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FEASIBILITY STUDY REPORT
MR. C CLEANERS SUPERFUND SITE

NEW YORK STATE DEPARTMENT
OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS
WASTE REMEDIATION

NOVEMBER 1996

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0266-314-005

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1.0 INTRODUCTION

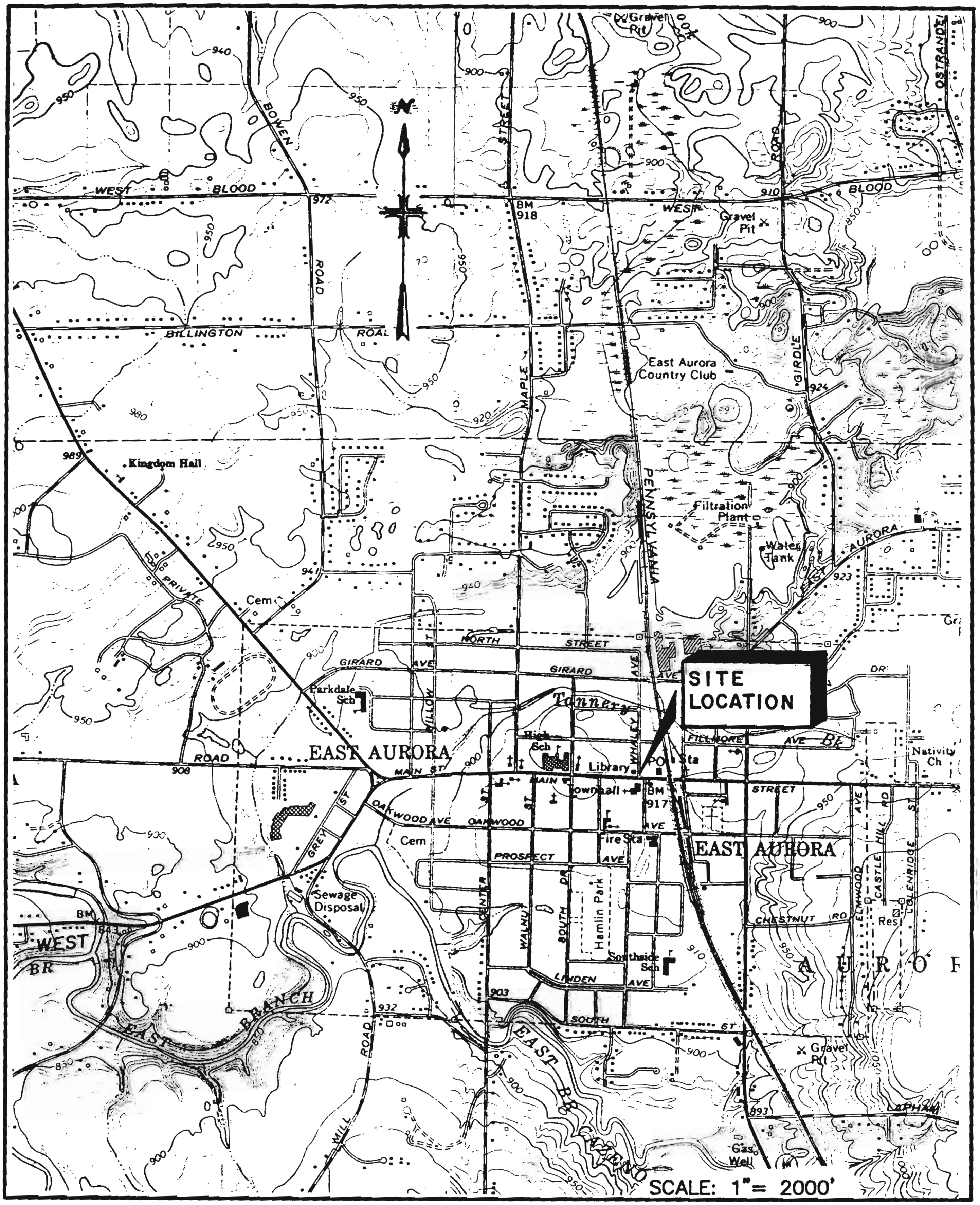
1.1 SITE LOCATION AND DESCRIPTION

The Mr. C Cleaners Site (Site No. 9-15-157) in East Aurora, New York has been listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites. The Site is located in an area occupied, in part, by Mr. C Cleaners, Inc., an operating dry cleaning business since 1974, at 586 Main Street in the Village of East Aurora, New York (see Figures 1-1 and 1-2). The 1/2-acre property includes a one floor building on a concrete slab foundation and an adjacent paved parking lot. The rear-half of the building is rented to three separate businesses including: Auto Plate Glass, PO Box Plus, and a barber shop. The front half of the building is dedicated to the dry cleaning business.

In December 1991, the NYSDEC was called to investigate chemical-like odors detected in the First Presbyterian Church, south-west of the Site (see Figure 1-2). The New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH) collected air samples on several occasions and detected the presence of tetrachloroethene (PCE), a common dry cleaning solvent. Subsequent investigations found PCE contamination in the sanitary sewers, groundwater, and soil vapor. The NYSDEC identified the sanitary sewers as a likely contaminant migration pathway and Mr. C Cleaners, located approximately 400 feet from the Church, as a suspected source. The Site was designated as a Class "2" site, meaning that the Site is believed to pose a significant threat to the public health and the environment.

The NYSDEC assigned Malcolm Pirnie, Inc. to perform a Remedial Investigation and Feasibility Study (Work Assignment D-002852-7) to develop a remedial alternative for the Site. Malcolm Pirnie completed the Remedial Investigation (RI) in two phases. The first phase of the RI was performed in July 1994. The Phase II RI was performed between December 1994 and April 1995. This document presents relevant background information from both phases of the remedial investigation and provides an engineering Feasibility Study of remedial alternatives.

FIGURE 1-1



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DEC-31-MAP

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SITE LOCATION MAP

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FIGURE 1–2

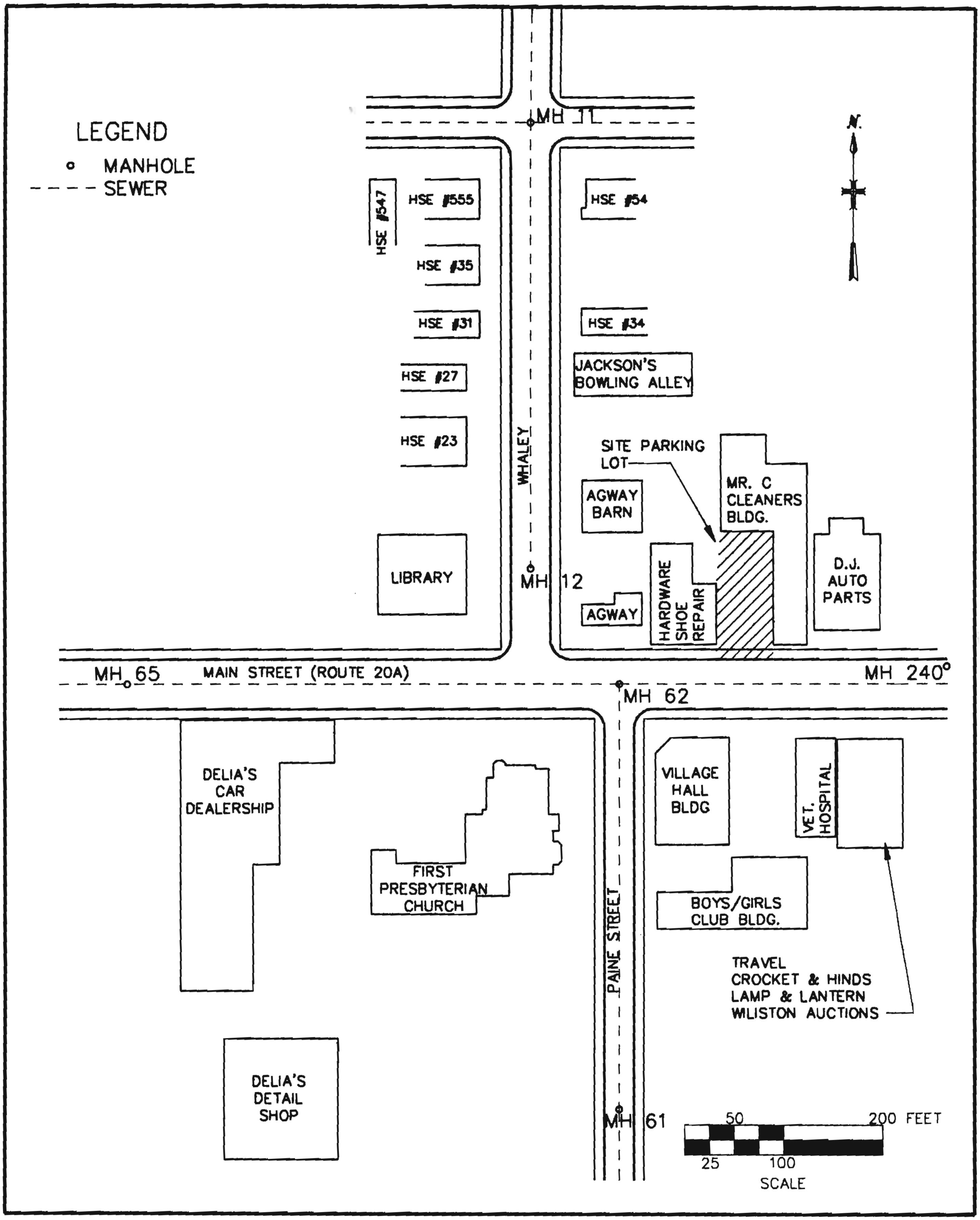

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FIG_3-2

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SITE VICINITY MAP

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1.2 PURPOSE AND ORGANIZATION OF THE REPORT

The purpose and objectives of this FS are to identify and evaluate alternatives for the remediation of contaminants identified in the RI and to develop a remedial approach which provides reliable protection of human health and the environment in a cost effective manner.

This FS report is composed of five sections:

- Section 1 presents a summary of the site background including location, description, history, geology/hydrogeology, nature and extent of contamination, contaminant fate and transport, and an assessment of the public health and environmental risk posed by the site. Applicable New York State Standards, Criteria and Guidelines are also identified for the site.
- Section 2 presents the remedial action objectives for the site, identifies general response actions available to address the contaminants of concern and impacted media, and the volume and areal extent of media requiring remediation.
- Section 3 identifies remedial technologies for the affected media and screens these technologies with respect to their effectiveness and implementability.
- Section 4 presents a detailed analysis of the remedial alternatives which passed the initial screening in Section 3. The detailed analysis is conducted in accordance with NYSDEC's criteria for selection of a remedy (viz., Technical and Administrative Guidance HWR-4030). A comparison of the remedial alternatives for each media is also presented.
- Section 5 describes the recommended remedial alternative, summarizes the selection rationale, and presents a preliminary cost estimate for the remedy.

1.3 BACKGROUND INFORMATION

1.3.1 Site History

Historic land use in the vicinity of Mr. C Cleaners was identified from Sanborn fire insurance maps dating from 1912 to 1958. Information on recent site history was obtained from records of a NYSDEC interview with the Site owner (NYSDEC File No. 915157, March 27, 1992). In general, the corner of Main Street between Mr. C Cleaners

Whaley Avenue has been occupied by hotels, auto sales and service, and gas stations since 1912. Railroad service has been available east of Mr. C Cleaners since at least 1920.

The existing building used by Mr. C Cleaners is believed to have been built around 1927. The former uses of the property as identified on the available Sanborn maps and in NYSDEC file information are listed below:

- 1912 - hotel
- 1920 - auto and tractor service station
- 1927 - auto repair, garage
- 1951 - auto sales and service, spray painting
- 1958 - laundry
- ?-1970 - Dates Drycleaning, Inc. (out of business in 1970)
- 1970-1974 - Sweet Kleen, Inc. (drycleaners)
- 1974-present - Mr. C Cleaners, Inc.

The parking lot area west of the Mr. C Cleaners building was formerly occupied by businesses as described below:

- 1912 - Hotel
- 1920 - Auto sales, tin shop, shed
- 1927 - Store, dwelling, garage
- 1951 & 1958 - Bake Shop
- ?-1974 - Paved asphalt parking lot

The history of environmental investigations related to the Site began in October 1991 with the investigation of odors detected in the basement of the First Presbyterian Church. In early 1992 the NYSDEC collected water samples from sanitary sewers along Main Street, Paine Street, Whaley Avenue, and Oakwood Avenue. An environmental site assessment was conducted at the Site by Huntingdon Analytical Services in 1992 which included a soil gas survey and installation, and sampling of six monitoring wells. The RI for the Site, which was completed by Malcolm Pirnie in 1995 included the installation of 18 new monitoring wells; the analysis of 72 groundwater samples; two soil samples; six sanitary sewer samples; 11 indoor air samples; and performance of two short-term aquifer pumping tests. Summaries of the findings of the previous Site investigations as well as findings of investigations of the Agway Energy Products property are presented in the RI report (Malcolm Pirnie, 1995).

1.3.2 Adjacent Properties

Property in the vicinity of Mr. C Cleaners is zoned commercial and residential. The area along Main Street is primarily in commercial use, and the adjacent side streets are residential. The nearest residential area is 300 feet to the northwest. Nearly all of the residences in the area are single family dwellings with basements.

Plate 1 shows the location of Mr. C Cleaners and nearby land use. To the north of the Site is Agway Energy Products, a bowling alley and residences along Whaley Avenue; to the east is the D.J.'s Auto Parts building and a railroad spur and viaduct. To the south is the East Aurora Village Hall, a veterinary hospital, and a commercial retail building. The First Presbyterian Church of East Aurora is located southwest of Mr. C Cleaners. West of the Church is Delia's Automobile Dealership. Directly west of Mr. C Cleaners are two commercial storefront-type buildings, storage buildings belonging to Agway Energy Products, and the East Aurora Public Library.

A petroleum spill was identified west of Mr. C Cleaners at the Agway Energy Products in 1987 (NYSDEC Spill No. 8703755). Agway facilities include a former office and gasoline pumps located on Main Street, a storage barn facing Whaley Avenue, and a store behind the Mr. C Cleaners building. The gasoline pumps and underground storage tanks were removed in February 1993 (Matrix Env. Tech., 1993) and a groundwater recovery well with an air stripper was installed. The groundwater extraction and treatment systems are not currently in operation because dry cleaning solvent constituents and breakdown products (viz., vinyl chloride) were detected in groundwater removed by the Agway collection system in 1992.

A 1987 petroleum spill (NYSDEC Spill No. 8705612) was also identified at the Cumberland Farms gas station on Main Street approximately 900 feet west of Mr. C Cleaners.

Because the Site consists of a commercial storefront setting and includes a sidewalk, the area is frequented by pedestrians and business users. The two commercial buildings directly west of Mr. C Cleaners are occupied by a shoe repair business and Dubois Hardware. Additionally, the Shoe Repair building is rented to a styling salon and the Hardware building to Catalog Shopping Network. The second floor of both buildings is commercial office space. The Public Library is used extensively by residents in the area.

The Site and surrounding area are serviced by municipal and public utilities including: the Village sanitary sewer system, the Erie County Water Authority (ECWA), electricity, natural gas, and telephones. Storm water from roads and parking lots is drained to storm sewers. The Village has been using the ECWA since June 1980 when the Village discontinued the use of a municipal groundwater supply system. Conversations with Village residents indicate that some residents in the Village have their own wells for general use, such as, irrigation and other nonpotable uses. To determine which residents had wells, a door-to-door survey was completed during the RI on Whaley Avenue to the intersection with Fillmore, and on Fillmore Avenue between Whaley and North Grove. Four homeowners on Fillmore Avenue have wells, none of which are used for drinking water. Three of the wells were sampled during the RI. Additionally, the three wells were surveyed for water level elevations. There are no other known sources of water use in this area.

1.3.3 Site Geology/Hydrogeology

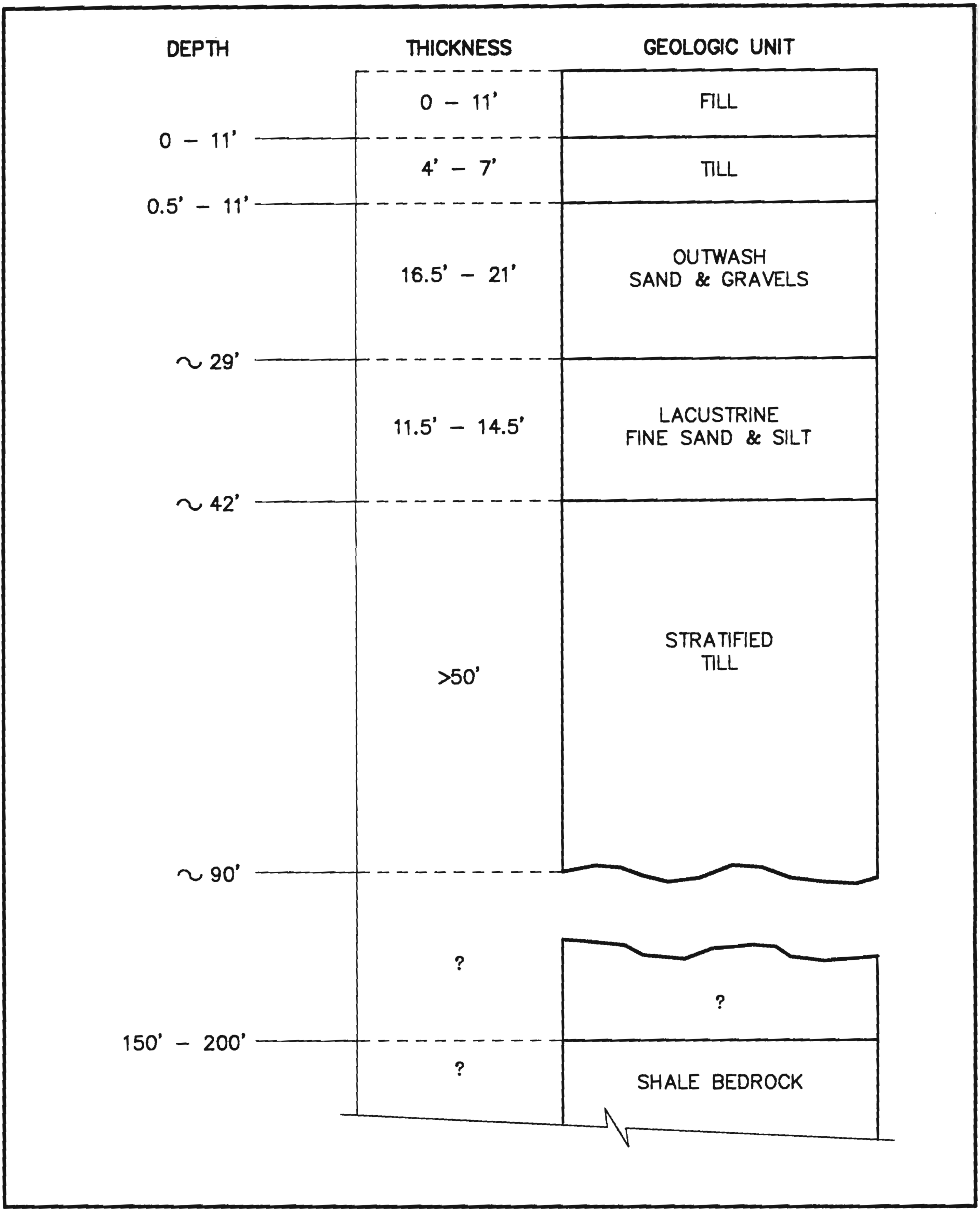
1.3.3.1 Site Geology

The Village of East Aurora is situated above a bedrock valley that was the course of the pre-glacial Cazenovia Creek (Blackmon, 1956). Depth to bedrock is estimated at 150 to 200 feet below grade (Blackmon, 1956). The stratigraphic units identified at the Site include:

- Fill material
- Clayey silt till
- Gravel and sand outwash
- Lacustrine sandy silt
- Stratified till

These units are illustrated on Figure 1-3, and a brief description is provided below. A thorough description of each unit is presented in the RI (Malcolm Pirnie, 1995).

FIGURE 1–3



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Fill Material

Fill was encountered from grade to 11.0 feet below ground surface at drilling locations near the Library, Agway, Mr. C Cleaners, Presbyterian Church, Fillmore Avenue, and the Town Hall. The composition of the fill material varies across the site. Fill encountered at Mr. C Cleaners was clayey silt with gravel underlain by gravel with clayey silt and a trace of brick fragments. Fill material north of the Agway storage barn occurs in the uppermost two feet and was characterized as a moist gravel with sand. The fill encountered near the Library is a clayey silt with traces of brick fragments. The proportion of gravel and sand content is highly variable.

Clayey Silt Till

Till composed mostly of brown clayey silt was encountered in nearly all monitoring well and soil boring locations. Till ranged in thickness from 4.0 feet to 7.0 feet. At most locations the till is comprised of clayey silt with varying amounts of sand and gravel-size shale fragments. Weak stratifications were observed at most locations.

Outwash Sand and Gravel

Glacial outwash material was observed in each borehole ranging in thickness from 13.9 to 28 feet. As described by Blackmon (1956), the outwash unit is comprised of sediment transported out of the ice-mass by meltwater, and sediment washed into a floodplain from higher level pro-glacial lakes. The outwash grades from sandy gravel near the top of the unit to very fine sand at the base, which is approximately 27 feet below ground surface. The upward coarsening of the material is most likely due to a re-advance of the ice, which passed over the outwash and deposited the clayey silt till.

Gravel outwash ranges in thickness from 2.0 to 26.0 feet. The greatest thickness of gravel occurs in the parking lot west of the Mr. C Cleaners building where gravel comprises most of the outwash unit.

Medium to coarse sand with varying amounts of fine sand underlies gravel. The sand ranges in thickness from 1.5 to 12.0 feet. Fine and very fine sand units occurred at the base of the outwash unit in all borings except those along Fillmore Avenue and in the Mr. C

Cleaners parking lot. Fine and very fine sand has a tendency to liquefy when disturbed and defines the bottom of the outwash sequence.

