Extraction and Treatment	Groundwater Surface Water Monitoring
Capital Costs:	-	$229,000 - $497,000	$148,200	$7,805
Direct & Indirect Expenses	-	$127,600 - $203,200	$124,700	$47,320
Annual O&M Costs:	-	$70,000	$81,800	$0
Present Worth Costs: 10% discount rate		$635,741 - $947,129	$1,015,402	$55,125

Note:

1. There are no costs directly associated with Alternative G1 (No Action).
2. Present worth costs for Alternatives G2 and G3 are calculated based on 5 years and 25 years of operation and maintenance, respectively.
3. Costs associated with any necessary predesign studies are not included.

TABLE 4-2
Cost Estimate
ALTERNATIVE GW-2: Airsparging

	Item	Quant. Range		Unit Cost	Unit	Cost Range	
	Direct Capital Costs:						
1	Air injection wells	80	125	$1,500	ea	$120,000	$187,500
2	Vapor extraction piping/trenching	1980		$7 to $11	ft	$13,860	$21,780
3	Perimeter vapor control	890		$17 to $28		$15,130	$24,920
3	SVE/Sparge Equipment				ls	$62,000	$100,000
4	Soil vapor extraction (SVE) skid			$14,500	ls	$14,500	$14,500
5	Treatment building	400		$52	sf	$20,800	$20,800
6	Permeability enhancement	80	125	$350	ls	$350	$350
7	Deed Restriction			$5,000	ls	$5,000	$5,000
	Total Capital Costs					$251,640	$374,850
	Direct Expenses						
1	Mob/Demob/H&S Facilities			$2,500	ls	$2,500	$2,500
2	Oversight labor	320		$45	hr	$14,400	$14,400
	Total Direct Expenses					$16,900	$16,900
	Total Direct Capital and Expense Costs					$268,540	$391,750
	Indirect Expenses						
1	Engineering (25% of total direct costs)					$67,100	$97,900
2	Contingency (20% of total direct costs)					$53,700	$78,400
	Total Indirect Expenses					$120,800	$176,300
	Total Capital Costs & Direct & Indirect Expenses					**$389,340**	**$568,050**
	O & M Costs:						
1	Air-sparging/SVE system O&M				ls	$60,000	$90,000
2	Groundwater and Surface Water Mtrg.				ls	$5,000	$10,000
	Total Annual O&M Costs					$65,000	$100,000
	Present Worth Costs:						
1	Present Worth of Annual O&M Costs (10% discount rate, 5 years operation)					**$246,401**	**$379,079**
	TOTAL PRESENT WORTH					**$635,741**	**$947,129**

TABLE 4-3
Cost Estimate
ALTERNATIVE G3: Manage Plume through Groundwater Extraction and Treatment

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
1	Deed Restriction		$5,000	ls	$5,000
2	Add 2 new recovery wells	2	$10,000	each	$20,000
3	Pump, controls & apert. per well	2	$4,000	each	$8,000
4	Metering pit and discharge piping		$13,200	ls	$13,200
5	Perform step-rate pump test in 2 new wells	2	$4,000	well	$8,000
6	Treatment building	600	$55	sf	$33,000
7	Air stripper system		$50,000	ls	$50,000
9	Discharge piping to river outfall	200	$15	lf	$3,000
10	Outfall Structure		$8,000	ls	$8,000
	Total Capital Costs				$148,200
	Direct Expenses				
1	Treatment system start-up		$30,000	ls	$30,000
2	Permitting		$10,000	ls	$10,000
	Total Direct Expense Costs				$40,000
	Total Direct Capital and Direct Expense Costs				$188,200
	Indirect Expenses				
1	Engineering (25% of total direct costs)				$47,100
2	Contingency (20% of total direct costs)				$37,600
	Total Indirect Expenses				$84,700
	Total Capital Costs & Direct & Indirect Expenses				**$272,900**
	O & M Costs:				
1	Groundwater and surface water monitoring		$10,000	ls	$10,000
2	Treatment system O&M		$62,000	ls	$62,000
3	Well maintenance (14 wells total)	14	$700	well	$9,800
	Total Annual O&M Costs				$81,800
	Present Worth Costs:				
1	Present Worth of Annual O&M Costs (10% discount rate, 25 years)				**$742,502**
	TOTAL PRESENT WORTH				**$1,015,402**

Note:

1. The above table represents the estimated costs associated with installing two extraction wells and installing an shallow tray air stripper water treatment system with a 30 gpm capacity. Treated water would be discharged at an outfall structure on the Hackensack River. Costs do not include predesign studies that may be necessary.