Lacustrine Deposits

Lacustrine sandy silt underlies the outwash sequence. The lacustrine deposit ranges in thickness from 11.5 to 14.5 feet. The material is mostly silt and fine to very fine sand; has a tendency to liquefy when disturbed; and exhibits uniform textural characteristics where encountered.

Stratified Till and Sand

Underlying the lacustrine unit is a sequence of interbedded fine-grained till and sand at least 49.5 feet thick. Stratified till and sand was encountered to a depth of 90 feet in the deepest exploratory boring. Regional geologic information indicates that bedrock may be approximately 150 feet deep.

This unit contains lenses of stratified medium and fine sand interbedded with layers of clayey silt and silty clay till. The till contains trace to little amounts of sand, and commonly breaks along a faintly visible internal fabric. A sharp contact separates the two lithologies. The proportion of sand layers is substantially less than the proportion of layers comprised of fine-grained till. Silty clay till layers range from thin laminae to layers 5 to 11 feet thick. The sand layers also occur as thin laminae, but the thickest layers are only 3 feet thick.

In each boring, a thicker silty clay or clayey silt unit is present ranging from 5 feet to 11 feet. In general, this material contains 23.3 to 39.9 percent clay.

1.3.3.2 Site Hydrogeology

Hydrostratigraphic units are sequences of geologic materials that are hydraulically connected and possess similar hydrogeologic properties including hydraulic conductivity, head, and porosity. The major hydrostratigraphic units at the Site are presented in Table 1-1 and include an unconfined (water table) aquifer consisting of saturated outwash deposits (the outwash aquifer); the underlying saturated lacustrine deposits (the lacustrine aquifer); and a confining layer comprised of the stratified till deposits. The outwash and lacustrine units

TABLE 1-1

MR. C CLEANERS SUPERFUND SITE FEASIBILITY STUDY REPORT

HYDROSTRATIGRAPHIC UNIT TABLE

Hydrostratigraphic Unit	Geologic Units
Outwash Aquifer	Outwash Sand and Gravel
Lacustrine Aquifer	Lacustrine Sandy Silt
Confining Layer	Stratified Till

are hydraulically connected aquifers that possess distinctly different hydraulic properties. Hydraulic heads (i.e. groundwater flow direction) in the two units are nearly the same and the two units are physically continuous. However, the outwash and lacustrine aquifers have different hydraulic conductivities and porosities.

Outwash Aquifer

Groundwater in this unit occurs under unconfined (water table) conditions. The saturated thickness of the outwash aquifer is approximately 18 feet and shows little variation across the study area. Between April 1994 and January 1995 groundwater levels were approximately 9.5 to 10.5 feet below ground surface. Hydraulic head distributions within this unit are depicted in isopotential maps presented as Figure 1-4.

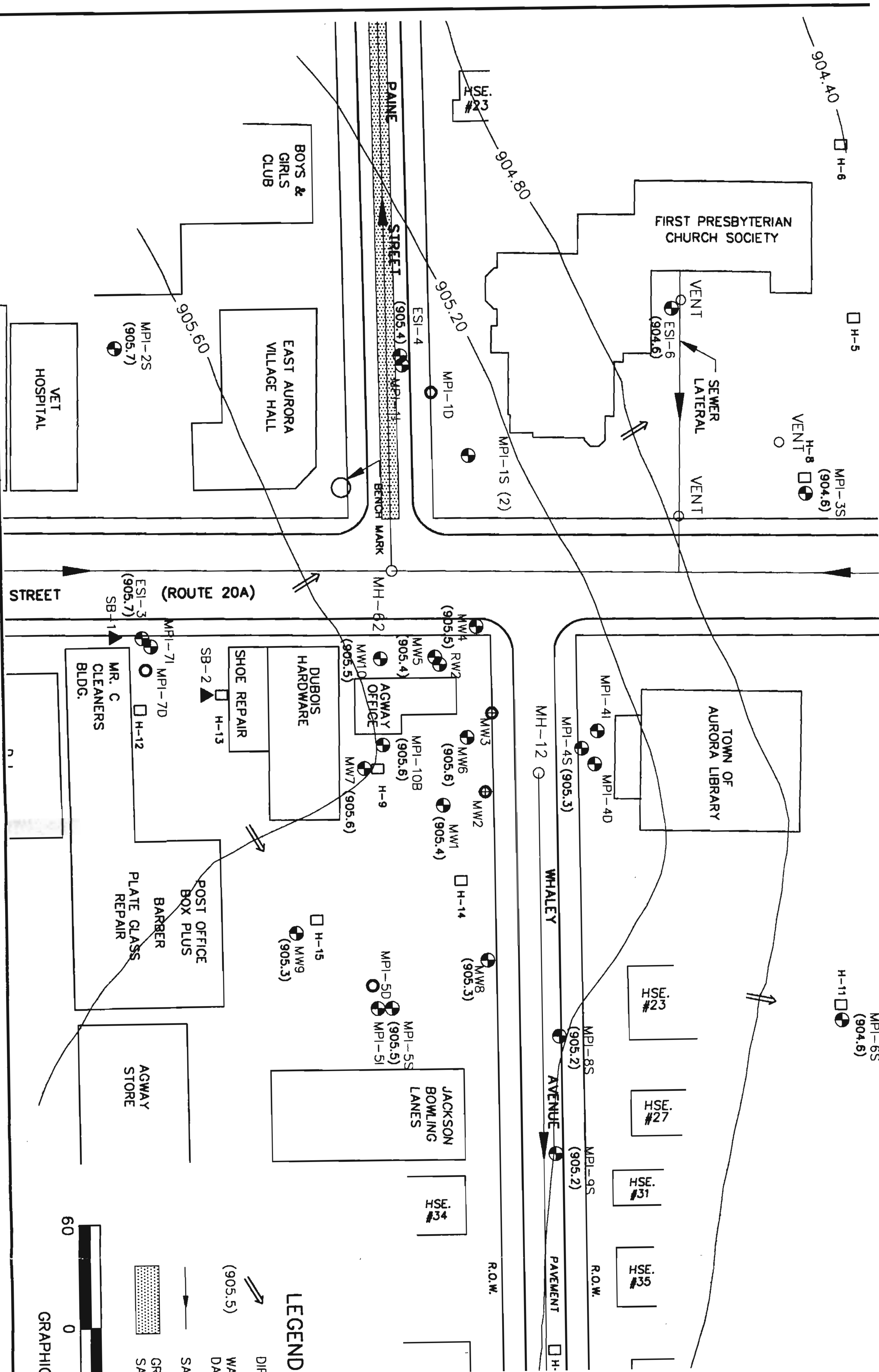
North of Main Street, groundwater flows in a northwest direction. The groundwater flow divides at Main Street and generally flows southwest toward the First Presbyterian Church. The location of the groundwater divide may vary seasonally.

Recharge of the aquifer occurs principally through infiltration of precipitation. Exfiltration from clay tile sewers situated above the water table may also contribute to recharge. Recharge to the water table appears to occur relatively quickly, and then dissipates rapidly; therefore, sewer exfiltration may cause a localized mound in the vicinity of a leaking sewer.

Horizontal hydraulic gradients for the water table unit range from 0.004 to 0.002 ft/ft depending on the date; and they were slightly higher south of Main Street. These are very low hydraulic gradients, reflective of the low topographic relief and the comparatively high hydraulic conductivity. Vertical gradients are very slightly vertically downward. A comparison of the horizontal and vertical hydraulic gradients indicate that groundwater flow in the water table aquifer is essentially horizontal.

The geometric mean of in situ hydraulic conductivity results for outwash aquifer upper zone wells is 8.6 E-3 cm/s. Wells screened across the entire outwash sequence have a geometric mean hydraulic conductivity of 4.0 E-3 cm/s.

Horizontal groundwater seepage velocities for the outwash aquifer for the northwest and southwest flow directions were calculated using measured horizontal gradients and


904.40
H-6
HSE. #23
904.80
BOYS & GIRLS CLUB
PAINE STREET
FIRST PRESBYTERIAN CHURCH SOCIETY
VENT
ESI-6 (904.6)
SEWER LATERAL
H-5
905.20
905.60
MPI-2S (905.7)
VET HOSPITAL
EAST AURORA VILLAGE HALL
ESI-4 (905.4)
MPI-1I
MPI-1D
MPI-1S (2)
VENT
H-8
MPI-3S (904.6)
BENCH MARK
MH-62
STREET
(ROUTE 20A)
ESI-3 (905.7)
SB-1
MPI-7I
MPI-7D
H-12
MR. C CLEANERS BLDG.
SB-2
H-13
SHOE REPAIR
DUBOIS HARDWARE
MW10 (905.5)
MW5 (905.4)
MW4 (905.5)
RW2
AGWAY OFFICE
MW3
MW6 (905.6)
MPI-10B (905.6)
MW7 (905.6)
H-9
MW2
MW1 (905.4)
MH-12
MPI-4I
MPI-4S (905.3)
MPI-4D
TOWN OF AURORA LIBRARY
H-14
WHALEY AVENUE
POST OFFICE BOX PLUS
BARBER
PLATE GLASS REPAIR
H-15
MW9 (905.3)
MPI-5D
MPI-5S (905.5)
MPI-5I
MW8 (905.3)
HSE. #23
H-11
MPI-6S (904.6)
MPI-8S (905.2)
AGWAY STORE
JACKSON BOWLING LANES
HSE. #27
MPI-9S (905.2)
HSE. #31
HSE. #34
R.O.W.
PAVEMENT
R.O.W.
HSE. #35
H-
LEGEND
DI
WA
DA
(905.5)
SA
GR
SA
60
0
GRAPHIC

average hydraulic conductivity values. Effective porosity values used in the velocity calculations were selected from the low end of a range of total porosity values in the hydrogeologic literature for sand and gravel (Freeze and Cherry, 1979). The calculated seepage velocities and average hydrogeologic properties of the outwash aquifer are summarized in Table 1-2.

Lacustrine Aquifer

The average hydrogeologic properties of the lacustrine aquifer are summarized in Table 1-2. The saturated thickness is approximately 13 feet. Hydraulic conductivity tests performed in the four lacustrine aquifer wells ranged from 1.5E-4 cm/s to 4.9E-4 cm/s, and averaged 2.8E-4 cm/s. Boring descriptions, grain size distributions, and hydraulic conductivity values exhibit little variation between the four lacustrine well locations. The Hydrogeologic properties of the lacustrine unit are more uniform than in the outwash unit.

The horizontal hydraulic gradient in the lacustrine aquifer ranges from 0.002 to 0.003, which is very similar to gradients in the outwash aquifer. Groundwater flow directions in the lacustrine and outwash aquifers appear to be very similar; however, the number and spacing of lacustrine aquifer wells and the low hydraulic gradient make a comparison of flow directions in the two units uncertain. Calculated horizontal seepage velocities are 40 to 60 times slower than in the outwash unit.

Stratified Till Unit

The stratified till confining layer at Mr. C Cleaners is comprised of layers of clayey silt and sand. Laboratory permeability analyses of undisturbed (Shelby tube) samples from the thicker unit of clayey silt yielded an average hydraulic conductivity value of 4.8 E-8 cm/s. Slug testing performed east of the library (MPI-4D) resulted in a hydraulic conductivity of 8.8 E-6 cm/s. This value is slightly higher than the laboratory hydraulic conductivity and reflects the average hydraulic conductivity of the clayey silt and sandy intervals in the screened zone.

TABLE 1-2

MR. C CLEANERS SUPERFUND SITE
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SUMMARY OF HYDROGEOLOGIC PROPERTIES

Hydrostratigraphic Unit	Geologic Unit	Physical Properties			Groundwater Flow Properties		
		Saturated Thickness (ft.)[(1)(4)]	Hydraulic Conductivity (cm/s)[(3)]	Effective Porosity[(2)]	Principal Flow Direction	Horizontal Gradient[(1)] (ft./ft.)	Flow Velocity[(1)] (ft./day)
Overburden Water-Bearing Zone:							
Outwash Aquifer	Outwash (north of Main St.)	17.8	8.6 x 10^{-3}	0.25	NW	0.003	0.29
	Outwash (south of Main St.)	18.3	8.6 x 10^{-3}	0.25	SW	0.004	0.39
Lacustrine Aquifer	Lacustrine Sandy Silt	13.0	2.8 x 10^{-4}	0.35	SW/NW	0.003	0.007

Notes:

(1) Groundwater level data from 4/13/94.
(2) Effective porosity values are estimated from the low end of a range of total porosity values provided in the literature (Freeze and Cherry, 1979 and Fetter, 1980).
(3) Geometric Mean.
(4) Average Value.

The vertical hydraulic gradient between the stratified till and the outwash aquifer was vertically upward in January 1995, indicating little potential for downward contaminant migration into the stratified till.

Aquifer Testing

Aquifer testing was performed to assess aquifer characteristics in areas where remediation was considered likely based on the distribution of groundwater contaminants (see Section 1.3.4). A discussion of the aquifer test field methodology and data analyses are presented in the Mr. C Cleaners Aquifer Test Report (see RI Addendum, May 1996). A summary of the aquifer testing results are presented below.

Aquifer testing was performed in two of the study areas. Test zone A utilized pumping well RW-1 located near the suspected release point at Mr. C Cleaners. Test zone B utilized pumping well RW-3 situated behind #23 Whaley Avenue (See Figure 1-6 for the location of the pumping wells). Slug tests indicate that the two testing zones represent the extremes of hydraulic behavior anticipated in the outwash aquifer.

Based on an evaluation of pumping test data, the area near Mr. C Cleaners is a highly transmissive groundwater zone with a transmissivity on the order of 40,000 gpd/ft. Because the carbon unit utilized for treatment of the aquifer test discharge water limited the flow volume which could be properly treated for discharge, only short-term step-drawdown tests were performed in test zone A. Therefore, the test results do not reflect the potential influence of hydrogeologic boundaries. The aquifer parameters determined from the step-drawdown test are adequate to perform a comparison of remedial technologies but the accuracy of the parameters is not adequate for remedial design. A long term (72-hour) aquifer test should be performed to establish the transmissivity in test zone A and to evaluate the influence of hydrogeologic boundaries on long term pumping of the aquifer.

The area behind #23 Whaley is a less transmissive groundwater zone, with an estimated transmissivity of 1000 gpd/ft. The location of the boundary between the two groundwater zones was not determined during the aquifer test. However, the distribution of slug test results suggests that the boundary lies below the commercial property between the Mr. C Cleaners parking lot and the Agway property.

1.3.4 Nature and Extent of Contamination

1.3.4.1 Soil

Soil samples were analyzed at two locations (see Plate 1) in the unsaturated zone to identify the source of PCE. Two soil samples were collected from SB-1, located near Mr. C Cleaners sewer lateral. One soil sample was collected from SB-2, located near the side entrance of the shoe repair shop.

Big jump to make this conclusion
- Is discharge from basement or @ grade sewer
- Invest. of San. Sewer.
- Sewer mat'l const.
/

The highest PCE concentration was detected from SB-1, collected 6 to 8 feet below grade (48,000 ug/kg). The East Aurora Department of Public Works does not have records that indicate the depth of the sewer lateral. However, the high concentrations and the proximity to the lateral indicate that past leakage from the sewer lateral is a likely source of PCE. Past leakage of PCE from the sewer lateral may extend beneath the building.

The sample analyzed from SB-2, 8-10′ below grade contained 12,000 ug/kg PCE. Because the groundwater table is near 10 feet and rises and falls throughout the seasons, the concentrations of PCE in unsaturated soil may be derived from PCE dissolved in the shallow groundwater.

1.3.4.2 Groundwater

Groundwater samples were collected across the study area from monitoring wells, residential irrigation wells, and Hydropunch® locations (see Plate 1 for sampling locations). Groundwater samples were collected from four intervals, including the top of the outwash aquifer (i.e., water table), the base of the outwash aquifer, the lacustrine unit and the stratified till unit. Six sanitary sewer samples were also collected. All groundwater samples were analyzed for volatile organic compounds (VOCs), while a limited number of samples (three) were analyzed for complete Target Compound List (TCL) parameters (VOCs, semi-volatile organic compounds, pesticides, polychlorinated biphenyls, and metals). The VOC species and concentration ranges detected during the RI sampling are summarized in Table 1-3. The nature and extent of contamination in each of the four intervals sampled during the RI is summarized below. A thorough discussion of groundwater contaminants

TABLE 1-3

MR. C CLEANERS SUPERFUND SITE
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GROUNDWATER CONTAMINANTS

Parameter	**Concentration Range Detected (ug/l)**
Tetrachloroethene	1J - 18,000
Potential Degradation Products/Contaminants of Tetrachloroethene:	
• Trichloroethene	1J - 340
• 1,2 Dichloroethene	1J - 82
• 1,1 Dichloroethene	2J - 19J
• Vinyl Chloride	6J - 240
Petroleum Hydrocarbons:	
• Benzene	1J - 3200
• Toluene	3J - 740
• Ethylbenzene	3J - 430
• Xylene	6J - 1900
• Chlorobenzene	3J
Other Parameters:	
• 1,1,1 Trichloroethane	4J - 14
• Acetone(1)	5J - 91
• Chloroform	1J - 3J
• Methylene Chloride	1J - 120J
• 2-Butanone	5J - 10UJ
• 1,2-Dichloropropane	3J

Notes:

(1) Detected primarily in lacustrine aquifer.

(J) Estimated concentration.

and distribution is presented in the RI Report and RI Addendum (Malcolm Pirnie, July 1995, May 1996).

Top of Outwash Aquifer (Water Table)

Groundwater was analyzed from the water table at 35 locations during RI sampling (including monitoring wells, irrigation wells, and Hydropunch® locations). Substantial shallow volatile organic contamination was observed in the outwash aquifer.

PCE or the degradation products of PCE (trichloroethene (TCE), dichloroethene isomers (DCEs), dichloroethanes (DCA), and vinyl chloride) were detected at 26 of 35 sampling locations. The degradation products of PCE form as a result of reductive dehalogenation reactions that occur during anaerobic biodegradation. Small quantities of TCE and DCE may also have been present in the dry cleaning solvent.

Low concentrations of 1,1,1-trichloroethane (TCA) were detected east of the Village Hall at MPI-2S (14 ug/l TCA), at Mr. C Cleaners (4J ug/l TCA), and farther downgradient at ESI-4 (4J ug/l TCA). No other occurrence of TCA was detected during the RI. However, low concentrations of TCA (5 to 28 ug/l) have previously been detected in groundwater on the Agway property. TCA is not a breakdown product of PCE. Additionally, MPI-2S is cross-gradient from Mr. C Cleaners and neither PCE nor its breakdown products were found in MPI-2S. Therefore, it has been concluded TCA found at the site is likely from a separate source other than Mr. C Cleaners.

The greatest concentration of PCE detected in a water table well was collected from monitoring well ESI-3 (8,200 ug/l) which is located immediately adjacent to the suspected source area at Mr. C Cleaners. Concentrations of PCE or PCE breakdown products were detected at 15 additional sample locations located west of Mr. C Cleaners and north of Main Street at Agway, on Whaley Avenue, the Library, west of MPI-6S in two private irrigation wells, and on Fillmore Avenue. However, samples collected from MPI-1S (290 ug/l PCE) and ESI-6 (390 ug/l PCE) indicate the presence of PCE in a southwesterly direction also. Figure 1-5 illustrates the limits of the shallow PCE groundwater plume at concentrations greater than the drinking water standard (5 ug/l) and at concentrations greater than 100 ug/1. The distribution of PCE and PCE breakdown products at concentrations greater than 5 ug/l includes a very broad, but comparatively low concentration, PCE plume that originates at Mr. C Cleaners and spreads into two branches extending southwest to the Presbyterian Church and northwest to approximately 300 feet west of MPI-6S.

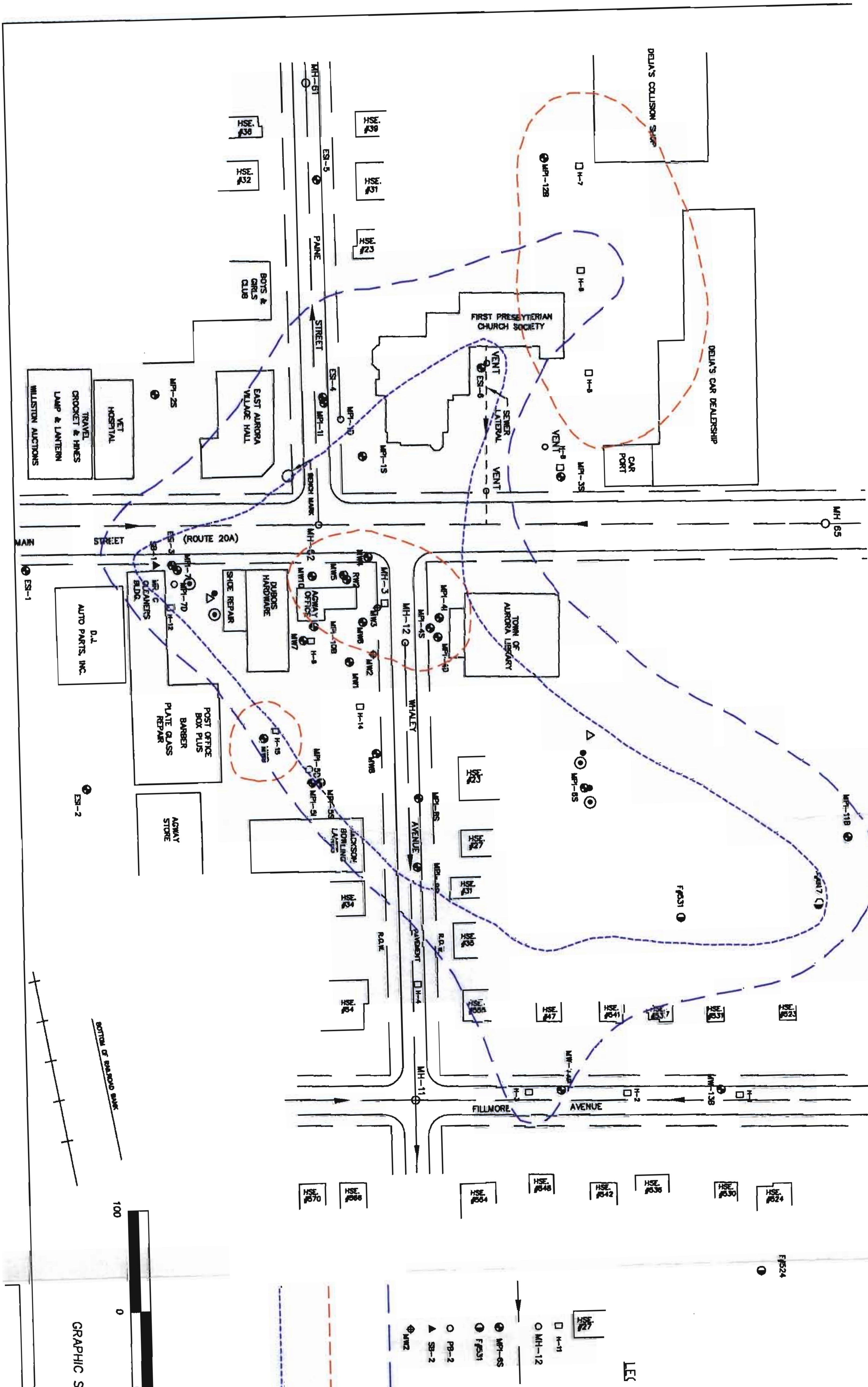
Benzene, toluene, ethylbenzene, and total xylenes (BTEX) were detected in samples collected west of Mr. C Cleaners on or near the Agway property. These groundwater contaminants are known constituents of gasoline and have been previously detected on the Agway property during remediation of a former gasoline spill. Samples collected from MW-5 exhibited the greatest concentration of total BTEX (6,270 ug/l). BTEX compounds were also detected west/southwest of the First Presbyterian Church. Figure 1-5 illustrates the limits of the BTEX plumes west/southwest of the church and on the Agway property.

The BTEX plumes are not related to the PCE concentrations found near Mr. C Cleaners. However, aerobic microbial oxidation of BTEX compounds consumes dissolved oxygen which is used as an electron acceptor. As dissolved oxygen is depleted, as indicated by low oxidation - reduction potential readings in the Agway wells, anaerobic conditions may develop in the groundwater. Thus, the BTEX compounds may be enhancing the anaerobic reduction of PCE to TCE, DCE isomers, and finally to vinyl chloride.

Three well locations were monitored for TCL compounds (viz., VOCs, semivolatile organic compounds, pesticides, PCBs, and metals): MPI-7I and ESI-3, near the suspected source; and the downgradient well, MPI-5S. Trace concentrations of phthalate esters were detected in all three wells. However, phthalates are most likely laboratory contaminants. No pesticides/PCBs were detected. Total iron, manganese, and magnesium concentrations exceeded the NYSDEC Class GA groundwater quality standards or guidance values. Sodium concentrations were slightly above levels commonly observed in groundwater from glacial aquifers and may be attributed to the use of deicing salt on Village roads and exfiltration from sanitary sewers. In general, substantial concentrations of inorganic parameters do not appear to be associated with the distribution of PCE in groundwater.

Base of Outwash

Groundwater was analyzed from the lower half of outwash at 27 locations during the Phase II RI sampling and aquifer testing program (including monitoring wells, test wells,


DELIA'S COLLISION SHOP
DELIA'S CAR DEALERSHIP
CAR PORT
FIRST PRESBYTERIAN CHURCH SOCIETY
VENT
SEWER LATERAL
BOYS & GIRLS CLUB
EAST AURORA VILLAGE HALL
VET HOSPITAL
TRAVEL CROCKET & HINES LAMP & LANTERN
WILLISTON AUCTIONS
PAINE STREET
MAIN STREET (ROUTE 20A)
BENCH MARK
WHALEY AVENUE
FILLMORE AVENUE
SHOE REPAIR
DUBOIS HARDWARE
AGWAY OFFICE
AGWAY STORE
M. C. CLEANERS BLDG.
D.J. AUTO PARTS, INC.
POST OFFICE BOX PLUS BARBER PLATE GLASS REPAIR
JACKSON BOWLING LANES
TOWN OF AURORA LIBRARY
R.O.W.
PAVEMENT
BOTTOM OF RAILROAD BANK
HSE. #36
HSE. #32
HSE. #39
HSE. #31
HSE. #23
HSE. #34
HSE. #54
HSE. #27
HSE. #35
HSE. #555
HSE. #47
HSE. #541
HSE. #537
HSE. #531
HSE. #523
HSE. #570
HSE. #566
HSE. #554
HSE. #548
HSE. #542
HSE. #536
HSE. #530
HSE. #524
MH-61
MH-65
MH-62
MH-3
MH-12
MH-11
ES-1
ES-2
ES-3
ES-4
ES-5
ES-6
SB-1
MPI-12B
MPI-2S
MPI-11
MPI-10
MPI-1S
MPI-3S
MPI-7C
MPI-7D
MPI-4I
MPI-4S
MPI-4D
MPI-10B
MPI-5D
MPI-5I
MPI-5S
MPI-6S
MPI-8S
MPI-9D
MPI-11B
MPI-13B
MPI-14B
MW1
MW2
MW3
MW5
MW6
MW7
MW8
MW9
MW10
RW2
H-1
H-2
H-3
H-4
H-5
H-6
H-7
H-8
H-9
H-12
H-14
H-15
F#531
F#517
F#524
100
0
GRAPHIC S
LEG
HSE. #27
H-11
MH-12
MPI-6S
F#531
PB-2
SB-2
MW2

Hydropunch® locations). The data obtained indicate substantial volatile organic contamination near the base of the outwash aquifer. PCE or the degradation products of PCE were detected at 20 of 27 sampling locations. The highest PCE concentration was collected from test well RW-1 (18,000 ug/l) located behind #23 Whaley Avenue. Substantial concentrations of PCE were also detected in monitoring wells MW-1 (3,750 ug/l), MPI-10B (1,700 ug/l), MPI-6S (1,600 ug/l) and Hydropunch® location H-11 (8,700 ug/l) downgradient of Mr. C Cleaners in a northwesterly direction. Sampling locations with PCE concentrations greater than 1000 ug/l delineate a narrow zone of comparatively high concentrations that is considered to be a source plume, or a zone of groundwater contamination from which further migration occurs. As illustrated on Figure 1-6, the source plume is approximately 80 feet wide and 500 to 600 feet long, and extends from the suspected release point at the Mr. C Cleaner's sewer lateral to the rear of #23 Whaley Avenue. The northwest trending plume illustrated on Figure 1-6 is considered to be the primary source of VOC contamination in the Study Area.

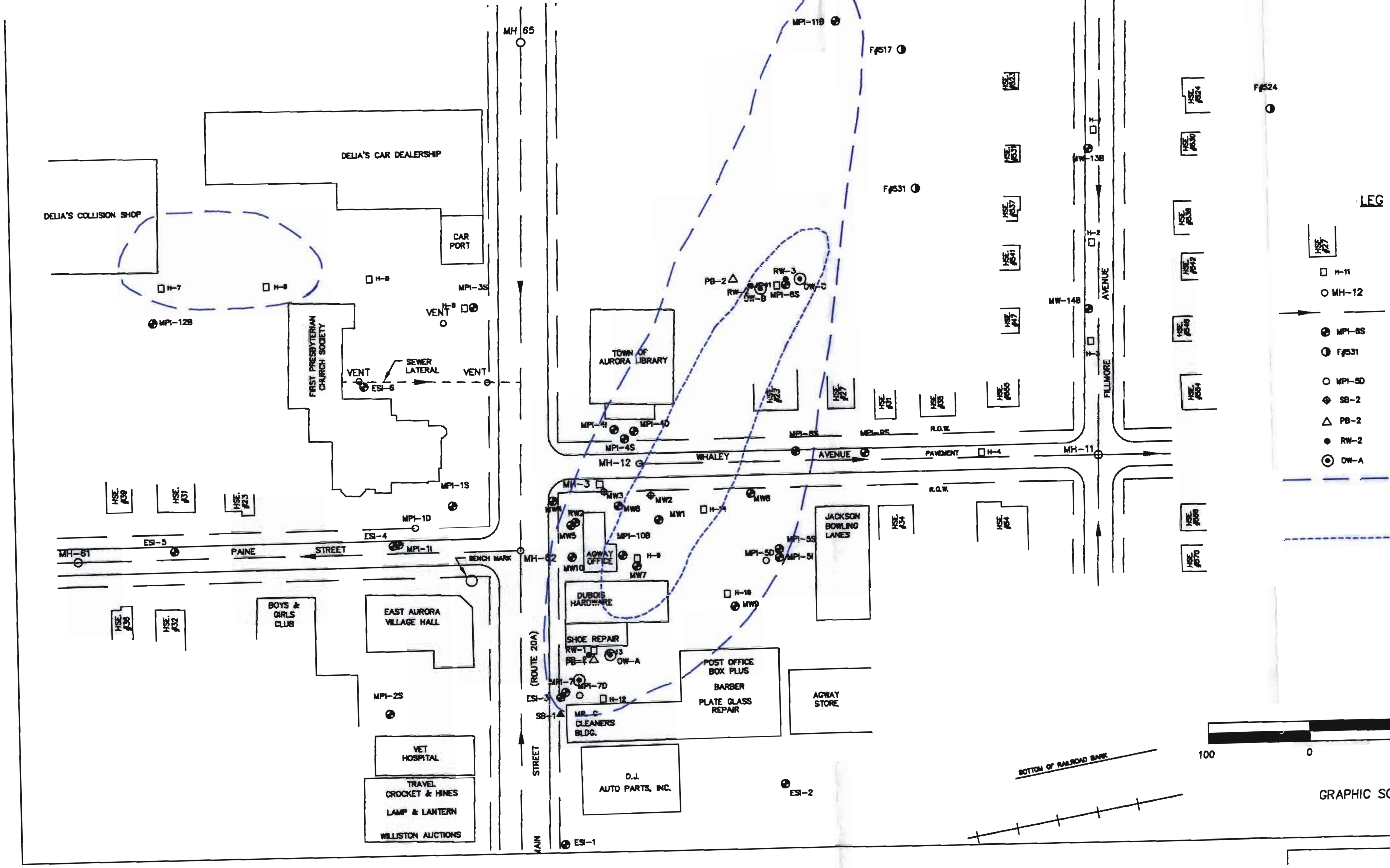
BTEX compounds were detected in three of five base-of-outwash monitoring wells, and seven base-of-outwash Hydropunch® sample locations. The highest total BTEX concentrations were found west of the Presbyterian Church in H-6 (849 ug/l), and are probably associated with the shallow BTEX plume in the same area.

Lacustrine

Groundwater from the lacustrine unit was analyzed at four Hydropunch® sampling locations and at the four wells screened in the lacustrine unit (MPI-1I, MPI-4I, MPI-5I, and MPI-7I). PCE or its degradation products were detected in three of the eight sample locations but at much lower concentrations than the outwash unit.

Stratified Till

Groundwater was collected and analyzed from one well (viz. MPI-4D) screened in the stratified till unit. Acetone was the only compound detected at 5J ug/l and is likely due to laboratory contamination. PCE concentrations were not detected in groundwater collected from MPI-4D. The stratified fill is a confining layer that defines the base of the water table


DELIA'S COLLISION SHOP
DELIA'S CAR DEALERSHIP
CAR PORT
H-7
H-8
H-8
MPI-12B
MPI-3S
VENT
FIRST PRESBYTERIAN CHURCH SOCIETY
VENT
SEWER LATERAL
VENT
ESI-6
MPI-1S
MPI-1D
HSE. #39
HSE. #31
HSE. #23
MH-61
ESI-5
PAINE
STREET
ESI-4
MPI-11
BENCH MARK
MH-62
HSE. #36
HSE. #32
BOYS & GIRLS CLUB
EAST AURORA VILLAGE HALL
MPI-2S
VET HOSPITAL
TRAVEL CROCKET & HINES LAMP & LANTERN
WILLISTON AUCTIONS
MAIN STREET (ROUTE 20A)
ESI-1
ESI-3
SB-1
MPI-7
MPI-7D
H-12
MR. C CLEANERS BLDG.
D.J. AUTO PARTS, INC.
RW-1
PB-1
MW13
OW-A
SHOE REPAIR
DUBOIS HARDWARE
POST OFFICE BOX PLUS
BARBER
PLATE GLASS REPAIR
AGWAY STORE
ESI-2
MH 65
MPI-11B
F#517
F#531
F#524
TOWN OF AURORA LIBRARY
MPI-4I
MPI-4D
MPI-4S
MH-12
MH-3
MW4
RW2
MW3
MW2
MW6
MW5
MW1
MW8
H-14
AGWAY OFFICE
MPI-10B
H-9
MW10
MW7
H-16
MW9
MPI-5D
MPI-5S
MPI-5I
JACKSON BOWLING LANES
WHALEY
AVENUE
PB-2
RW-3
RW-
OW-B
MW11
MPI-6S
OW-C
HSE. #23
HSE. #27
HSE. #31
HSE. #35
HSE. #555
HSE. #34
HSE. #54
MPI-8S
MPI-8S
R.O.W.
PAVEMENT
H-4
R.O.W.
MH-11
FILLMORE
AVENUE
H-3
H-2
H-1
MW-14B
MW-13B
HSE. #47
HSE. #541
HSE. #537
HSE. #531
HSE. #523
HSE. #570
HSE. #566
HSE. #554
HSE. #548
HSE. #542
HSE. #536
HSE. #530
HSE. #524
BOTTOM OF RAILROAD BANK
100
0
GRAPHIC SC
LEG
HSE. #27
H-11
MH-12
MPI-6S
F#531
MPI-5D
SB-2
PB-2
RW-2
OW-A

aquifer. Since the vertical gradient is upward, dissolved contaminants should not migrate into the stratified till unit.

Sanitary Sewer

PCE was detected at trace concentrations (<5 ug/l) in sanitary sewer wastewater samples collected from MH-62E (1J ug/l) and MH-61 (4J ug/l). Based on groundwater elevations, the sewer run between MH-62 and MH-61 may receive infiltration from groundwater. A comparison of PCE concentrations in wastewater to PCE concentrations at ESI-4 (32 ug/l), which is a water table well located next to the Paine Street sewer in the area of potential infiltration, indicates that the northern end of the Paine Street sewer may be intercepting a small volume of contaminated groundwater. However, trace concentration of volatile organic compounds could also potentially be discharged to the sewer system from Village residents or businesses. It is unlikely that the sewer system is presently having a substantial influence on the migration of PCE or PCE degradation products in the RI study area.

1.3.4.3 Indoor Air

Indoor air monitoring was conducted as part of the RI in March, 1994 (Phase I) and April, 1995 (Phase II). Samples were collected at the Boys and Girls Club, Jackson's Bowling Alley, the First Presbyterian Church (indoor and outdoor) and the Village Hall during Phase I, and at Jackson's Bowling Alley, the First Presbyterian Church, two private residences on Whaley Avenue, and two private residences on Fillmore Avenue during Phase II.

The U.S. Environmental Protection Agency's (U.S.E.P.A.) Volatile Organic Compounds Data Base indicates a mean indoor air base concentration for PCE of 21 micrograms per cubic meter (ug/m3). Concentrations of PCE above this mean concentration were detected in the basement of Jackson's Bowling Alley (220 ug/m3 during the Phase I and 153 ug/m3 during the Phase II), the ground floor of the First Presbyterian Church (28 ug/m3 during the Phase II), and from a basement sample of a home on Whaley Avenue (43 ug/m3). PCE was not detected in the outside air and background sample or in the trip blank.

In May 1996, air samples were taken from the ground level of the First Presbyterian Church and basements of two homes on Whaley Avenue. PCE was not detected above the U.S.E.P.A. mean indoor air concentration in the church sample. PCE was detected above the mean value in the two residence basement samples (65 and 115 ug/m3).

In July of 1996, the basement of one residence on Whaley Avenue which had 115 ug/m3 of PCE in the basement air was resampled. The concentration of PCE was 100 ug/m3 in the basement air and 50 ug/m3 in the upstairs living space. PCE was not detected in the outside air sample.

1.3.5 Contaminant Fate and Transport

Routes by which contaminants are transported from one portion of the site to another or from on-site to off-site locations are known as migration pathways. The Exposure Pathway Analysis conducted as part of the RI (Malcolm Pirnie, 1995) identified a number of contaminant migration pathways, including:

- Leakage from sanitary sewers
- Lateral/vertical groundwater movement
- Volatilization from groundwater
- Leaching from soil
- Volatilization from soil

These pathways are described below.

Leakage from sanitary sewers

In the past, dry cleaning wastes may have been discharged from Mr. C Cleaners or predecessor dry cleaners to the sanitary sewer. It is hypothesized that such practice was the primary PCE release mechanism, since no single event that may have released a slug of PCE into the sanitary sewer system was identified by the owner of Mr. C Cleaners or the NYSDEC. Waste PCE discharged to the sanitary sewer would have exfiltrated into the surrounding soil and groundwater. At the present time, the leakage of contaminants from the sanitary sewer to surrounding soil and groundwater is judged to be a minor migration pathway, because dry cleaning solvents are presently utilized in a closed-loop process; all dry cleaning wastes are handled by a commercial waste disposal firm; and the sewers were flushed in 1992. Thus, only residual contaminants in the sanitary sewer or immediately adjacent to the sewer would be available to migrate into surrounding media.

Lateral/Vertical Groundwater Movement

Ample RI evidence demonstrates that lateral movement of on-site contaminated groundwater has impacted off-site groundwater, particularly in the outwash aquifer. Lateral groundwater movement is the primary contaminant transport mechanism in the study area. Contaminant transport by this pathway is controlled by the natural hydraulic gradients in the vicinity of the site which produce advective transport. The direction of lateral groundwater movement in the outwash aquifer is to the northwest and to the southwest, with the divide occurring at Main Street. As discussed in Section 1.3.3.2, the flow velocity to the north of Main Street is estimated at 0.29 feet/day, and 0.39 feet/day to the south. These velocities are considered moderate. To a much lesser extent, vertical migration of contaminants from the outwash aquifer downward into the lacustrine unit has resulted in relatively low concentrations of PCE in the lacustrine aquifer.

Theoretically, there is the potential for contaminated groundwater to discharge to surface water downgradient of the site (viz. Tannery Brook). However, the groundwater velocity decreases west of Whaley Avenue due to a flattening of the hydraulic gradient, and the time of travel to Tannery Brook is calculated to be on the order of 10 to 20 years. In addition, the contaminants of concern are likely to volatilize upon entering the surface water body, therefore, potential transport of groundwater contaminants to surface water is judged to be a minor contaminant migration pathway.

Volatilization From Groundwater

VOCs present in groundwater have the potential to partition into the soil gas and migrate into structure basements. Results of the indoor air analyses conducted during the RI indicate that contaminants of concern in groundwater are volatilizing in the subsurface and entering building basements in the vicinity of the Site. PCE has been detected above

USEPA's mean indoor air value in the basements of Jackson's Bowling Alley, the First Presbyterian Church, and two homes on Whaley Avenue.

Leaching From Soil

Contaminants present in unsaturated soils can leach into the saturated zone under the influence of infiltration. Elevated concentrations of PCE were detected in unsaturated soils adjacent to the Mr. C Cleaners sanitary sewer lateral. Thus, through contact with sewer lateral exfiltration, or the fluctuating groundwater table, contaminated unsaturated soils may be a source of groundwater contamination through leaching. The infiltration of precipitation is unlikely to directly affect leaching because the sewer lateral underlies the building, the sidewalk, and the road pavement.

Volatilization From Soil

VOCs present in soil can volatilize into the interstitial soil pore spaces in unsaturated soils. These vapors then have the potential to migrate into subgrade structures. As discussed above, indoor air in four basements in the vicinity of the Site had detectable quantities of PCE during the RI (Malcolm Pirnie, 1995). Based on the distance from the Mr. C Cleaners sanitary sewer lateral to the basements where PCE was detected, it is unlikely that volatilization of contaminants from unsaturated soil near the sewer lateral is impacting indoor air quality. However, groundwater contaminants may have been adsorbed by soil along the groundwater migration path. Soils at the top of the outwash aquifer may become unsaturated as the water table fluctuates, and thus may provide a source for volatilization of VOCs.

1.3.6 Human Health and Environmental Risk Assessment

As part of the RI (Malcolm Pirnie, 1995), an Exposure Pathway Analysis and a Habitat Based Assessment were conducted. The Exposure Pathway analysis qualitatively evaluates the potential for adverse human health effects which might result from exposure to contaminants related to the Mr. C Cleaners Site, in the absence of any action to control or mitigate the contamination. The analysis consisted of a discussion of potential human exposure pathways to site contaminants and identification of potential receptors. The Habitat Based Assessment evaluated potential ecological exposure pathways. The intent of the Habitat Based Assessment was to identify sensitive species or habitat potentially affected by off-site contaminant migration. The results of the Exposure Pathway Analysis and Habitat Based Assessment are summarized below with respect to public health and environmental risk, respectively.

1.3.6.1 Human Health Risk

The Exposure Pathway Analysis identified PCE and its degradation products (TCE; 1,1-DCE; 1,2-DCE; and vinyl chloride), TCA, and chloroform as chemicals of potential concern for the Site, based on factors such as frequency of detection, range of concentrations and toxicity. BTEX compounds were not considered chemicals of potential concern for this Site since they are not associated with the disposal of dry cleaning wastes.

The possible means by which people (e.g., site occupants, off-site residents, municipal workers) could come in contact with site contaminants, either now or in the future, are itemized in Table 1-4. Each of these possible exposure scenarios were qualitatively analyzed to determine whether they are viable; and the reason associated with each determination has been provided.

The only exposure scenarios which were excluded from further consideration were incidental ingestion of, dermal contact with, and inhalation of chemicals of potential concern in off-site surface water and sediment. The surface water exposure scenario is unlikely due to the nature of the contaminants. The contaminants of concern will rapidly volatilize once they enter the streams. In addition, the time-of-travel for contaminated groundwater to reach a surface water discharge point is lengthy.