TABLE 4-4
Cost Estimate
ALTERNATIVE GW-4: Groundwater and Surface Water Monitoring

	Item	Quant.	Range	Unit Cost	Unit	Cost Range
	Direct Capital Costs:					
1	Monitoring Well Installation	1		$2,805	ea	$2,805
2	Deed Restriction			$5,000	ls	$5,000
	Total Capital Costs					$7,805
	Direct Expenses					
1	Sample Collection,Analysis and Reporting (2 years)			$47,320	ls	$47,320
	Total Direct Expenses					$47,320
	Total Direct Capital and Expense Costs					$55,125

TABLE 4-5
Summary of Estimated Costs for PCB Soil Alternatives
Orange & Rockland Utilities, Inc.

COSTS	Alternative PCB-S1	Alternative PCB-S2	Alternative PCB-S3
	No Action	Excavation/Diposal, Asphalt Cover and Institutional Controls	Excavation and Disposal
Capital Costs :	-	$169,218	-
Direct & Indirect Expenses		$288,138	$1,483,000
Annual O&M Costs:	-	$15,000	-
Present Worth Costs: 10 % discount rate	-	$598,759	$1,483,000

Notes:

1. There are no costs directly associated with Alternative S1 (No Action).
2. Alternative PCB-S2 involves excavation of soil containing PCBs in excess of 10 ppm (419 cy) and installation of an asphalt cap.
3. Alternative PCB-S3 involves excavation of soil containing PCBs in excess of 1 ppm in surface soils and 25 in subsurface soils (totaling 3,050 cy).
4. Present worth costs were calculated based on 30 years of operation.

TABLE 4-6
Cost Estimate
ALTERNATIVE PCB-S2: Excavation/Disposal, Asphalt Cover and Institutional Controls

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
1	Backfill and compaction of excavated areas	419	$22	cy	$9,218
2	Asphalt Cover		$149,000	ls	$149,000
3	Oil/Water Separator		$6,000	ls	$6,000
4	Institutional contols (deed restrictions)		$5,000	ls	$5,000
	Total Capital Costs				$169,218
	Direct Expenses				
1	Mobilization/demobilization		$1,000	ls	$1,000
2	Construct soil staging areas		$1,500	ls	$1,500
3	Excavation and handling of PCB contaminated soils	419	$6	cy	$2,514
4	Confirmatory soil sampling	16	$130	ea	$2,080
5	Transport and disposal of soil	568	$300	ton	$170,400
6	Field oversight	60	$60	hr	$3,600
7	Health and safety facilities (decon)		$1,500	ls	$1,500
	Total Direct Expenses				$182,594
	Indirect Expenses				
	Engineering (10 % of total expenses)				$35,181
	Contingency (20 % of total expenses)				$70,362
	Total Indirect Expenses				$105,544
	Total Capital Costs & Direct & Indirect Expenses				**$457,356**
	O & M Costs:				
1	Maintenance of asphalt cap		$15,000	ls	$15,000
	Total Annual O&M Costs				$15,000
	Present Worth Costs:				
1	Present Worth of Annual O&M Costs (10% discount rate, 30 years)				**$141,404**
	TOTAL PRESENT WORTH				**$598,759**