Exposure pathways were identified which can be considered complete, i.e., pathways which have: (1) a source or chemical release from a source; (2) an exposure point where contact can occur; and (3) an exposure route by which contact can occur. The complete pathways are presented in Table 1-5 and are discussed by media below.

TABLE 1-4

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT
EXPOSURE PATHWAY ANALYSIS

IDENTIFICATION OF POTENTIAL ROUTES OF EXPOSURE (CURRENT AND FUTURE LAND USE)

Potentially Exposed Population	Exposure Route, Medium, and Exposure Point	Pathway Selected for Evaluation ?	Reason for Selection or Exclusion
Site Occupants, Site Visitors	Inhalation of chemicals of potential concern from groundwater and subsurface soil.	Yes	Air samples from adjacent commercial basements indicate contamination.
Adjacent Commercial Occupants, Adjacent Visitors, Off-site Residents	Incidental ingestion of, dermal contact with and inhalation of chemicals of potential concern in groundwater.	Yes	Although the site is serviced by public water supply, several nearby residents have groundwater wells that are used for irrigation. Future use of groundwater as a source of potable water cannot be precluded based on its GA classification. Air samples from residences indicate potential contamination as a result of volatilization from groundwater and subsurface soils.
Off-site Residents/ Recreationalists	Incidental ingestion of, dermal contact with and inhalation of chemicals in surface water and sediment.	No	Cazenovia Creek, Tannery Brook and the Sinking Ponds wetland are within 2 miles of the site. However, the drainage patterns and nature of the contaminants suggest no current impact. The potential for future contamination exists although the time of travel is likely to be very long.
Utility Workers and Future Construction Workers	Incidental ingestion of, dermal contact with and inhalation of chemicals of potential concern in groundwater and subsurface soil.	Yes	Groundwater and soil contamination may be encountered by laborers working on the Main Street, Whaley Avenue or Fillmore Avenue sewer lines. The water table is close to the sewer inverts, therefore; the potential for exposure exists from construction that requires excavation.

TABLE 1-5

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT
EXPOSURE PATHWAY ANALYSIS

IDENTIFICATION OF PATHWAYS CONSIDERED COMPLETE

Exposure Medium/ Exposure Route	Site Occupants and Visitors	Utility Workers/ Construction Workers	Off-Site Population(1)
Groundwater:			
Incidental Ingestion	—	A	C, L
Dermal Contact	—	A	C, L
Inhalation of Vapor Phase Chemicals	A	A	C, L
Subsurface Soil:			
Incidental Ingestion	—	A	—
Dermal Contact	—	A	—
Inhalation of Vapor Phase Chemicals	A	A	C, L

Notes:
A = Exposure to adults only
C = Exposure in children may be significantly greater than in adults
L = Lifetime Exposure
(1) Indicates adjacent commercial occupants, adjacent visitors and off-site residents.
— = Exposure in this population via this route is not likely to occur.

Groundwater

The groundwater is classified by the NYSDEC as GA (best use, drinking water source). Groundwater is not used as a potable supply in the area; the Village of East Aurora is on public supply. However, some village residents use groundwater for irrigation purposes. Therefore, the potential exists for exposure to contaminants in groundwater resulting from residential use. Another potential for exposure to chemicals of potential concern would be via volatilization from subsurface soils and groundwater to on-site and adjacent properties.

The shallowest groundwater levels encountered are approximately 7.5 feet below ground surface. Therefore, while exposure to VOCs at the ground surface is unlikely, there is the potential for exposure to contaminants in groundwater resulting from excavations for either new basements construction or utility repair. Another potential for exposure of utility workers to chemicals of potential concern would be via volatilization from subsurface and groundwater to the air from excavation activities.

The groundwater serves as a continuing source of off-site groundwater contamination and has the potential to impact air quality in on-site and off-site properties. Two phases of indoor air sampling during the RI of four commercial buildings indicates a continuing migration of VOCs from groundwater to indoor air. Elevated concentrations of VOC contamination (i.e., in excess of groundwater standards) were detected in site groundwater.

Indoor Air Quality

Groundwater and subsurface soil contamination may be serving as a continuing source of PCE vapors in buildings on and adjacent to the site. Consequently, impacted indoor air could represent a potential for exposure to PCE through inhalation. Concentrations of PCE above the NYSDOH residential guideline of 100 ug/m3 have been found in the basements of the bowling alley and one residential home on Whaley Street.

Subsurface Soil

Subsurface soil contamination serves as a continuing source of groundwater contamination, and could pose a hazard to utility workers who may contact contaminants during excavation and repair of utility lines. Another potential for exposure would be to on-site and adjacent business occupants and visitors from chemicals of potential concern in subsurface soils migrating and volatilizing into the buildings.

1.3.6.2 Environmental Risk

Elements of the Habitat-Based Assessment includes:

- A summary of the environmental setting of East Aurora
- A characterization of naturally-occurring flora and fauna found in the study area
- The presence of threatened and endangered flora and fauna or species of special concern
- Identification of significant habitat recognized by the NYSDEC
- Proximity to NYSDEC and/or federal wetland areas
- Values of resources to humans

Based on the results of the Phase I RI, contaminated groundwater appears to be the only potential ecological exposure pathway associated with the site. Local drainage patterns, groundwater flow directions (inferred from topography) and the nature of the contaminants originating from Mr. C Cleaners suggest that the groundwater contaminant plume would not likely affect any significant or sensitive flora or fauna.

1.3.7 Site Characterization Data Gaps

A review of site characterization data collected during the RI identified two areas of insufficient data that will be needed for completion of a remedial design for the Mr. C Cleaners site. These data include:

- Aquifer transmissivity and the extent of the high transmissivity groundwater zone near Mr. C Cleaners. A three-day pumping test should be completed in this area using test well RW-1 and existing observation wells. Pumping rates should be high enough (estimated 55 gpm) to demonstrate the influence of hydrogeologic boundaries on the potential groundwater collection zone. The data will be used to design properly sized groundwater treatment systems, and estimate the area of influence of remediation wells.

- Delineation of the leading edge of the source plume behind #23 Whaley. Concentrations of VOCs determined under dynamic pumping conditions during aquifer testing were over twice the magnitude previously detected. Therefore, the leading edge of the source plume may be farther west of MPI-6S. The recommended sampling program includes the Hydropunch™ sampling methodology used during the Phase II RI with offsite sample analysis. Sampling should be conducted perpendicular to the axis of the source plume to define the plume width; and then parallel to the plume axis to determine the leading edge.

1.4 INDOOR AIR INTERIM REMEDIAL MEASURE

The NYSDEC defines an Interim Remedial Measure (IRM) in its 1992 Technical and Administrative Guidance Memorandum No. 4042 as "an activity which can be undertaken without extensive investigation and evaluation to prevent, mitigate or remedy environmental damage or the consequences of environmental damage attributable to a site. IRMs are intended to function as a temporary rather than final remedial response to a problem". The NYSDEC has elected to install an IRM basement air cleaner in these two resedential homes on Whaley Street. The air cleaners consist of sorbent-filled canisters designed to operate continuously 24 hours a day. The units have 360 degree air flow providing 8 or more room air changes per hour and are simple to install and maintain. Room air cleaners were selected over conventional ventilation since they do not create a negative air pressure that could further induce contaminants into the basement.

The units are considered a temporary measure and will be left in place until plume remediation efforts reduce the groundwater concentrations to the point that they will no longer increase basement air concentrations above the NYSDOH guidelines.

1.5 STANDARDS, CRITERIA AND GUIDELINES (SCGs)

The index of SCGs issued by the NYSDEC (revised, July 1995) was used as a basis for identifying SCGs for the Mr. C Cleaners Site. Compliance with SCGs is intended to protect human health and the environment. This SCG review identifies potentially applicable New York State regulations and guidance drawn from a variety of sources, including various NYSDEC divisions, the New York State Department of Health, the New York State Department of Labor, and the New York State Department of Agriculture and Markets, as well as federal regulations and guidance from the EPA, U.S. Army Corps of Engineers, and the Occupational Safety and Health Administration (OSHA).

The procedures presented in the CERCLA Compliance with Other Laws Manual (EPA/540/F-89/006) were used to determine whether the SCGs were Applicable or Relevant and Appropriate. SCGs were determined to be "Applicable" (A), "Relevant and Appropriate" (RA), or "Neither Applicable nor Relevant and Appropriate" (NA). To be "Applicable", an SCG must specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at the site. SCGs which are not "Applicable", but which address a problem or situation sufficiently similar to those encountered at the site are considered "Relevant". SCGs considered "Relevant" are then further screened to determine whether the SCG is "Appropriate" to the circumstances at the site. The determination that an SCG is "Relevant and Appropriate" relies on best professional judgement. In addition to New York State Regulations, non-promulgated guidance are included in the SCG review. These guidance memoranda, if determined to be "Applicable" or "Relevant and Appropriate" for the site, are designated "To Be Considered".

The potentially applicable SCGs have been classified into three categories; including action-specific, location-specific, and chemical-specific SCGs. The action-specific SCGs were evaluated for remedial actions which may be applicable to groundwater and indoor air remediation at and in the vicinity of the Site. Location-specific SCGs were evaluated by taking into consideration any special conditions relevant to the location of the Site. Chemical-specific SCGs were determined for groundwater, surface water, and air for contaminants of concern found at the Site. The results of the SCG analysis are presented below.

1.5.1 Action-Specific SCGs

The applicability of action-specific SCGs was determined for remedial actions for groundwater. Section 3.2 presents a discussion of the remedial actions for groundwater which were evaluated and thus considered here including in-situ groundwater treatment via air stripping and ex-situ groundwater treatment using air stripping, advanced oxidation process (AOP) or carbon.

NYSDEC Division of Air Resources (DAR) regulations 6NYCRR Part 200, 201, 211 and 212 are considered applicable for those groundwater treatment technologies which will produce point source air emissions, viz., in-situ or ex-situ air stripping. Air Guide-1, a DAR guidance for point source emissions, is judged "to be considered" for these same technologies. 6NYCRR Part 371, which provides for identification and listing of hazardous wastes, is applicable for all groundwater treatment alternatives. 6NYCRR Part 370, which defines terms and general standards applicable to 6NYCRR Parts 370 through 374 and 376, is also applicable for all groundwater treatment alternatives. Alternatives which could potentially produce residuals classified as hazardous wastes (e.g., spent activated carbon), would need to comply with 6NYCRR Part 372, which regulates the hazardous waste manifest system and record keeping requirements. Subparts of 6NYCRR Part 373-2, standards that define acceptable management of hazardous waste, are considered relevant and appropriate for the in-situ and ex-situ groundwater treatment alternatives. These subparts include 6NYCRR Part 373-2.2 (General Facility Standards), 6NYCRR Part 373-2.3 (Preparedness and Prevention), and 6NYCRR Part 373-2.4 (Contingency Plan and Emergency Procedures). 6NYCRR Part 373-2.24 (Miscellaneous Units) is considered relevant and appropriate for the ex-situ groundwater treatment alternatives. General provisions and funding for inactive hazardous waste disposal site remediation regulations promulgated in 6NYCRR Part 375 are considered applicable to all in-situ and ex-situ groundwater treatment alternatives as well as the indoor air remedial alternatives. 29 CFR Part 1910.120, health and safety regulations for hazardous waste operations and emergency response actions, are considered applicable for all groundwater and indoor air remedial alternatives.

Effluent from any of the ex-situ groundwater treatment alternatives could be discharged to either the Village of East Aurora POTW via a sanitary sewer, or to Tannery Brook via a storm sewer. Discharge to Tannery Brook via a storm sewer would have to meet the substantive requirements of a SPDES permit. The NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.3.8, which limits new or changed discharges to POTWs, is judged "to be considered" for discharge of treated groundwater from the ex-situ treatment alternatives to the POTW. 6NYCRR Part 750 through 757 (regulations regarding the SPDES program), are considered applicable to discharge of treated groundwater from the ex-situ treatment alternatives to the storm sewer. The following TOGS are judged "to be considered" for discharge of treated groundwater from the ex-situ treatment alternatives to the storm sewer: TOGS 1.2.1 (development of effluent and monitoring limits for point source releases to surface waters), TOGS 1.3.1 (guidance for determining maximum allowable loadings and corresponding effluent limits for point source releases to surface waters), TOGS 1.3.2 (use of toxicity testing in the SPDES program), TOGS 1.3.4 (guidance for applying Best Professional Judgement to determining effluent limits), and TOGS 1.3.7 (guidance on selecting analytical detection limits and quantitation limits in SPDES permits).

Additionally, although not included in the NYSDEC list of SCGs, the chemical bulk storage regulations contained in 6NYCRR Parts 595 through 599 are considered applicable to ex-situ treatment by AOP, since hydrogen peroxide (a hazardous substance listed in 6NYCRR Part 597) would be stored in bulk as part of the treatment system.

1.5.2 Location-Specific SCGs

The only location-specific SCG judged to have relevance at the Mr. C Cleaners Site was NYSDEC TOGS 2.1.3, which clarifies the meaning of "primary water supply aquifer" and "principal aquifer". Since this SCG is a guidance, it is classified as "to be considered" for the Site.

1.5.3 Chemical-Specific SCGs

Chemical-specific SCGs which are considered applicable to the Site groundwater include 6NYCRR Parts 700 through 703, and 6NYCRR Part 705. 6NYCRR Part 700 provides definitions of terms, 6NYCRR Part 701 outlines classifications for groundwaters and surface waters, 6NYCRR Part 702 explains the derivation and use of standards and guidance values, and 6NYCRR Part 703 presents surface water and groundwater quality standards. Groundwater and surface water quality standards for the contaminants of concern at the Site are presented in Table 1-6. Surface water quality standards will conservatively be considered as treatment system effluent limits for discharge to Tannery Brook via the storm sewer. TOGS 1.1.1, a compilation of ambient water quality standards (including 6NYCRR Part 703 standards), is a "to be considered" guidance for groundwater quality.

Contaminants of concern may be discharged to the atmosphere by several of the remedial alternatives, including groundwater treatment using in-situ or ex-situ air stripping. The New York State Department of Health Fact Sheet, Air Contamination Above Dry Cleaners (1992), is considered applicable for residences in that PCE concentration limits established in this guidance is for residences located above a source of PCE vapors. Air quality standards for non-methane hydrocarbons contained in 6NYCRR Part 257 are considered applicable for air emissions from either an in-situ or ex-situ air stripper, but are considered neither applicable nor relevant and appropriate for indoor air ventilation. Limitations on emissions contained in Air Guide-1 are judged "to be considered" for air emissions from either an in-situ or ex-situ air stripper.

The USEPA Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, is judged “to be considered” for determining human health risks associated with the Site. The Exposure Pathway Analysis presented in the RI was conducted according to this guidance.

TABLE 1-6

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT

CHEMICAL-SPECIFIC SCG VALUES

Containment of Concern	6NYCRR 703.5 Class GA Groundwater Standard (ug/l)	6NYCRR 703.5 Class C Surface Water Standard (ug/l)	TOGS 1.1.1 Class C Surface Water (ug/l)	Indoor Air NYSDOH Fact Sheet [(4)] (ug/m^3)
Chloroform	7	NE[(3)]	NE	NE
1,1-Dichloroethene	5[(1)]	NE	NE	NE
cis-1,2-Dichloroethene	5[(1)]	NE	NE	NE
trans-1,2-Dichloroethene	5[(1)]	NE	NE	NE
Tetrachloroethene	5[(1)]	NE	1	100
1,1,1-Trichloroethane	5[(2)]	NE	NE	NE
Trichloroethene	5[(1)]	NE	11	NE
Vinyl Chloride	2	NE	NE	NE

Notes:

(1) Standard established under principal organic contaminant class "Substituted Unsaturated Hydrocarbon".

(2) Standard established under principal organic contaminant class "Halogenated Alkane".

(3) NE=Not Established.

(4) Air Contamination Above Dry Cleaners (NYSDOH 1992).

2.0 REMEDIAL ACTION OBJECTIVES

This section presents the Remedial Action Objectives for the site, identifies General Response Action for remediation of the contaminated media, and describes the volume and areal extent of media requiring remediation.

2.1 REMEDIAL ACTION OBJECTIVES

The Remedial Action Objectives (RAOs) for the Mr. C Cleaners site were developed based on the result of Exposure Pathway Analysis and Habitat-Based Assessment presented in the Remedial Investigation (RI) report (Malcolm Pirnie, June 1995). The Exposure Pathway Analysis provided a qualitative discussion of potential human exposure pathways for site contaminants and identification of potential receptors. The exposure pathways that present potential human exposure include:

- Inhalation of contaminants volatilized from groundwater and subsurface soil to indoor air. Migration of contaminants to basement air was demonstrated by indoor air sampling results during the RI.
- Direct ingestion of groundwater, dermal contact with groundwater, or direct inhalation of contaminant vapors by groundwater users. However, groundwater use is non-essential, due to the availability of a public water supply.
- Direct ingestion, dermal contact, or inhalation of contaminants during subsurface excavation. The potential exposure is short term and could be mitigated by health and safety measures.

The Habitat-Based Assessment evaluated potential ecological exposure pathways, but concluded that no habitats were potentially affected by the off-site migration of contaminants. Based on these studies, the following RAOs have been developed for the Mr. C Cleaners site:

- Mitigate human health risk by reducing the potential for inhalation of vapors in on-site and off-site basements

- Mitigate the source area of the contaminant plume to prevent further migration of the chlorinated volatile organic compounds (VOCs) and reduce volatilization into adjacent basements

- Achieve NYSDEC groundwater quality standards to the extent practical.

2.2 COMPARISON OF REMEDIAL SCENARIOS

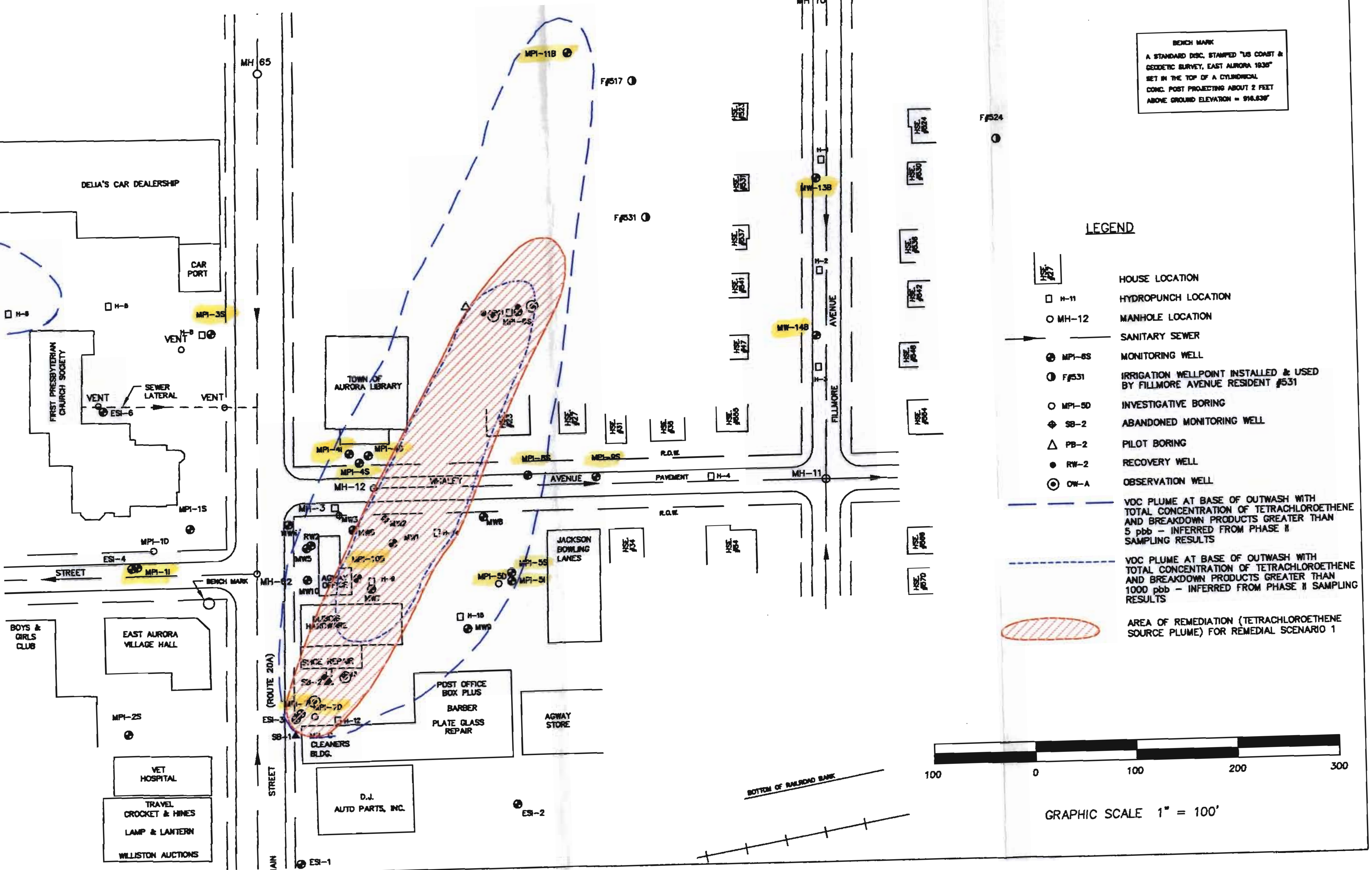
During the development of the RAOs, two scenarios for the mitigation of groundwater contamination were identified that would meet the RAOs. Scenario 1 would actively remediate that portion of the groundwater contamination plume that exhibits the highest concentration of PCE (i.e., the source plume), generally concentrations greater than 1,000 ug/l, while PCE concentrations less than 1,000 ug/l would disperse and degrade naturally by actively eliminating further contributions of contaminants from the source area. Long-term monitoring of potential exposure pathways would be required. The area of active remediation under Scenario 1 is illustrated on Figure 2-1.

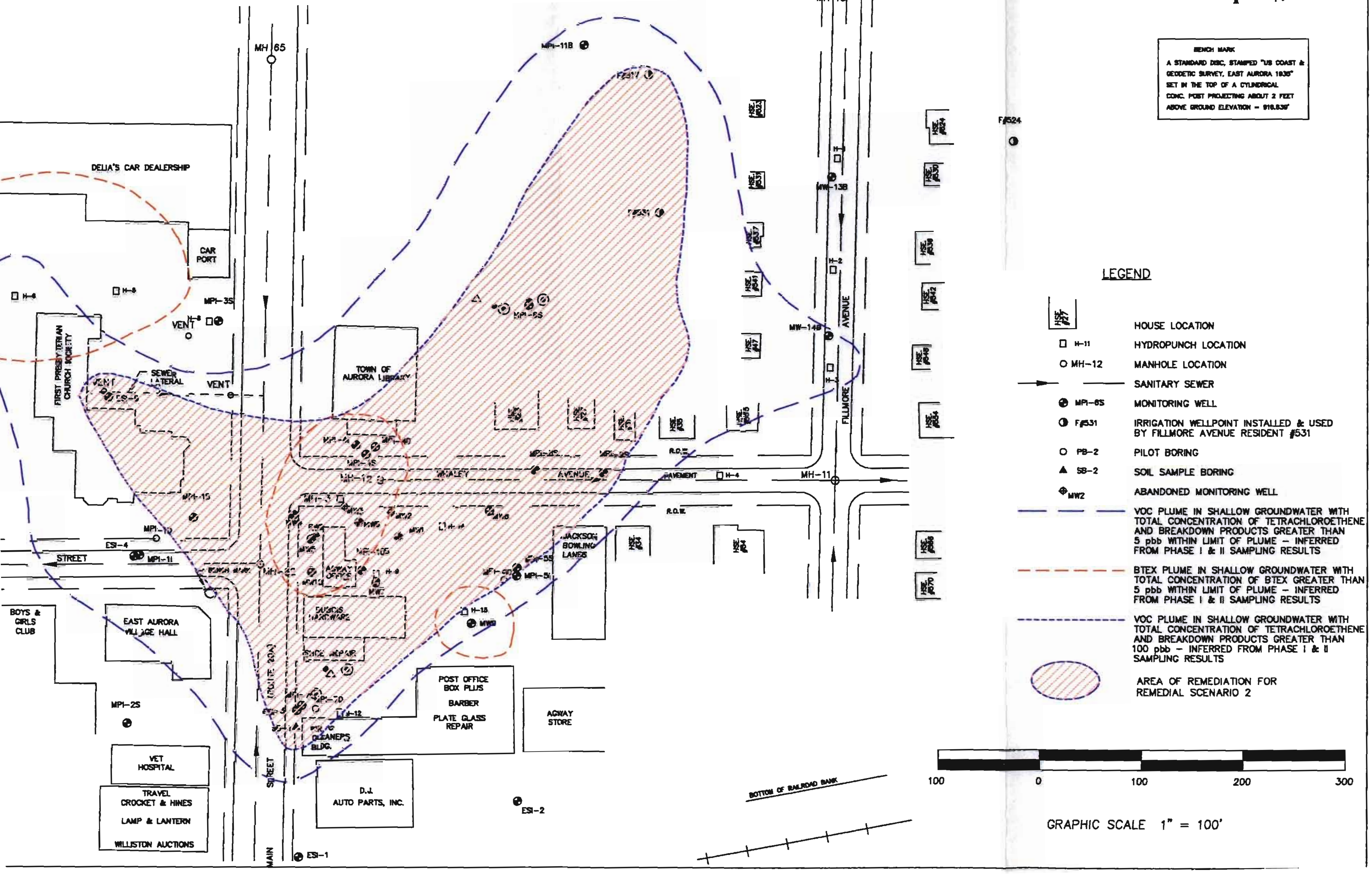
Scenario 2 would actively remediate PCE contaminated groundwater in the source plume area as well as that portion of the plume with concentrations less than 1000 ug/l. Areas of groundwater remediation would include the:

- Source plume
- Presbyterian Church
- Jackson's Bowling Alley
- Whaley Avenue residences
- Fillmore Avenue irrigation wells.

The area of remediation under Scenario 2 is illustrated on Figure 2-2.

Both Scenarios 1 and 2 would be effective in preventing further migration of the VOCs and reduce volatilization into adjacent basements. The containment of the source plume under Scenario 1 is expected to keep the current conditions stable and eventually improve due to natural degradation, while the capture area under Scenario 2 is more expansive and is designed to actively reduce concentrations in the plume in the vicinity of the impacted basements. Scenario 1 requires fewer groundwater remediation wells than


BENCH MARK
A STANDARD DISC, STAMPED "US COAST & GEODETIC SURVEY, EAST AURORA 1936" SET IN THE TOP OF A CYLINDRICAL CONC. POST PROJECTING ABOUT 2 FEET ABOVE GROUND ELEVATION = 916.636'
LEGEND
HSE. #27 HOUSE LOCATION
H-11 HYDROPUNCH LOCATION
MH-12 MANHOLE LOCATION
SANITARY SEWER
MPI-6S MONITORING WELL
F#531 IRRIGATION WELLPOINT INSTALLED & USED BY FILLMORE AVENUE RESIDENT #531
MPI-5D INVESTIGATIVE BORING
SB-2 ABANDONED MONITORING WELL
PB-2 PILOT BORING
RW-2 RECOVERY WELL
OW-A OBSERVATION WELL
VOC PLUME AT BASE OF OUTWASH WITH TOTAL CONCENTRATION OF TETRACHLOROETHENE AND BREAKDOWN PRODUCTS GREATER THAN 5 ppb – INFERRED FROM PHASE II SAMPLING RESULTS
VOC PLUME AT BASE OF OUTWASH WITH TOTAL CONCENTRATION OF TETRACHLOROETHENE AND BREAKDOWN PRODUCTS GREATER THAN 1000 ppb – INFERRED FROM PHASE II SAMPLING RESULTS
AREA OF REMEDIATION (TETRACHLOROETHENE SOURCE PLUME) FOR REMEDIAL SCENARIO 1
100 0 100 200 300
GRAPHIC SCALE 1" = 100'
BOTTOM OF RAILROAD BANK
MH 65
MPI-11B
F#517
F#531
F#524
H-1
MW-13B
H-2
MW-14B
H-3
FILLMORE AVENUE
MH-11
H-4
PAVEMENT
R.O.W.
R.O.W.
WHALEY AVENUE
MPI-6S
MPI-8S
MPI-4I
MPI-4S
MPI-4D
MH-12
MH-3
MW3
MW2
MW1
MW4
RW2
MW5
MW10
MW6
MW8
MW9
H-14
H-9
H-18
H-12
MPI-10S
MPI-5S
MPI-5D
MPI-5I
MPI-7D
PB-2
SB-2
SB-1
ESI-1
ESI-2
ESI-3
ESI-4
ESI-6
MH-62
BENCH MARK
(ROUTE 20A)
MAIN STREET
STREET
TOWN OF AURORA LIBRARY
AGWAY OFFICE
DUSCIK HARDWARE
SHOE REPAIR
CLEANERS BLDG.
POST OFFICE BOX PLUS
BARBER
PLATE GLASS REPAIR
AGWAY STORE
JACKSON BOWLING LANES
D.J. AUTO PARTS, INC.
DELIA'S CAR DEALERSHIP
CAR PORT
MPI-3S
H-8
H-6
H-5
VENT
VENT
VENT
SEWER LATERAL
FIRST PRESBYTERIAN CHURCH SOCIETY
MPI-1S
MPI-1D
MPI-1I
MPI-2S
EAST AURORA VILLAGE HALL
BOYS & GIRLS CLUB
VET HOSPITAL
TRAVEL CROCKET & HINES
LAMP & LANTERN
WILLISTON AUCTIONS
HSE. #524
HSE. #530
HSE. #536
HSE. #542
HSE. #548
HSE. #564
HSE. #570
HSE. #537
HSE. #541
HSE. #547


BENCH MARK
A STANDARD DISC, STAMPED "US COAST & GEODETIC SURVEY, EAST AURORA 1935"
SET IN THE TOP OF A CYLINDRICAL
CONC. POST PROJECTING ABOUT 2 FEET
ABOVE GROUND ELEVATION – 916.836'
LEGEND
HSE #217 HOUSE LOCATION
H-11 HYDROPUNCH LOCATION
MH-12 MANHOLE LOCATION
SANITARY SEWER
MPI-6S MONITORING WELL
F#531 IRRIGATION WELLPOINT INSTALLED & USED BY FILLMORE AVENUE RESIDENT #531
PB-2 PILOT BORING
SB-2 SOIL SAMPLE BORING
MW2 ABANDONED MONITORING WELL
VOC PLUME IN SHALLOW GROUNDWATER WITH TOTAL CONCENTRATION OF TETRACHLOROETHENE AND BREAKDOWN PRODUCTS GREATER THAN 5 pbb WITHIN LIMIT OF PLUME – INFERRED FROM PHASE I & II SAMPLING RESULTS
BTEX PLUME IN SHALLOW GROUNDWATER WITH TOTAL CONCENTRATION OF BTEX GREATER THAN 5 pbb WITHIN LIMIT OF PLUME – INFERRED FROM PHASE I & II SAMPLING RESULTS
VOC PLUME IN SHALLOW GROUNDWATER WITH TOTAL CONCENTRATION OF TETRACHLOROETHENE AND BREAKDOWN PRODUCTS GREATER THAN 100 pbb – INFERRED FROM PHASE I & II SAMPLING RESULTS
AREA OF REMEDIATION FOR REMEDIAL SCENARIO 2
100
0
100
200
300
GRAPHIC SCALE 1" = 100'
BOTTOM OF RAILROAD BANK
MH 65
MPI-11B
F#217
F#531
F#524
DELIA'S CAR DEALERSHIP
CAR PORT
MPI-3S
VENT
H-8
H-6
FIRST PRESBYTERIAN CHURCH SOCIETY
SEWER LATERAL
VENT
MPI-6S
TOWN OF AURORA LIBRARY
MPI-4S
MPI-4D
MH-12
WHALEY
AVENUE
PAVEMENT
R.O.W.
H-4
MH-11
FILLMORE
AVENUE
MW-13B
MW-14B
H-1
H-2
H-3
MPI-1S
MPI-1D
MPI-1I
ESI-4
STREET
MPI-3
MPI-105
AGWAY OFFICE
H-9
DUBOIS HARDWARE
SHOE REPAIR
MPI-7D
H-12
CLEANERS BLDG.
(ROUTE 20A)
JACKSON BOWLING LANES
MPI-5S
MPI-5I
MPI-5D
H-18
MW9
POST OFFICE BOX PLUS
BARBER
PLATE GLASS REPAIR
AGWAY STORE
D.J. AUTO PARTS, INC.
ESI-2
ESI-1
MAIN
STREET
BOYS & GIRLS CLUB
EAST AURORA VILLAGE HALL
MPI-2S
VET HOSPITAL
TRAVEL
CROCKET & HINES
LAMP & LANTERN
WILLISTON AUCTIONS

Scenario 2 and therefore, would involve less potential for worker/resident exposure to hazards and fewer short-term disruptions to the community during construction than Scenario 2.

Both Scenarios 1 and 2 would be designed as long-term remedial alternatives, and would require regular maintenance to ensure their continued effectiveness. Because Scenario 1 would require fewer wells and a smaller treatment system for groundwater treatment than Scenario 2, less maintenance is required.

Both Scenarios 1 and 2 reduce the mobility and volume of VOCs. Scenario 2 would provide a quicker remediation of low level groundwater contamination outside the source area. However, assuming a pump and treat system is carried out for either scenario, Scenario 1 would be designed to collect approximately 95 gpm of contaminated water having an estimated VOC content of 1,000 ppb, or 1.14 lbs/day of VOCs. Scenario 2 would also be designed to collect the same quantity of VOCs in the source area plus an additional 80 gpm (40 gpm from the Whaley-Fillmore area and 40 gpm from the Church area) having an estimated average VOC concentration of 100 ppb. Scenario 2 would result in the removal of 1.24 lbs/day of VOCs. Thus the mass of VOCs captured under Scenario 2 is only 9% greater than under Scenario 1.

Both Scenarios 1 and 2 are implementable; however, Scenario 1 can be more readily carried out than Scenario 2, since Scenario 1 requires fewer remediation wells and a smaller treatment system than Scenario 2. Also, assuming a groundwater extraction and treatment system is carried out for either scenario, discharge to the 12-inch storm sewer along Whaley Avenue would be required. The treated effluent from Scenario 2 would consume a greater portion of the storm sewer capacity than from Scenario 1, substantially diminishing the capacity of the sewer to handle storm water.

Both scenarios 1 and 2 will adequately mitigate human health risk associated with exposure to vapors in residential basements, which has been identified as the primary human health concern at the site. Scenario 2 provides a quicker remediation of the low level groundwater contamination which in turn more rapidly decreases the potential for exposure to VOCs during foundation construction, utility excavation and/or from use of irrigation wells found within and outside the source plume. Under Scenario 1, the potential for VOC exposure via these routes will also diminish outside the source area but at a slower rate through natural attenuation.

Based on the potential for increased exposure during construction, and a minimal increase in VOC mass removal rates (i.e., 9% increase), potential reduction in storm sewer capacity, and increased cost of construction; Scenario 2 will not be retained for further analysis in this Feasibility Study. Scenario 1 has a smaller treatment system and fewer remediation wells, which significantly reduces the cost of remediation while still fulfilling the requirements of the RAOs. Therefore, Scenario 1 will be carried through the Feasibility Study, and groundwater remediation activity will be restricted to the source plume area .

2.3 GENERAL RESPONSE ACTIONS

General Response Actions describe those broad classes of actions that satisfy the RAOs. The General Response Actions are medium-specific and may include treatment, containment, excavation, disposal, or a combination of these. General Response Actions for groundwater and soil are presented in Table 2-1.

2.4 VOLUME AND EXTENT OF MEDIA REQUIRING REMEDIATION

The volume of media requiring remediation at the site is dependent on the cleanup goals established for the media. Class GA groundwater standards presented in 6NYCRR Part 703 are cleanup goals for the outwash aquifer. These cleanup goals were used to define the volume of contaminated groundwater at the site.

The volume of contaminated groundwater to which the general response actions would be applied is contained within the area of the source plume. Based on a saturated thickness of 18 feet for the outwash aquifer, and an area of approximately 80 feet by 500 feet, the estimated total volume of contaminated groundwater in the source plume at the site assuming a porosity of 25% is 1.3 million gallons.

The volume of contaminated soil to which the general response actions would be applied occurs between the water table and the base of the sewer lateral. Assuming a 140

TABLE 2-1

MR. C CLEANERS SITE
FEASIBILITY STUDY

GENERAL RESPONSE ACTIONS

Environmental Medium	**General Response Actions**
Groundwater	No Action
	In-Situ Treatment
	Collection/On-Site/Ex-Situ Treatment/Off-Site Disposal
Soil	No Action
	Institutional Controls
	Containment/Isolation
	In Situ Treatment
	Excavation/Off-Site Disposal
	Excavation/Off-Site Treatment/Off-Site Disposal
	Excavation/On-Site Treatment/On-Site Disposal
	Excavation/On-Site Treatment/Off-Site Disposal

foot long lateral in a three foot wide trench, which is connected to a sanitary main 10 feet deep, the estimated volume of contaminated soil is approximately 78 cubic yards.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, remedial alternatives deemed applicable to the impacted media and contaminants of concern at the Mr. C Cleaners site are developed and undergo preliminary screening. The objective of this preliminary screening is to narrow the list of potential remedial alternatives which will be evaluated in detail. Each alternative is evaluated with respect to its overall effectiveness and its technical and administrative implementability. In accordance with NYSDEC TAGM No. 4030, cost is not used as a screening criterion.

3.1 SOIL

The RI identified a limited area of contaminated soil in the unsaturated zone in the vicinity of the sanitary sewer lateral which originates under the Mr. C's building and leads to Route 20A. As the integrity of the lateral is suspect, it is believed that past contaminant exfiltration from the sewer lateral may have resulted in contamination of the unsaturated soils and groundwater beneath and in front of the Mr. C's building. The contaminated soil is located in an area of heavy vehicular and pedestrian traffic as well as numerous above grade and below-grade structures; therefore, implementation of a comprehensive in-situ or ex-situ soil treatment alternative would present significant implementation difficulties. Additionally, any contaminated soils present beneath the Mr. C Cleaners building would also be very difficult to access, and complete treatment of the affected soils would not be likely. Although partial soil remediation would not effectively achieve the Remedial Action Objectives, because much of the source area would remain; such remediation will reduce contaminant loading to the groundwater.

The Exposure Pathway Analysis presented in the RI (Malcolm Pirnie, 1995) identified utility workers as a potentially exposed population with respect to contaminated soils. However, potential isolated health risks of this nature can be controlled by means other than soil remediation. Specifically, health risks to workers repairing underground utilities that require excavation in the contaminated soil area could be managed through institutional controls requiring appropriate use of engineering controls and personal protective equipment.

Based on the implementation constraints posed by the site location, the limited contribution which soil treatment alternatives would provide toward achieving Remedial Action Objectives, and the ability to control potential soil-related risks by other means, direct soil treatment is not recommended for the Mr. C Cleaners site. More practical alternatives to direct soil treatment include elimination of exfiltration from the sewer lateral, or the conjunctive use of an in-situ air stripping well for soil and groundwater remediation.

Heavily contaminated soils beneath the lateral, where present, can contribute to groundwater contamination via exfiltration of sanitary wastewater from the active sewer line or by contact with the fluctuating groundwater table (the infiltration of precipitation contributes little to contaminant migration because the lateral is covered by the building, the sidewalk, and road pavement). Contaminant loadings from soils between the seasonally high groundwater table and the bottom of the sewer lateral can be mitigated by eliminating exfiltration from the sewer. This could be achieved through lining of the sewer lateral, excavating and replacing the existing sewer lateral, or by grouting the existing lateral and replacing it with a new lateral. These sewer remediation alternatives are described below.

Continued soil to groundwater contaminant loadings caused by contact with the groundwater table, however, cannot be effectively controlled through sewer remediation, but the in-situ air stripping technology presented in Section 3.2.3.1 can be applied to remediation of contaminated soil and groundwater. This presents an alternative approach to control of the soil to groundwater loadings beneath the sewer lateral and is also described below.

3.1.1 No Action

The No Action alternative is defined as taking no action to remediate the contaminated soil.

Effectiveness- The No Action alternative would result in continued potential off-site contaminant migration by allowing the continued use of the potentially leaky sewer for sanitary wastewater discharge, thus providing a continuing source of VOCs to the shallow groundwater from the soils located between the seasonally high groundwater table and the sewer lateral. In addition, contaminated soil between the seasonally low and high water table elevations would continue to impact groundwater quality. Thus, the No Action alternative would be ineffective in meeting the Remedial Action Objectives.

Implementability - The No Action alternative does not require implementation.

Conclusion - The No Action alternative provides a benchmark for comparison of other remedial alternatives and justifies the need for soil remediation. Thus, the No Action Alternative will be retained throughout the preliminary screening and detailed analysis of alternatives.

3.1.2 Sewer Lateral Lining

Polyethylene sliplining represents a relatively new technology used for the repair of deteriorated sewer lines. The technology is typically applied to lines 8" or larger in diameter, although it can be applied to smaller lines as well. Sliplining generally involves pulling a continuous flexible liner through the inside of the sewer line to provide a barrier against infiltration/exfiltration. The first step in the process involves hydraulic cleaning of the existing line followed by a TV inspection to identify roots or other debris, which must be removed either by further hydraulic flushing (if feasible) or excavation and repair of the affected section of the lateral. Two pits are then excavated at the ends of the lateral to be repaired; one to access the liner feed end of the pipe and the other to facilitate pulling the liner through the pipe with power winching equipment.

Effectiveness - Sliplining would be effective in preventing exfiltration of sanitary wastewater if a continuous seal could be made across the entire lateral length. However, as with all of the sewer remediation alternatives considered, sliplining only partially mitigates contaminant migration from soils to the groundwater since fluctuations in the water table will continue to bring groundwater into contact with contaminated soil below the seasonally high water table.

Implementability - Several technical and administrative barriers reduce the implementability of sliplining technology for the Mr. C's site. Sliplining requires excavation of a large liner entrance/pulling pit at the ends of the pipe which would require, at a minimum, excavation on Route 20A and at the Mr. C Cleaners building. As Route 20A is a state transportation highway, special permits and construction restrictions would be needed to minimize traffic impacts during excavation work. In addition, continuous slip-lining is only applicable for straight runs of pipe. Thus, if the discharge line exits the building and turns 90 degrees toward Route 20A, a separate liner would be required between the 90 degree bend and the building. Similarly, it is not uncommon for a sewer lateral and a main line to be constructed at different depths, whereby the majority of the lateral is relatively shallow but drops-off sharply near the point of connection to the main line. Again, bends of this nature preclude continuous sliplining and would necessitate further excavation to allow sliplining in discrete sections.

In addition to excavation of the pits, badly deteriorated areas of pipe or areas characterized by heavy debris/tree roots, if identified, will also require excavation through potentially heavily-contaminated soils. As the condition of the sewer lateral is unknown but suspected to be in poor condition, such additional excavation is likely and may not be possible under the building and would require implementation of engineering controls to mitigate utility worker and public exposure to VOC vapors during construction. The excavated soils would also need to be properly contained and disposed of as hazardous waste.

Conclusions - Based on the likely significant disturbance of contaminated soils required, the exposure potential during construction and location limitations for the entrance and exit pits, sliplining the sewer lateral will not be retained for further analysis.

3.1.3 Excavation and Replacement of the Existing Sewer Lateral

Excavation of the existing 140-foot sewer lateral and replacement with a new line in the same location is discussed below.