TABLE 4-7
Cost Estimate
ALTERNATIVE PCB-S3: Excavation and Off-Site Disposal

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Costs:				
1	Mobilization/Demobilization		$1,000	ls	$1,000
2	Construct soil staging areas		$1,500	ls	$1,500
3	Excavation and handling of PCB contaminated soils	3,050	$13	cy	$39,650
4	Confirmatory soil sampling	16	$130	ea	$2,080
5	Transport and disposal of soil	4,000	$300	ton	$1,200,000
6	Backfill and compaction of excavated areas	3,050	$22	cy	$67,100
7	Field Oversight	210	$60	hrs	$12,600
8	Health and safety facilities (decon)		$1,500	ls	$1,500
	Total Direct Costs				$1,325,400
	Indirect Costs:				
1	Engineering (20% of total direct costs minus transport and disposal costs)				$25,100
2	Contingency (10% of total direct costs)				$132,500
	Total Indirect Costs				$157,600
	TOTAL COSTS				$1,483,000
	O & M Costs: There are no O&M costs associated with this alternative.				
	TOTAL PRESENT WORTH				$1,483,000

Note:

1. Transportation and disposal costs of all waste soils are based upon burial at CWM Chemical Services, Inc. located in Model City, New York.

TABLE 4-8
Summary of Estimated Costs for BTEX Soil Alternatives
Orange & Rockland Utilities, Inc.

COSTS	Alternative BTEX-S1	Alternative BTEX-S2	Alternative BTEX-S3	Alternative BTEX-S4
	No Action	Soil Vapor Extraction	Excavation and Disposal	Bio-sparging
Capital Costs:	-	$62,000	-	$77,000
Direct & Indirect Expenses	-	$84,300	$879,900	$130,800
Annual O&M Costs:	-	$34,500	-	$60,000
Present Worth Costs: 10 % discount rate 5 year duration	-	$277,082	$879,900	$435,247

Notes:

1. There are no costs directly associated with Alternative S1 (No Action).
2. Present worth costs are calculated based on 5 years of operation.

TABLE 4-9
Cost Estimate
ALTERNATIVE BTEX-S2: Dual groundwater/Vapor Extraction

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
1	Vapor extraction wells	10	$1,000	ea	$10,000
2	Soil vapor extraction system		$22,000	ls	$22,000
	Total Capital Costs				$32,000
	Direct Expenses				
1	Mobilization/demobilization		$1,000	ls	$1,000
2	Design study/pilot test		$30,000	ls	$30,000
3	Permitting		$10,000	ls	$10,000
4	SVE system startup		$30,000	ls	$30,000
5	Health and safety facilities (decon)		$1,500	ls	$1,500
	Total Direct Expenses				$72,500
	Total Capital and Direct Expense Costs				$104,500
	Indirect Expenses:				
1	Engineering (20% of capital direct expense costs)				$20,900
2	Contingency (20% of capital and direct expense costs)				$20,900
	Total Indirect Costs				$41,800
	TOTAL CAPITAL COSTS & DIRECT AND INDIRECT EXPENSES				**$146,300**
	O & M Costs:				
1	Vapor extraction system maintenance		$6,500	ls	$6,500
2	Vapor treatment system O&M		$28,000	ls	$28,000
	Total Annual O&M Costs				$34,500
	Present Worth Costs:				
1	Present Worth of Annual O&M Costs (10% discount rate, 5 years)				**$130,782**
	TOTAL PRESENT WORTH				**$277,082**

Note:

1. The above table represents the estimated costs associated with installing a vapor extraction system composed of 10 vertical vapor extraction points, discharge piping and carbon adsorption vapor phase treatment system.
2. Costs do not inlude installation of a dual grounwater/vapor extraction well or water treatment system which are included under Alternative G3.

TABLE 4-10
Cost Estimate
ALTERNATIVE BTEX-S3: Excavation and Off-Site Disposal

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Costs:				
1	Mobilization/demobilization		$1,000	ls	$1,000
2	Construct soil staging areas		$1,500	ls	$1,500
3	Excavation and handling of BTEX contaminated soils (includes sheet-piling)	6,000	$15	cy	$90,000
4	Confirmatory soil sampling	24	$50	ea	$1,200
5	Transport and disposal of soil	7,800	$60	ton	$468,000
6	Backfill excavated areas	6,000	$22	cy	$132,000
7	Field oversight	300	$60	hrs	$18,000
8	Health and safety facilities (decon)		$1,500	ls	$1,500
9	Water Management				$20,000
	Total Direct Costs				$733,200
	Indirect Costs:				
1	Engineering (5% of total direct costs)				$36,700
2	Contingency (15% of total direct costs)				$110,000
	Total Indirect Costs				$146,700
	TOTAL COSTS				$879,900

Note:

1. The above table represents the estimated costs associated with excavating the BTEX contaminated soil for disposal at a permitted secure landfill.