Effectiveness - Replacement of the leaky sewer lateral would prevent exfiltration of sanitary wastewater from the sewer. As previously discussed this type of control only partially mitigates contaminant migration to the groundwater, because fluctuations in the water table will continue to bring groundwater into contact with contaminated soil.

Implementability - Excavation and replacement of the existing sewer lateral between its point of origin beneath Mr. C's facility and the connection to the main line on Route 20A is a feasible alternative. However, several administrative and technical barriers greatly diminish the implementability of this approach. The soil and sewer lateral are located in an area of heavy vehicular and pedestrian traffic, which will necessitate extensive coordination with local and state agencies to minimize disruption of the community and traffic. In addition, the work will likely require several days to complete, during which time significant portions of the excavation trench will be opened. This will greatly reduce the ability of the construction crew to minimize exposure/release of VOC's. Temporary sanitary facilities or a temporary sanitary discharge line would also need to be installed for the businesses connected to the existing line. Depending on the physical properties of the soils under Mr. C's facility, special construction procedures may also be required to prevent loss of structural integrity during excavation of the portion of the sewer lateral beneath the building floor and immediately outside the building wall.

Finally, assuming a 140 foot long by 10 foot wide by 7 foot deep trench, 363 cubic yards of contaminated soil would be excavated and a portion of this volume would require off-site disposal as a hazardous waste.

Conclusion - Based on the increase in exposure during construction, disruption of Mr. C Cleaners business, and construction difficulties/administrative barriers, excavation and in-situ replacement of the sewer lateral will not be retained for further analysis.

3.1.4 Abandonment of Existing Sewer Lateral and Construction of New Sewer Lateral

This alternative would incorporate disconnecting the existing sewer lateral from the building, thereby eliminating exfiltration. A new sewer lateral would be constructed running west to Whaley Street in same trench proposed for the groundwater treatment discharge lines (see Section 3.2.4). Construction of the new sanitary sewer lateral at Whaley Street and at the building would be supplemented by plugging any old floor drains or other connections to the former sewer line with grout.

Optionally, a degree of in-situ soil treatment can be achieved by exfiltrating an appropriate oxidizer or microbial stimulant from the lateral. Hydrogen peroxide can directly oxidize PCE and it's degradation products. Combinations of hydrogen peroxide and phenol, or other electron acceptors would promote microbial degradation of the contaminants. Advantages of this approach are that the exfiltration would follow the same pathway taken by the spent dry cleaning solvent (suspected to have been discharged to the lateral), and would likely contact the contaminated soil. The progress of the in-situ soil treatment could be monitored by analyzing groundwater at well ESI-3 for VOCs. However, the combination of hydrogen peroxide and steel pipe or trap components may generate explosive hydrogen gas. Therefore, the construction of the lateral should be determined prior to introducing hydrogen peroxide. The appropriate chemical additive, and the concentration and frequency of application would need to be determined based on the observed groundwater monitoring results at ESI-3. Aside from reactions with the lateral material, there is little risk in attempting several different additives, and sampling ESI-3 to establish the result. If oxidation is incomplete, any undesirable degradation products or nonreacted chemicals would be captured at a downgradient remediation well. The in-situ soil treatment option will not be carried through to detailed analysis due to insufficient knowledge of the sewer construction, but this option could be considered in conjunction with the sewer replacement alternative.

Effectiveness - Abandonment and relocation of the existing sewer lateral will prevent exfiltration of sanitary wastewater and will partially prevent contaminant migration from soils to the groundwater.

Implementability - Abandoning the old sewer lateral and construction of a new lateral would be readily implementable at the Mr. C Cleaner site using standard construction equipment and laborers. However, sewer relocation would cause the temporary disruption of commercial activities inside the Mr. C Cleaners building.

Whaley Street is owned by the Village and the road experiences significantly less traffic than Route 20A. Also, since trench excavation for the groundwater treatment air distribution lines will already be completed there will be less overall disruption associated with tie-in of a new line at this location.

Conclusion - Abandonment of old sewer lateral and construction of a new lateral will be retained for detailed analysis, described in Section 3.2.3.1.

3.1.5 Modification of Groundwater Remedy to Remediate Soil

This alternative would utilize an in-situ groundwater treatment technology called a vertical circulation well to remediate contaminated soil beneath the sewer lateral. The vertical circulation well bubbles air through the extracted groundwater before it is brought to the surface, thus acting as an in-situ air stripper. An in-situ air stripping well would be installed adjacent to the Mr. C Cleaners building approximately mid-distance between the location of the dry cleaning operations and Main Street, with the extracted groundwater routed to flush over the contaminated soil under the building. The number and location of the in-situ air stripping wells would be determined during design, as well as the means to achieve flushing of the soils under the building; however, this alternative would require that the design include a remediation well located as close as possible to the area of contaminated soil.

Effectiveness - The in-situ air stripping wells incorporate two contaminant removal mechanisms that would affect contaminated soil. First, operation of the wells creates a groundwater circulation across the uppermost water table. The in-situ air stripping technologies are predicted to develop a circulation radius ranging from 40 to 50 feet. Therefore, positioning a well near the Mr. C's building would capture groundwater directly below the sewer lateral. Soil contaminant removal would also occur by flushing the contaminates from the soil with remediated groundwater.

Secondly, the in-situ air stripping technology utilizes vapor extraction to remove compounds that are stripped from the groundwater. Vapor extraction will influence the unsaturated zone outside the well and is likely to volatilize soil contaminants. The No

Conclusion - Based on the potential ability for the in-situ groundwater treatment to remediate contaminated soil with no serious barriers to implementation, this technology is retained for detailed analysis.

3.2 GROUNDWATER

Groundwater remediation potentially could be achieved through in-situ treatment, or collection and ex-situ treatment with subsequent off-site discharge. Groundwater collection, treatment and discharge alternatives, as well as the No Action alternative, are described and evaluated below.

3.2.1 No Action

The No Action alternative is defined as taking no action to remediate on-site or off-site contaminated groundwater.

Effectiveness - The No Action alternative would not mitigate off-site contaminant migration, and would not reduce the volatilization of groundwater contaminants into indoor air. Natural biodegradation of contaminants will continue to occur with degradation of PCE producing vinyl chloride, which is more toxic, persistent, and mobile in the subsurface than PCE. Thus, the No Action alternative would be ineffective in meeting the Remedial Action Objectives.

Implementability - The No Action alternative does not require implementation.

Conclusion - The No Action alternative provides a benchmark for comparison of other remedial alternatives and justifies the need for groundwater remedial action. Thus, the No Action alternative will be retained throughout the preliminary screening and detailed analysis of alternatives.

3.2.2 Groundwater Collection

Groundwater collection is necessary for ex-situ groundwater treatment. Based on RI and pumping test data, the contaminated groundwater plume extends from Mr. C Cleaners through two hydrologically distinct zones. Each zone is defined by substantially different transmissivities. Therefore, recovery well designs would be different for each zone.

The contaminated groundwater source plume traverses a high transmissivity zone between the source area near well ESI-3 to RW-1. Further west the source plume traverses a low transmissivity zone to the western edge of the PCE source plume. The boundary between the high and low transmissivity zones along the axis of the source plume is located beneath the shoe repair/hardware store buildings west of the Mr. C Cleaners parking lot.

The complete hydraulic containment of the source plume is not required to meet the remedial action objectives. Rather, a groundwater remediation plan must effectively reduce source plume concentrations to levels observed in the broader plume with more dispersed contamination .

Three groundwater collection technologies were considered potentially applicable at the Mr. C Cleaners site including, vertical wells, horizontal wells, and collection trench(es). These collection technologies are screened below.

3.2.2.1 Vertical Wells

Groundwater can be collected by pumping from properly designed and constructed vertical wells, discharged into a pipe, to be conveyed to the treatment system. The development of a conceptual well configuration using vertical well designs requires an estimate of aquifer transmissivity and specific yield, pumping rates, radii of influence for the proposed wells, and the distribution of contaminants. With this information the number and spacing of wells, the well design, and the total estimated groundwater flow rate can be specified. Data collected during the RI and the short-term aquifer testing program provided the information necessary to develop a conceptual well configuration.

However, a long-term aquifer test on the outwash aquifer should be performed to better estimate groundwater influent to a treatment system.

Based on the existing data, a collection system based on vertical wells would require one high yield (55 gpm) well in the high transmissivity zone near Mr. C Cleaners, as well as, multiple low yield (5 gpm) wells located throughout the low transmissivity zone. The collection radius of the high yield well would encompass the source area and the immediate downgradient area including groundwater beneath the shoe repair/hardware store buildings. The total flow rate of the vertical well option is estimated to be 95 gpm.

Effectiveness- Groundwater collection from vertical wells is a proven technology with extensive field application. The mass removal of PCE from the aquifer would occur as a result of the withdrawal of contaminated groundwater. However, the degree of mass removal, and the time frame required to reduce groundwater concentrations is uncertain. Dissolved organic contaminants generally move more slowly through granular aquifers than the groundwater itself because of sorptive interactions with the aquifer solids. Contaminants residing on the aquifer matrix or dissolved in water present in closed pores is not readily removed by groundwater withdrawal. Therefore, multiple plume volumes (experience indicates as many as 10 pore volumes) would need to be removed in order to flush these absorbed contaminants and reduce groundwater concentrations.

Experience at other sites has shown that substantial reductions in PCE concentrations can be achieved with pumping, especially in the absence of pure phase PCE. No evidence of pure phase PCE has been identified at the Mr. C Cleaners site. It is likely that groundwater concentrations within the PCE source plume can be lowered to contaminant levels detected outside the limits of the plume.

Implementability - Vertical wells can be installed with readily available drilling equipment and materials. Submersible pumps and electric power would be required at each well. Water discharge lines would need to be installed in below grade trenches, which will potentially cross public roads or buried utilities. Due to the need for multiple extraction wells in the low transmissivity zone, a network of subsurface discharge pipes would necessitate some disruption of vehicular and pedestrian traffic during installation. Administratively, easements may need to be obtained to install the wells and the pipe trenches.

Conclusions - Based on the proven application of groundwater collection from vertical wells, and the ease of implementation, groundwater collection from vertical wells will be retained for further analysis.

3.2.2.2 Horizontal Wells

Groundwater can be pumped from a well installed horizontally near the base of the aquifer and along the axis of the highly contaminated groundwater plume. The well would be installed in a borehole drilled along the base of the outwash aquifer, which is the subsurface horizon along which high concentrations of PCE have been detected. The water would be conveyed to an on-site groundwater treatment facility. The well would have to be screened solely in the low transmissivity zone to avoid withdrawing water preferentially from the high transmissivity zone. The well would be installed from the southeast end of the plume and would dead end in the vicinity of well MPI-6S behind the Library. This a total horizontal distance of 500 feet of which approximately 300 feet would be screened. Screened wells that incorporate a sandpack as part of the screen are available commercially, and would be needed to produce sediment-free water, and to limit future plugging of the well screen.

Effectiveness - A horizontal well would create a trough of depression along the axis of the plume, which would effectively hydraulically contain the highly contaminated plume. Multiple wells would not be required in the low transmissivity zone, and there would be no disruption of the surface west of the Mr. C Cleaners parking lot.

The productivity of a horizontal well decreases as the ratio of the horizontal to vertical hydraulic conductivity (K_h/K_v) increases. In an isotropic aquifer ($K_h/K_v = 1$), a 300-foot horizontal well screen is equivalent to 17 - 18-foot vertical screens. In highly anisotropic aquifers ($K_h/K_v > 1$), vertical wells are more productive per linear feet of well screen. The productivity of a horizontal well can be compared to a vertical well using the relationship (Wilson, 1995):

- $h_e = h \text{ x } (k_h/k_v)^{½}$
- Where h_e = the effective aquifer thickness and
  h= the actual aquifer thickness (18 ft.)

The pumping test completed in the low transmissivity zone behind the Library indicated that the aquifer anisotropy (k_h/k_v) has an approximate value of 4. Therefore, the effective aquifer thickness would be 36 ft, and one 300 foot horizontal screen at the base of the aquifer would be equivalent to the effectiveness of only eight 18-foot vertical screens.

Implementability - Specialized equipment and expertise would be required to install the well. There needs to be sufficient space on the surface to set up drilling equipment that includes a drilling rig, a control trailer, drilling fluid system, cuttings handling system, drill pipe rack and handling system. Directional drilling requires an adequate step-off distance between the entry point and the beginning of the horizontal alignment. For the Mr. C Cleaners site, this requirement would most likely place the entry point in Main Street, which would present a major disruption to vehicular traffic in the Village. Access restrictions (private homes and landscaping) would require a blind borehole at the western end of the well. Therefore, the well would be installed using the push-in method (as opposed to being pulled through from the opening at the opposite end). This may be difficult over the full length of the borehole.

Conclusions - Based on site access restrictions, potentially significant disruption to the public, and the ability to accomplish the similar objectives with a reasonable number of more easily-installed vertical wells, horizontal wells will not be retained for further analysis.

3.2.2.3 Collection Trench

A groundwater collection trench could be installed perpendicular to the flow of groundwater at the downgradient edge of the plume behind the Library. The trench would need to be 28 feet deep, with a slotted pipe set in granular backfill at the base, and additional granular backfill to the watertable. Soil fill would be placed and compacted to the surface. A wet well at one end or in the middle would contain a submersible pump, which would be operated to maintain a hydraulic gradient toward the trench. The natural hydraulic gradient, augmented by the artificial gradient near the trench would direct contaminated groundwater to the trench where it would be withdrawn for treatment.

Effectiveness - The trench would be highly effective in intercepting all contaminated groundwater migrating in the highly contaminated PCE plume, but would rely on the natural groundwater rate of travel from the source to the trench.

Implementability - Due to the depth of contamination, construction of the trench would require more space than is available behind the Library and therefore would impinge on private homes and landscaping, and the Library building itself. Excavation would also expose the public to potentially significant VOC vapors during construction.

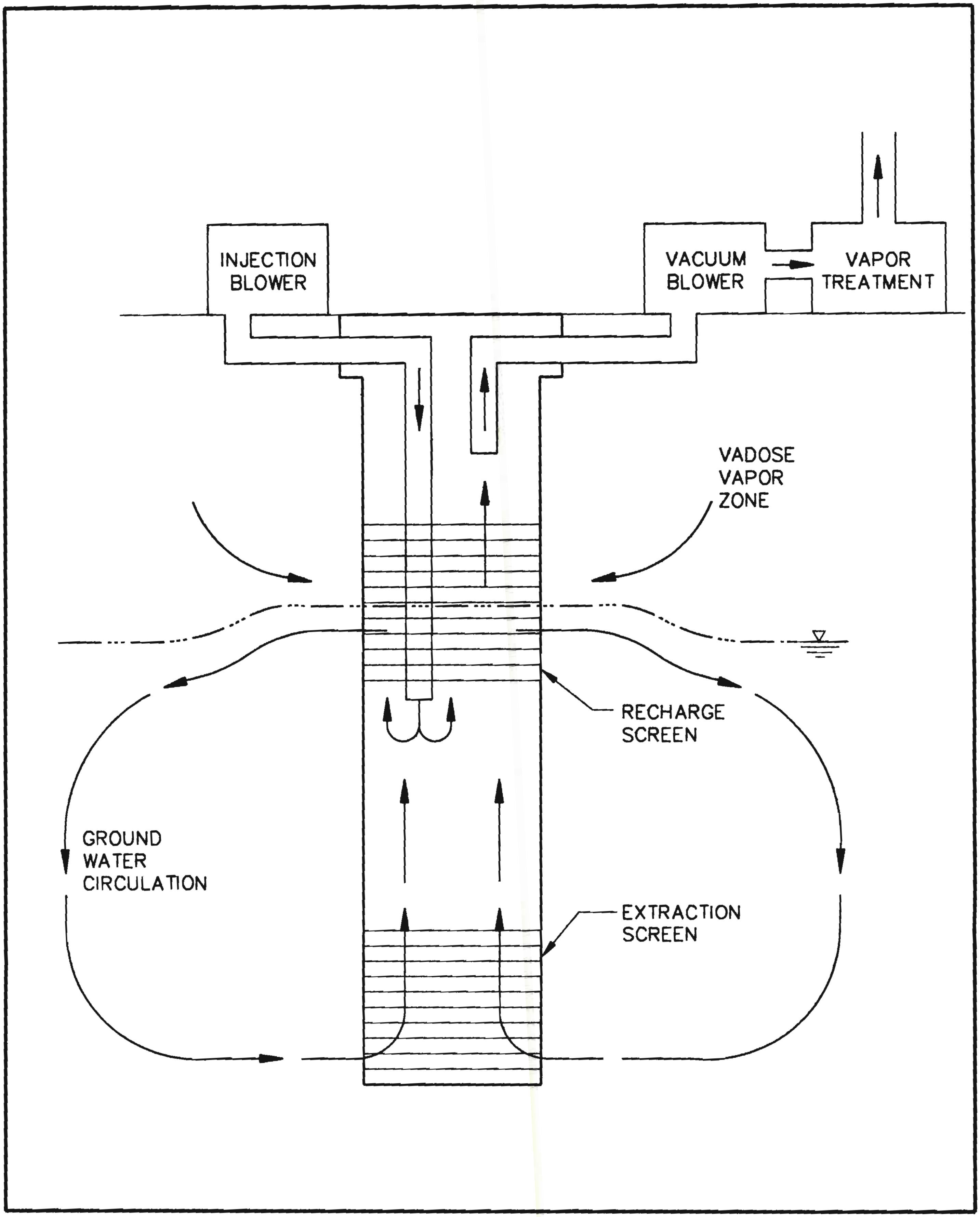
Conclusions - Based on the access constraints in the only technically effective location and the exposure potential during construction, collection trenches will not be retained for further analysis.

3.2.3 In-Situ Groundwater Treatment

Two in-situ groundwater treatment technologies were considered applicable for groundwater remediation at the Mr. C Cleaners site, including in-situ air stripping with vertical circulation wells and air sparging. These two technologies are screened below.

3.2.3.1 In-situ Air Stripping with Vertical Circulation Wells

In-situ air stripper wells create a subsurface groundwater treatment cell. A schematic in-situ air stripper well is illustrated in Figure 3-1. The well is screened at two depths: i) within the saturated zone in contact with the contaminated groundwater, and ii) within the vadose zone at or above the water table. Water flows into the bottom screen in response to a pressure differential developed with a submersible pump, air-lift pumping, or a sample vacuum applied above the water. Water within the well rises up the well casing and exits to the upper screen into the vadose zone. The water then



MR. C CLEANERS
FEASIBILITY STUDY

IN-SITU AIR STRIPPING PROCESS SCHEMATIC

MALCOLM PIRNIE

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NYSDEC
DIVISION OF HAZARDOUS WASTE REMEDIATION

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percolates outward and downward through the vadose zone back into the aquifer. Thus, a three dimensional circulation pattern is created in the vicinity of the in-situ air stripper. Air is injected into the well at a point above the lower screen by means of an interior pipe, forming a continuous stream of bubbles which mixes with the water column in the well. The contact of the air with the water strips volatile organic compounds (VOCs) from the water.

A vacuum is applied to the casing above the upper screen, so that VOC contaminated air is drawn out of the well. The vacuum blower delivers the collected vapors to a vapor treatment system before discharge to the atmosphere. Vadose zone vapors are also drawn into the well and into the vapor treatment system.

Groundwater moves by virtue of the existing hydraulic gradient into the area of influence of the in-situ air stripper well. Pumping rates are selected to allow multiple passes of the groundwater through the well, since groundwater quality standards would not be achieved with a single pass through the well. Typically eight to twelve passes are achieved before the natural hydraulic gradient moves the groundwater out of the area of influence of the well.

Effectiveness - In-situ air stripping is a relatively new technology and has had limited field application in the United States either on the pilot scale or full scale. However, two vendors IEG Technologies Corp. of Charlotte, North Carolina (IEG); and EG&G Environmental, Inc. of Pittsburgh, Pennsylvania, offer patented versions of the in-situ air-stripping technology.

IEG, Inc. (through its licensed vendor, SBP Technologies, Inc.) has installed 54 in-situ air-stripping wells in the United States since 1991 under the trade name Vacuum Vaporizer Well™ or UVB™. One-third of the UVB™ installations treated groundwater contaminated with chlorinated volatile organic compounds. The remainder are being used to treat groundwater contaminated with gasoline, jet fuel, or creosote. IEG originated the in-situ air-stripping concept in Germany, where its parent company has installed over 250 UVB wells since 1987.

EG&G offers a similar technology under the trade name NoVOCs™. The two versions differ in the mechanism used to generate contact between contaminated groundwater and air, and in the air: water ratios of the stripping process.

Site specific geologic characteristics influence the circulation path of the groundwater. The radius of influence due to pumping at a specific rate is similar using any pumping technology. However, the recirculation radius is controlled by the flow rate and to some degree by the anisotropic hydraulic conductivity of the soil. If vertical short circuiting occurs along the well casing, lateral pipes can be installed to carry recirculated water away from the casing. If the vadose zone hydraulic conductivity is too low, infiltration galleries can be constructed to promote recirculation.

In-situ air-stripping is effective with a stripping zone inside the in-situ air stripper well and a vadose zone thickness of at least 10 feet. Depth to water at the Mr. C Cleaners site ranges from 10 to 11 feet seasonally. Therefore, physical aquifer constraints should not limit the effectiveness of the in-situ air stripping technology.

Implementability - In-situ air stripping wells involve patented designs sold by relatively few contractors. Although the selection of vendors is limited, at least two in-situ air stripping vendors were identified during the FS. Construction of the in-situ air stripping wells is performed with commonly available drilling equipment. Each in-situ air stripping well would be manifolded to a blower system for air injection, and to a vapor treatment system to treat VOC-laden air extracted from the well. Air extraction and injection lines would be placed in below-grade trenches, which would likely transverse public roads. There is minimal potential for VOC exposure during trench excavation, due to the depth to groundwater. Vehicular and pedestrian traffic may be impacted during implementation of the in-situ air stripping system. Administratively, easements may need to be obtained to install the pipe trenches. The substantive requirements of a Permit to Construct and Certificate to Operate in accordance with NYSDEC Division of Air Resources regulations will need to be met for the point source air discharge from the in-situ air stripping system.