TABLE 4-11
Cost Estimate
ALTERNATIVE BTEX-S4: Biosparging

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
1	Air injection wells	2	$5,000	ea	$10,000
2	Vapor extraction piping		$7,000	ls	$7,000
3	Air compressor		$10,000	ea	$10,000
4	Soil vapor extraction (SVE) skid		$17,000	ls	$17,000
5	Treatment building	600	$55	sf	$33,000
	Total Capital Costs				$77,000
	Direct Expenses				
1	Labor (excluding treatment building)	320	$45	ls	$14,400
2	Health and safety facilities (decon)		$1,500	ls	$1,500
3	System Startup		$30,000	ls	$30,000
	Design study/pilot test		$30,000	ls	$30,000
5	Mobilization/demobilization		$1,000	ls	$1,000
	Total Direct Expenses				$76,900
	Total Capital Costs And Direct Expenses				$153,900
	Indirect Expenses				
1	Engineering (15% of total direct costs)				$23,100
2	Contingency (20% of total direct costs)				$30,800
	Total Indirect Expenses				$53,900
	TOTAL CAPITAL COSTS & DIRECT & INDIRECT COSTS				**$207,800**
	O & M Costs:				
1	Air-sparging system O&M		$60,000	ls	$60,000
	Total Annual O&M Costs				$60,000
	Present Worth Costs:				
1	Present Worth of Annual O&M Costs (10% discount rate, 5 years operation)				**$227,447**
	TOTAL PRESENT WORTH				**$435,247**

Note:
1. The above table represents the estimated costs associated with installing an biosparging system composed of a system of horizontal vapor extraction points, vertical air injection points, discharge piping and carbon adsorption vapor phase treatment system.

5.0 SUMMARY AND CONCLUSIONS

This section provides a summary of the alternatives that were evaluated in detail and the recommended remedial alternatives. A summary of the rationale used for selecting the recommended alternatives is presented.

The RI investigation indicated that the shallow overburden groundwater at the ORU Site exhibited petroleum related VOCs and chlorinated VOCs at concentrations that exceeded the NYSDEC groundwater standards. Shallow bedrock groundwater exhibited concentrations of chlorinated VOCs that exceeded NYSDEC groundwater standards. Subsurface soil in the vicinity of the former underground storage tank exhibited petroleum related VOCs that exceeded NYSDEC ARARs. There is an estimated 6,000 cubic yards of impacted soil. Two areas of the Site exhibited surface soil PCB concentrations that exceeded the NYSDEC ARARs and the Federal TSCA soil cleanup criteria of 25 ppm for restricted access sites.

Based on the results of the RI, remedial alternatives were evaluated with respect to achieving the remedial action objectives. The focus of the remedial action objectives is to prevent the migration of Site surface soil that contains PCBs to the Hackensack River through sediments in surface water, and to reduce the potential for the contaminated soils from becoming a source of groundwater contamination.

To meet the remedial action objectives, the following alternatives were selected for detailed analysis:

Groundwater:

- Alternative G1: No Action
- Alternative G2: Air Sparging
- Alternative G3: Manage Plume with Groundwater Extraction and Treatment
- Alternative G4: Groundwater and Hackensack River Surface Water Monitoring

PCB Soils:

- Alternative PCB-S1: No Action
- Alternative PCB-S2: Excavation, Disposal, Asphalt Cover, and Institutional Controls
- Alternative PCB-S3: Excavation and Disposal

BTEX Soils:

- Alternative BTEX-S1: No Action
- Alternative BTEX-S2: Dual Groundwater/Vapor Extraction