Conclusion - Based on the potential ability for in-situ air stripping system to remove the contaminants of concern from groundwater and its implementability, this technology will be retained for detailed analysis.

3.2.3.2 Air Sparging

Air sparging involves pressurized air injection below the water table to create a crude air stripper in the subsurface, with the saturated soil column acting as the packing.

The air flow encourages volatilization of organic contaminants from the aqueous phase into the vapor phase. Air sparge points are usually coupled with soil vapor extraction wells to collect sparged vapors from the subsurface. The collected vapors are typically treated using activated carbon or possibly a catalytic oxidizer situated above-grade prior to discharge to the atmosphere.

Effectiveness - The Henry's Law constants for the contaminants of concern indicate that all of these compounds would be amenable to remediation by means of stripping technologies. Therefore, air sparging would likely be effective in transferring the contaminants of concern from the aqueous phase to the vapor phase. However, since the site is located in a heavily developed area, the potential exists for sparged vapors to migrate beyond the soil vapor extraction wells and enter building basements or to migrate along the permeable bedding surrounding underground utilities. Thus, in a setting such as the Mr. C Cleaners site, air sparging has the potential to increase contaminant migration to undesirable receptors.

Implementability - Air sparge points and soil vapor extraction wells can be installed with typical drilling equipment and materials. Air injection and soil vapor extraction would be accomplished using commonly available compressors and vacuum blowers. Air sparge points and soil vapor extraction wells would need to be manifolded to the compressor and vacuum blower via pipelines placed in below grade trenches, which could potentially transverse public roads. Vehicular and pedestrian traffic would likely be impacted during implementation of an air sparging system. Administratively, easements may need to be obtained to install the pipe trenches. The substantive requirements of a Permit to Construct and Certificate to Operate in accordance with

NYSDEC Division of Air Resources regulations would need to be met for the point source air discharge from the soil vapor extraction portion of the system.

Conclusion - Based on the potential for an air sparge system to increase the migration of vapor phase contaminants into building basements, air sparging will not be retained for further analysis.

3.2.4 Ex-Situ Groundwater Treatment

Groundwater removed from the subsurface by the groundwater collection system will require treatment prior to discharge. The two discharge options for treated groundwater include indirect discharge to the Village of East Aurora Publicly-Owned Treatment Works (POTW) or direct discharge to Tannery Brook. Three ex-situ treatment technologies are potentially applicable for remediating site groundwater, including air stripping, advanced oxidation process (AOP), and activated carbon. These treatment technologies are described and evaluated following a brief evaluation of the two discharge options below.

The contaminant concentration conditions which were used to evaluate the treatment technologies are summarized in Table 3-1. The maximum contaminant concentrations historically observed at the site were selected as the influent concentrations to the treatment system. A range of iron concentrations were detected in groundwater from various portions of the site, thus, it was conservatively assumed that iron pretreatment would be required for those treatment processes prone to iron fouling (viz., air stripping and AOP). An influent groundwater flow rate of 95 gpm was used.

Treated groundwater could potentially be discharged to either the Village of East Aurora Publicly-Owned Treatment Works (POTW) via the Whaley Avenue sanitary sewer or to Tannery Brook via the Whaley Avenue storm sewer. Tannery Brook is classified as a Class C stream. As discussed in Section 1.4.3 and shown in Table 3-1, Class C surface water quality guidance values are relatively low (viz., 1 ug/l for PCE and 11 ug/l for TCE). The pretreatment limits which would be acceptable to the POTW are likely to be higher than these guidance values. However, treated effluent from any of the ex-situ groundwater treatment processes would need to be conveyed to the POTW

TABLE 3-1

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT

GROUNDWATER TREATMENT SYSTEM DESIGN PARAMETERS

Parameter	Influent Concentration (ug/l)	TOGS 1.1.1 Class C Surface Water Guidance (ug/l)	Conceptual Design Effluent Goal (ug/l)(3)
Tetrachloroethene(1)	8200	1	<1
Potential Degradation Products/Contaminants of Tetrachloroethene:			
• Trichloroethene	280	11	<1
• 1,2 Dichloroethene	82	NE	<1
• 1,1 Dichloroethene	19J	NE	<1
• Vinyl Chloride	240	NE	<1
Petroleum Hydrocarbons:			
• Benzene	3200	NE	<1
• Toluene	740	NE	<1
• Ethylbenzene	430	NE	<1
• Xylene	1900	NE	<1
• Chlorobenzene	3J	NE	<1
Other Parameters:			
• 1,1,1 Trichloroethane	14	NE	<1
• Acetone(2)	91		
• Chloroform	3J	NE	<1
• Methylene Chloride	120J	NE	<1
• 2-Butanone	10UJ		
• 1,2-Dichloropropane	3J	NE	<1

Notes:

(1) Acetone was detected primarily in lacustrine unit and thus is not expected to be present in groundwater extracted from the outwash aquifer.

(2) A PCE concentration of 18,000 ug/l was reported from recovery well RW-3 in Test Zone B after the Feasibility Study was initiated.

(3) Values assumed for the purpose of performing the analysis. Actual goals will be determined by NYSDEC.

J = Estimated value due to limitations identified during quality control review.
UJ = Estimated detection limit.
NE= Not Established.

via sanitary sewer lines which are known to leak in the vicinity of the Mr. C Cleaners site. Thus, residual contaminants in the treated effluent may exfiltrate into the bedding material surrounding the sanitary sewer, potentially contaminating the bedding material and soil in the vicinity of the sewer. Additionally, residual VOCs could potentially volatilize from the exfiltrated water, and impact indoor air in subsurface structures. Groundwater being discharged to Tannery Brook would likely be treated to much lower limits, and thus would pose less threat should it exfiltrate from the storm sewer into surrounding bedding materials and soil. Therefore, Tannery Brook has been selected as the discharge option for treated groundwater from the ex-situ groundwater treatment alternatives.

3.2.4.1 Air Stripping

Air stripping is a mass transfer process by which volatile organic compounds (VOCs) are transferred from the aqueous phase to an air stream. The VOC-laden air may require emissions controls to meet State air emissions regulations prior to atmospheric discharge. Air stripping is most effective for organic compounds having high volatility and low aqueous solubility.

Air stripping can be accomplished using packed columns, bubble diffusion units, or low profile units. All three types of units provide similar performance with respect to removal of the contaminants found at the site. However, packed columns are more prone to fouling by iron deposition, and cleaning procedures are labor intensive. Bubble diffusion units and low profile units are both relatively resistant to iron fouling. Bubble diffusion units are more difficult to retrofit compared to low profile units should increased or decreased flow capacity be required. For these reasons, low profile air stripping will be the stripping technology considered.

Effectiveness - Desk-top modeling of air stripper performance for treatment of the Mr. C Cleaners groundwater plume, assuming the concentrations identified in Table 3-1, indicated that, air stripping would be effective in reducing the concentrations of the contaminants of concern to less than 1 ug/l. Benzene, toluene, ethylbenzene and xylene (BTEX) would also be removed to 1 ug/l or below. Thus, air stripping is judged to be effective in meeting effluent limits for discharge of treated groundwater to Tannery Brook.

Iron concentrations detected during the RI and the pump test ranged from less than 0.1 mg/l to 21.2 mg/l. Based on this variability, addition of a sequestering agent to minimize iron fouling is recommended upstream of the air stripper. Alternatively, depending upon the discharge limits for iron established by the NYSDEC, iron pretreatment or post-treatment may require a precipitation process to meet the effluent discharge limits.

A NYSDEC Air Guide-1 analysis was performed to evaluate the need for emissions controls for the air stripper. It was conservatively assumed that all volatile organic compounds in the influent groundwater are completely transferred to the vapor stream (viz., non-detectable concentrations in the air stripper aqueous effluent). To meet Annual Guideline Concentrations (AGCs) and Short-term Guideline Concentrations (SGCs) without air emissions controls for all compounds potentially present in the influent to the air stripper, a 90-foot high stack would be required. Since this is impractical given the commercial/residential setting of the site, air emissions controls were assumed to be required. Air emissions controls for chlorinated VOCs typically include vapor-phase activated carbon or catalytic oxidation. Biofilters (viz., vapor phase bioreactors) are applicable for aerobically biodegradable VOCs such as BTEX compounds. However, biofilter technology has not yet been developed for VOCs which are typically biodegraded by anaerobic means. Catalytic oxidation of chlorinated VOCs produces hydrochloric acid as a byproduct of the oxidation process. Typically, the hydrochloric acid must be removed by scrubbing the air stream with a caustic solution before discharge to the atmosphere. The scrubber generates a brine solution which must be discharged. A quench step is required upstream of the scrubber to reduce the temperature of the air stream. Due to the complexity of a catalytic oxidation/quench/scrubber system, catalytic oxidation will not be considered as a potential air emission control technology for the Mr. C Cleaners site. Thus, vapor phase activated carbon will be assumed as the air emission control system for the air stripper system.

Implementability - A low profile air stripper is readily implementable at the Mr. C Cleaners site. Low profile air strippers are available as skid mounted units from several manufacturers, and can be installed readily by a mechanical contractor. Vapor-phase activated carbon is also available from numerous suppliers, and can be readily implemented at the site. Since the spent-vapor phase activated carbon could potentially be a hazardous waste, hazardous waste manifesting and record keeping may be required as part of the on-going operation and maintenance of an air stripper with activated carbon air emissions controls.

Groundwater will be collected both in the vicinity of Mr. C Cleaners and north of the library. Groundwater from both locations would need to be piped to a central treatment system location. This will involve placing a pipe trench across Whaley Avenue. Treated groundwater would be piped from the treatment system to a manhole in the Whaley Avenue storm sewer. Therefore, easements would need to be obtained to install these pipelines. Installation of the pipelines would temporarily impact vehicular and pedestrian traffic along Whaley Avenue.

The substantive requirements of a SPDES permit would need to be met for the discharge of treated groundwater via the storm sewer to Tannery Brook. The substantive requirements of a Permit to Construct and Certificate to Operate in accordance with NYSDEC Division of Air Resources regulations will need to be met for the point source air discharge from the air stripper or emissions control equipment.

Conclusion - Air stripping is an effective and implementable technology which will be retained for detailed analysis.

3.2.4.2 Advanced Oxidation Process

Advanced Oxidation Process (AOP) is the generic term for the treatment process which uses ultraviolet (UV) light and hydrogen peroxide to oxidize organic contaminants to lower molecular weight non-toxic compounds. If the organic compounds are chlorinated, chloride will be an end product of AOP treatment. At high doses of UV light and hydrogen peroxide, the organic compounds are oxidized completely to form carbon dioxide and water. Because AOP is an organic compound destruction process, there are no air emissions from the treatment system.

Effectiveness - An AOP bench-scale study was conducted by Vulcan-Peroxidation Systems, Inc. (VPSI) using water collected from recovery well RW-1 located east of the Mr. C Cleaners building. The bench-scale study report prepared by VPSI is presented in Appendix A. The PCE concentration in the collected groundwater (800 ug/l) was lower than the maximum PCE concentration previously observed at the site, therefore, VPSI spiked the groundwater to increase the PCE concentration, resulting in an influent PCE concentration of 3,744 ug/l. The results of the bench-scale test indicate that PCE and its breakdown products (viz., trichloroethene, dichloroethenes, and vinyl chloride) are easily oxidized by UV/peroxide, and AOP can achieve non-detectable concentrations (viz., less than 1 ug/l) of these compounds. However, a number of compounds potentially present in the collected groundwater are less readily oxidized than PCE, including 1,1,1-Trichloroethane (TCA), BTEX compounds, and methylene chloride. Non-detectable concentrations of these compounds can be achieved by AOP, however, a significantly larger system would be required compared to that sized to treat PCE and its breakdown products to non-detectable concentrations.

Iron present in the groundwater potentially could oxidize in the AOP reactor and foul the quartz sleeves surrounding the UV lamps. Although AOP systems are typically equipped with an automatic wiper mechanism to remove iron scale, addition of an iron sequestering agent would be necessary to further reduce the potential for iron fouling.

Implementability - An AOP unit would be readily implementable at the Mr. C Cleaners site. Skid-mounted AOP systems are available from several manufacturers, and can be installed by a mechanical contractor.

Groundwater will be collected both in the vicinity of Mr. C Cleaners and north of the library, therefore, groundwater would need to be piped from each collection zone to a central treatment system location. This will involve placing a pipe trench across Whaley Avenue. Treated groundwater would their be piped from the treatment system to a manhole in the Whaley Avenue storm sewer. Easements would likely need to be obtained to install these pipelines. Installation of the pipelines would temporarily impact vehicular and pedestrian traffic along Whaley Avenue.

The substantive requirements of a SPDES permit would likely need to be met for the discharge of treated groundwater via the storm sewer to Tannery Brook.

Conclusion - AOP is an effective and implementable treatment technology which will be retained for detailed analysis.

3.2.4.3 Activated Carbon

Activated carbon removes organic compounds from aqueous waste streams by adsorbing the compounds into the pores of activated carbon granules. For groundwater treatment purposes, activated carbon is usually supplied in packed treatment vessels. Activated carbon would likely require pre-filtration using a bag or cartridge filter to remove suspended solids which could blind the activated carbon bed.

Effectiveness - If properly sized, an activated carbon system will produce an effluent which has non-detectable concentrations of contaminants of concern. When the adsorptive capacity of the activated carbon is reached, detectable concentrations of the least readily adsorbed contaminants begin to appear in the effluent. At such time, the carbon is spent and requires replacement or regeneration. Activated carbon has a high adsorptive capacity for many of the compounds present in the Mr. C Cleaners groundwater, however, vinyl chloride and methylene chloride are poorly adsorbed. These compounds would control the activated carbon change out, since these compounds would be the first to break through and appear in the effluent. Three different activated carbon suppliers have estimated that the carbon usage rate to treat the site groundwater would range from 6 to 12 pounds of activated carbon per 1000 gallons of groundwater. At an influent groundwater flow rate of 95 gpm, over 20,000 pounds of carbon would be replaced every month. Thus, activated carbon is judged to be relatively ineffective as the primary means for treating the Mr. C Cleaners groundwater. Activated carbon may be useful, however, as an aqueous stream polishing step for an AOP system, or for treatment of air emissions from an air stripper or in-situ air stripper wells.

Implementability - An activated carbon groundwater treatment system would be readily implementable at the site. Activated carbon systems are available from numerous suppliers, and can be readily installed by a mechanical contractor.

Groundwater will be collected both in the vicinity of Mr. C Cleaners and north of the library, thus groundwater would need to be piped from both collection areas to a central treatment system location. This will involve placing a pipe trench across Whaley Avenue. Treated groundwater would be piped from the treatment system to a manhole in the Whaley Avenue storm sewer. Therefore, easements would need to be obtained to install these pipelines. Installation of the pipelines would temporarily impact vehicular and pedestrian traffic along Whaley Avenue.

The substantive requirements of a SPDES permit would need to be met for the discharge of treated groundwater via the storm sewer to Tannery Brook. Since the spent activated carbon could potentially be a hazardous waste, hazardous waste manifesting and recordkeeping may be required as part of the on-going operation and maintenance of the system.

Conclusion - Activated carbon is relatively ineffective as the primary means for treating groundwater due to its low adsorptive capacity for vinyl chloride and methylene chloride, and thus will not be retained for detailed analysis as a primary treatment technology. However, activated carbon may be useful in combination with other groundwater treatment technologies for either aqueous stream polishing or vapor phase treatment and will be included in the detailed analysis as appropriate.

3.2.4.4 AOP + Air Stripping

A treatment system consisting of AOP and air stripping could be designed to capitalize on the treatment strengths of each technology. Air stripping alone requires air emissions controls to meet NYSDEC Air Guide-1 limits for PCE, vinyl chloride and benzene. An AOP treatment system adequately sized to treat PCE and its breakdown products to below detection limits would not completely treat TCA, methylene chloride and BTEX compounds to non-detectable concentrations. However, an AOP system could be used as "pretreatment" for air stripping, by sizing to reduce PCE, vinyl chloride and benzene to concentrations to eliminate the need for air emissions controls from the air stripper. The air stripper would then easily remove the remaining VOCs from the AOP effluent.

Effectiveness - A combined AOP + air stripping treatment system would be effective in reducing VOC concentrations to below detectable limits. The majority of the VOCs present in the collected groundwater would be destroyed by the AOP system. The remaining VOCs would then be removed to below detection limits (less than 1 ug/l) by the air stripper. The air stripper would be equipped with a 30-foot high stack to meet Good Engineering Practice (GEP) air emission stack guidelines (Appendix B of Air Guide-1, April 1994). The reduction in PCE, vinyl chloride and benzene achieved by the AOP unit combined with the 30-foot high stack would allow the air stripper to operate within NYSDEC Air Guide-1 limits with no air emissions controls. A sequestering agent is recommended to be added upstream of the AOP unit to minimize iron fouling of both the AOP unit and the air stripper. The NYSDEC discharge limits for iron (to be established) may require iron removal by precipitation.

Implementability - Similar to systems consisting of AOP or air stripping alone, a combined AOP + air stripper system would be readily implementable at the Mr. C Cleaners site. Both AOP units and air strippers are available as skid mounted units from several manufacturers, and can be installed by a mechanical contractor.

Groundwater will be collected both in the vicinity of Mr. C Cleaners and north of the library, thus groundwater would need to be piped from both collection areas to a central treatment system location. This will involve placing a pipe trench across Whaley Avenue. Treated groundwater would be piped from the treatment system to a manhole in the Whaley Avenue storm sewer likely requiring easements. Installation of the pipelines would temporarily impact vehicular and pedestrian traffic along Whaley Avenue. The substantive requirements of a SPDES permit would need to be met for the discharge of treated groundwater via the storm sewer to Tannery Brook. The substantive requirements of a Permit to Construct and Certificate to Operate in accordance with NYSDEC Division of Air Resources regulations would need to be met for the point source air discharge from the air stripper.

Conclusion - AOP + air stripping is an effective and implementable combination technologies and will be retained for detailed analysis.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 EVALUATION CRITERIA

The detailed analysis of those technologies remaining after the screening will be performed according to NYSDEC TAGM #4030, "Selection of Remedial Actions at Hazardous Waste Sites." The detailed analysis will also follow the general process specified in the "Interim Guidance for Conducting Remedial Investigation/Feasibility Study under CERCLA" (USEPA, 1988).

Additionally, the NYSDEC has established specific objectives which must be addressed by the remedial alternatives. The alternatives must:

- Be protective of human health and the environment.
- Attain SCGs (or explain why compliance with SCGs is not necessary to protect public health and the environment).
- Satisfy the preference for treatment that significantly and permanently reduces toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants.
- Be cost effective.

To meet these goals, a series of seven criteria have been established which will be evaluated for each alternative during the detailed analysis:

Compliance with Standards, Criteria and Guidelines (SCGs) - This criterion is used to determine how each alternative complies with applicable or relevant and appropriate State Standards, Criteria and Guidelines. Compliance with SCGs will be discussed relative to action-specific and chemical-specific SCGs only, since none of the location-specific SCGs were determined to be applicable or relevant and appropriate for the Mr. C Cleaners Site.

Overall Protection of Human Health and Environment - This criterion provides a final check to assess whether each alternative meets the requirement that is protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under the evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs. This evaluation focuses on how each alternative achieves protection over time and reduces site risks; how each contaminant source is eliminated, reduced or controlled; and uses of the site after remediation.

Short-Term Impacts and Effectiveness - This criterion addresses the effects of the alternative during the construction and implementation phase until the remedial actions have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to its effects on the community and on-site workers during the remedial action, environmental impacts resulting from implementation, and the amount of time until protection is achieved. Time estimates do not take into account the duration of the design phase, but do include time associated with bench or pilot-scale testing.

Long-term Effectiveness and Permanence - This criterion addresses the results of a remedial action in terms of the risk remaining at the site after the response objectives have been met. The primary focus of this evaluation is to determine the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The factors to be evaluated include the magnitude of remaining risk and the adequacy, suitability and long-term reliability of management controls for providing continued protection from residuals (i.e., assessment of potential failure of the technical components).

Reduction of Toxicity, Mobility, or Volume - This criterion addresses the preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility or volume of the contaminants. The factors to be evaluated include the treatment process employed, the amount of hazardous material destroyed or treated, the degree of reduction expected in toxicity, mobility or volume, the degree to which treatment is irreversible, and the type and quantity of treatment residuals.

Implementability - This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during the implementation. Technical feasibility considers construction and operational difficulties, reliability, ease of undertaking additional remedial action (if required), and the ability to monitor its effectiveness. Administrative feasibility considers obtaining permits or approvals for implementing remedial actions. The availability of services and materials such as off-site treatment, storage and disposal capacity, and necessary equipment and skilled operators is considered under this criterion.

Cost - This criterion addresses the capital costs, annual operation and maintenance costs, and present worth analysis over the life of the projected remediation period. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor and materials necessary to perform remedial actions. Indirect costs include expenditures for engineering, financial and other services that are not part of the actual installation activities but are required to complete the installation of remedial alternatives. Annual operation and maintenance costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action.

A present-worth analysis will be used to evaluate expenditures that occur over different time periods by discounting future costs to a common base year, usually the current year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that if invested in the base year and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life. A discount rate equal to the current 30-year U.S. treasury bond rate (viz., 7.85%) shall be used. In accordance with TAGM #4030, the performance period considered shall not exceed 30 years.

4.2 GROUNDWATER

The detailed analysis of in-situ and ex-situ groundwater treatment alternatives is presented in this section. The No Action alternative is included also. Technical information submitted by vendors, and used to evaluate the groundwater alternatives is provided in Appendix A.

4.2.1 Alternative GW-1: No Action

The No Action alternative is defined as taking no action to remediate on-site or off-site contaminated groundwater. Natural biodegradation would continue to occur. The No Action alternative would include periodic monitoring of volatile organics in groundwater and at potential exposure points.

A monitoring program would be implemented to track the natural degradation of the plume and detect the presence of indoor air contamination. The monitoring program would be comprised of annual sampling and analysis at selected private irrigation wells, and all Phase 1 and Phase 2 groundwater monitoring wells; and semi-annual sampling and analysis of indoor air from potentially affected residential basements.

Compliance with SCGs - Since there are no remedial actions associated with this alternative, action-specific SCGs do not apply. Under the No Action alternative, chemical-specific NYSDEC groundwater quality standards (6NYCRR Part 703) would not be achieved through biodegradation within a reasonable time period.

Overall Protection of Human Health and the Environment - The No Action alternative would not be adequately protective of human health in the source plume area, because the potential for migration of volatile organics to indoor air would persist for an indeterminable period. Also, the migration of contaminants from the source plume to presently unaffected exposure points may occur. Degradation of PCE may eventually produce vinyl chloride, which is more toxic than its parent compounds.

Short-term Impacts and Effectiveness - The No Action alternative would have no short-term impacts on the community or the environment, since there is no implementation involved with this alternative.

Long-term Effectiveness and Permanence - All of the human health risks posed by the unremediated Mr. C Cleaners site groundwater in the source plume area would remain. The only long-term maintenance associated with this alternative is periodic sampling and analysis of on-site and off-site monitoring wells, and known potential exposure points.

Reduction of Toxicity, Mobility and Volume - The No Action alternative will not reduce the toxicity, mobility or volume of groundwater contaminants, aside from the natural biodegradation of contaminants which may occur. The toxicity and mobility of contamination may actually increase under the No Action alternative, since anaerobic biodegradation of PCE produces vinyl chloride, which is more mobile in the subsurface and more toxic than PCE.

Implementability - Implementation required by the No Action alternative only involves long-term monitoring, which is readily implementable.

Cost - Estimated monitoring costs for Alternative GW-1 are presented in Section 4.4. The estimated total present worth for this alternative, representing 30 years of monitoring, is $241,500. A cost breakdown is presented in Appendix C.

4.2.2 In-situ Groundwater Treatment

4.2.2.1 Alternative GW-2: In Situ Air Stripping

The evaluation of in-situ air stripping was performed using conceptual remedial designs provided by outside vendors based on site information developed during the RI. Site specific hydrogeologic conditions, contaminant distributions, water quality data, and the remedial objectives were provided to SBP Technologies, Inc. of White Plains, New York (SBP); and to EG&G Environmental of Pittsburgh, Pennsylvania (EG&G). SBP holds an exclusive license to in-situ air stripping technology patented by IEG Technologies, Inc., and developed by IEG's parent company in Germany. EG&G holds the patent on a similar process developed by Battell Pacific Northwest Laboratories.

The locations, depths, and pumping rates of the in-situ air stripping remediation wells were conceptually established by each vendor using the results of the aquifer testing program. A discussion of the aquifer test field methodology and data analyses are presented in the Mr. C Cleaners Aquifer Test Report (see RI Addendum, May 1996). A summary of the aquifer testing results are presented in Section 1.3.3.2.

EG&G proposes a network of six in-situ air stripping wells of the NoVOCs™ design including one 8-inch diameter, 80 gpm well located in the Mr. C Cleaners parking lot; two 6-inch diameter, 20 gpm wells located on the Agway property; and three 6-inch diameter, 5 gpm wells located between Whaley Avenue and the rear of #23 Whaley. The 5 gpm wells would be fitted with a 4-inch educter pipe to improve pumping efficiency. To enhance recharge of the treated water, infiltration galleries would be constructed around each well. Each infiltration gallery would be comprised of a 5-foot by 5-foot by 10 foot excavation backfilled with clean gravel.

Figure 4-1 illustrates the location and approximate radius of influence of the conceptual in-situ air stripping wells.

Air handling equipment would include an air injection blower, a moisture separator, and an air vacuum blower located in a central process building. Each well would be connected to the process building via buried air injection and vacuum lines. Air emissions would need to be passed through vapor phase carbon prior to discharge.

SBP proposes a network of three in-situ air stripping wells of the UVB-400^{TM} design including: one well located at the Mr. C Cleaners parking lot near the suspected release area; one well located in the Whaley Avenue Right-of-Way; and one well located on Library property behind #23 Whaley Avenue near the leading edge of the source plume. The radius of influence of each treatment/circulation cell is projected by SBP to be approximately 40 feet. This configuration would provide contaminant containment and treatment for approximately 240 feet of the 500 foot source plume. Natural groundwater flow would carry the intervening portions of the source plume into the treatment/circulation cells.

The UVB-400^{TM} design differs in several respects from the NoVOCs^{TM} design. Each well would be constructed so that the upper screen straddles the water table. The stripping zone is two feet in length, but utilizes air: water ratios of between 100 and 200. In contrast, the NoVOCs^{TM} design requires a stripping zone of approximately 10 feet or greater and utilizes air: water ratios of 10 to 20. The UVB-400^{TM} design generates higher air: water ratios using a proprietary groundwater and air distribution mechanism. Also, in contrast to the NoVOCs^{TM} design, water flow is maintained with a submersible pump rather than by airlift pumping.

Air injection and air withdrawal blowers would be installed in a vault at each wellhead. This eliminates frictional losses between a central equipment building and the wellheads; thereby, minimizing blower size and operational costs. A central building and air collection pipes would be still be needed for centralized air emission controls using vapor phase carbon.


DELIA'S COLLISION SHOP
DELIA'S CAR DEALERSHIP
CAR PORT
FIRST PRESBYTERIAN CHURCH SOCIETY
H-7
H-6
H-5
H-8
MPI-12B
MPI-3S
VENT
SEWER LATERAL
ESI-6
MPI-1S
MPI-1D
MPI-1I
ESI-4
ESI-5
MH-61
PAINE
STREET
BENCH MARK
MH-62
MH 65
HSE. #39
HSE. #31
HSE. #23
HSE. #36
HSE. #32
BOYS & GIRLS CLUB
EAST AURORA VILLAGE HALL
MPI-2S
VET HOSPITAL
TRAVEL
CROCKET & HINES
LAMP & LANTERN
WILLISTON AUCTIONS
AIN
STREET
(ROUTE 20A)
ESI-1
ESI-3
SB-1
MR. CLEANERS BLDG.
D.J. AUTO PARTS, INC.
PROPOSED AIR TREATMENT PROCESS LOCATION
ESI-2
SHOE REPAIR
DUBOIS HARDWARE
AGWAY OFFICE
POST OFFICE BOX PLUS
BARBER
PLATE GLASS REPAIR
AGWAY STORE
JACKSON BOWLING LANES
RW-1
PB-1
OW-A
MPI-7D
H-12
RW2
MW5
MW10
MW4
MH-3
MW3
MW8
MW2
MW1
MPI-10B
H-9
MW7
H-10
H-13
MW9
MPI-5D
MPI-5S
MPI-5I
MPI-4I
MPI-4D
MPI-4S
MH-12
WHALEY
AVENUE
MPI-8S
MPI-9S
PAVEMENT
H-4
R.O.W.
MH-11
TOWN OF AURORA LIBRARY
PB-2
RW-2
OW-B
RW-3
MPI-6S
OW-C
HSE. #23
HSE. #27
HSE. #31
HSE. #35
HSE. #565
HSE. #34
HSE. #54
F#531
F#517
MPI-11B
HSE. #521
HSE. #531
HSE. #537
HSE. #541
HSE. #547
MW-13B
MW-14B
H-1
H-2
H-3
FILLMORE
AVENUE
MH 10
F#524
HSE. #524
HSE. #530
HSE. #536
HSE. #542
HSE. #546
HSE. #554
HSE. #566
HSE. #570
BOTTOM OF RAILROAD BANK
100
0
GRAPHIC SC
LEG
HSE. #27
H-11
MH-12
MPI-8S
F#531
MPI-5D
SB-2
PB-2
RW-2
OW-A

recharge of the treated water, infiltration galleries would be constructed around each well. Each infiltration gallery would be comprised of a 5-foot by 5-foot by 10 foot excavation backfilled with clean gravel.

Figure 4-1 illustrates the location and approximate radius of influence of the conceptual in-situ air stripping wells.

Air handling equipment would include an air injection blower, a moisture separator, and an air vacuum blower located in a central process building. Each well would be connected to the process building via buried air injection and vacuum lines. Air emissions would need to be passed through vapor phase carbon prior to discharge.

SBP proposes a network of three in-situ air stripping wells of the UVB-400™ design including: one well located at the Mr. C Cleaners parking lot near the suspected release area; one well located in the Whaley Avenue Right-of-Way; and one well located on Library property behind #23 Whaley Avenue near the leading edge of the source plume. The radius of influence of each treatment/circulation cell is projected by SBP to be approximately 40 feet. This configuration would provide contaminant containment and treatment for approximately 240 feet of the 500 foot source plume. Natural groundwater flow would carry the intervening portions of the source plume into the treatment/circulation cells.

The UVB-400™ design differs in several respects from the NoVOCs™ design. Each well would be constructed so that the upper screen straddles the water table. The stripping zone is two feet in length, but utilizes air: water ratios of between 100 and 200. In contrast, the NoVOCs™ design requires a stripping zone of approximately 10 feet or greater and utilizes air: water ratios of 10 to 20. The UVB-400™ design generates higher air: water ratios using a proprietary groundwater and air distribution mechanism. Also, in contrast to the NoVOCs™ design, water flow is maintained with a submersible pump rather than by airlift pumping.

Air injection and air withdrawal blowers would be installed in a vault at each wellhead. This eliminates frictional losses between a central equipment building and the wellheads; thereby, minimizing blower size and operational costs. A central building and air collection pipes would be still be needed for centralized air emission controls using vapor phase carbon.

Compliance with SCGs-Action-specific SCGs considered applicable for Alternative GW-2 include air emissions regulations (6NYCRR Parts 200, 201, 211, 212 and 257). Hazardous waste manifest system and record keeping requirements (6NYCRR Part 372) for managing spent vapor phase activated carbon would be applicable if the activated carbon is a hazardous waste. Portions of 6NYCRR Part 373-2 (action-specific standards that define acceptable management of hazardous waste described in Section 1.4.1) are considered relevant and appropriate. The in-situ air-stripping system would be designed to meet action and location-specific SCGs for the site through appropriate environmental permitting, monitoring and record keeping.

Chemical-specific SCGs include 6NYCRR Part 257 (air quality standards for non-methane hydrocarbons), the NYSDOH indoor air quality guideline for residences over dry cleaners, 6NYCRR Part 703 Groundwater Quality Standards, and Air Guide-1 emissions limits. However, a waiver from chemical-specific SCG's would be necessary as outlying reaches of the plume and the Church Area would not be directly remediated. Chemical specific SCGs are projected to be achieved within the source area by the in-situ air stripping system vendors within in ten years.

Overall Protection of Human Health and the Environment - Human health risks associated with the Mr. C Cleaners source plume would be significantly reduced by the in-situ air-stripping alternative. The in-situ air-stripping system would mitigate further migration of the source plume, thus meeting RAOs. Over time, the system will reduce groundwater contaminant concentrations by removing the most highly contaminated groundwater, which will reduce the potential for VOCs to volatilize into building basements, thus further meeting RAOs. Also, within the wells area of influence vadose zone vapors will migrate toward the well rather than to basements. The air emissions control equipment would be protective of human health by removing organic compounds from the air stream to concentrations below Air Guide-1 AGCs and SCGs.

The potential for exposure to VOC's during foundation construction, utility excavation and/or from use of irrigation wells will diminish outside the source plume area at a slower rate through natural attenuation.

Short Term Impacts and Effectiveness - In-situ treatment would be implemented by the installation of three to six remediation wells along the axis of the source plume. Each well requires significant subsurface excavation to create the infiltration gallery, posing a potential for worker/resident exposure to hazards and short-term disruptions to the community during construction. These risks can be minimized through proper use of personal protective equipment and worker health and safety procedures, and various measures available to minimize the area exposed during construction.

The UVB technology was tested in-situ at the March Air Force Base, California as part of the USEPA SITE Program for innovative technologies. Under the conditions of the test, TCE concentrations in groundwater were reduced an average of 94% after 18 months. SBP reports that of the UVB wells installed in Germany, at which chlorinated volatile organics were the primary contaminant, a total of 17 sites have been closed. Remediation periods ranged from 3 to 10 years. In one pilot test, using a NoVOCs™ system, from EG&G groundwater concentrations of 1,1,1-trichloroethane (TCA) were reduced from approximately 300 ug/l to less than 10 ug/l in approximately five passes through a in-situ air stripper well. TCA has a Henry's Law constant of $1.4x10^{-2}$ atm-m^3/mol, while tetrachloroethene (PCE) has a Henry's Law constant of $1.5x10^{-2}$ atm-m^3/mol (Henry's Law constant is an indicator of the strippability of a compound). Thus, it appears that the in-situ air stripping technology could be effective in reducing PCE concentrations to groundwater quality standards. The Henry's Law constants of other contaminants of concern are within one order of magnitude of TCA and PCE, and thus should be readily stripped from the groundwater by in-situ air stripping. Operational NoVOCs™ wells installed at Aubagne, France and Edwards Air Force Base, California reduced dissolved PCE concentrations in groundwater by 98% over ten months, and 75% over five months, respectively.

Long Term Effectiveness and Permanence - In-situ air-stripping would be considered a permanent remedial solution for the site, operating continuously until concentrations of VOC's in the groundwater diminish to the point that health risks have been mitigated to the extent practicable.

As discussed in Section 3.2.3, groundwater is circulated through the well multiple times. Each pass through the well constitutes one treatment cycle. The removal efficiency for each treatment cycle depends on the well configuration. For the conceptual remediation plan developed for the Mr. C Cleaners site, EG&G predicts that removal efficiencies per treatment cycle would range from 86% to 89% for PCE to 77% to 82% for TCE. The treatment cycle times for these designs range from approximately six days for the 80 gpm well, to 90 days for the 5 gpm wells. Therefore, remediation times predicted by EG&G are on the order of one to two years. SBP Technologies predicts a higher VOC removal efficiencies, on the order of 93 to 98%; however, SBP more conservatively predicts remediation times on the order of five to six years.

Groundwater contaminants will ultimately be transferred to vapor phase activated carbon. When the adsorptive capacity of the activated carbon is reached, the carbon would be removed from service and regenerated at an off-site facility. Should the activated carbon remain on-line beyond its adsorptive capacity, VOCs may pass through the carbon bed or some compounds may be desorbed from the bed as more strongly adsorbed compounds enter the unit. Two additional activated carbon filters would be used as backup to prevent VOC break through. It is anticipated that 2,500 to 4,000 pounds of vapor phase activated carbon would be consumed every month. Annual freight and carbon servicing costs could be minimized by putting oversized carbon canisters on-line.

Any in-situ treatment wells will require routine maintenance to ensure continued performance. Operation and maintenance for the in-situ treatment wells may require more frequent well maintenance (viz., acid cleaning) than is typically experienced with groundwater extraction wells, because of the potential for fouling of the well screens, as well as routine blower and air emissions control maintenance.

Long-term management of the site would include groundwater and indoor air monitoring as long as the potential for exposure to site contaminants persists.

Reduction of Toxicity, Mobility, or Volume - The in-situ treatment system would significantly reduce the mobility of contaminated groundwater within the source plume area. Air-stripping, either in-situ or ex-situ, involves the transfer of contamination from the groundwater to an air stream, which can be treated prior to release to the atmosphere. Emissions controls such as vapor phase granular activated carbon would effectively control the release of contamination to the atmosphere. The VOCs would be transferred to vapor phase activated carbon for irreversible destruction during regeneration.

Implementability - The patented in-situ air-stripping technologies incorporate collection and treatment equipment that is available for purchase. Administrative issues include: the need to obtain licenses to utilize the technology or to purchase from a licensed vendor; easements for constructing wells and laying pipe on private and commercial property; and the need to obtain the necessary permits for construction of the process enclosure. Also, the substantive requirements of an air emission Permit to Construct and Certificate to Operate would need to be met for an air stripper system.

Piping to supply air and vacuum to the remediation wells from the process building at Mr. C Cleaners would be placed in a trench traversing Whaley Avenue. Thus, vehicular and pedestrian traffic along Whaley Avenue, behind the library and in the Agway parking lot would be impacted during pipe trench construction. The process building could be easily installed using standard construction techniques.

Technical implementation associated with the systems include process control and monitoring. Because the in-situ treatment system will not incorporate mechanical equipment at the wells, process control is limited to the air handling equipment. This creates considerable flexibility in the number of wells and pumping rates used in the remediation. Changes to the system can be accommodated by changing blower sizes, and more frequent vapor phase carbon change out.

Cost - Capital cost estimates for in-situ treatment via the two in-situ air stripping systems described ranged from \$445,000 to \$727,000. All preliminary costs assume vapor-phase carbon will be implemented for air emissions control. Estimated costs for vapor-phase carbon include capital costs for oversized carbon canisters. This minimizes operation and maintenance costs by reducing the frequency of spent carbon change out, with its associated freight and carbon reactivation costs. Due the historical performance of the in-situ air stripping technologies, the present worth was calculated for the expected remediation time of 10 years. Annual operation and maintenance costs are \$106,500 with a present worth cost of \$714,700. A breakdown of the cost estimate is presented in Appendix C.

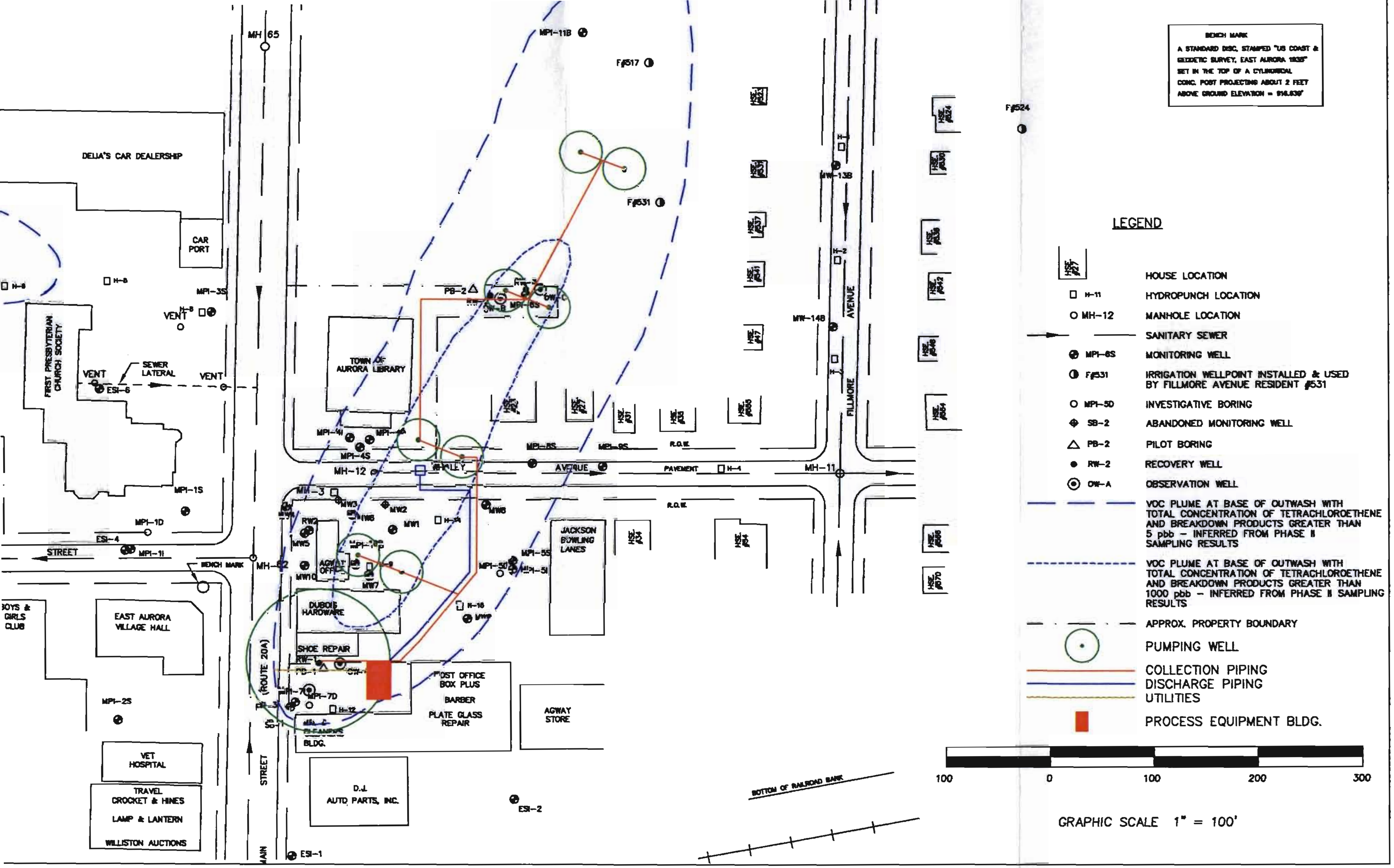
4.2.3 Groundwater Extraction

This section presents a detailed analysis of the vertical well groundwater extraction alternative which would be used in combination with the three ex-situ treatment alternatives presented in Section 4.2.4.

To evaluate the groundwater extraction alternative, the locations, depths, and pumping rates of the remediation wells were conceptually established based on the results of the aquifer testing program, which are summarized in Section 1.3.3.2.

A conceptual groundwater extraction plan was developed for test zone A based on groundwater pumping rates and areas of influence achieved during the step-drawdown test. The conceptual plan developed for test zone B used areas of influence based on the calculated transmissivities (see Appendix B). For the vicinity of Mr. C Cleaners (test zone A), the preliminary test data indicates that a single 6-inch diameter well, pumped at 55 gpm would influence ESI-3 near the suspected PCE release area, and MPI-10B on the Agway property. This would effectively encompass approximately 30% of the source plume. For the remaining 70% located in the low transmissivity region, the conceptual groundwater extraction plan includes four pairs of 4-inch diameter wells, pumped at 5 gpm, with an estimated radius of influence of 22 feet at steady state conditions. The pumping configuration is illustrated in Figure 4-2. Wells within each pair would be separated by 40 feet, giving a total area of influence that encompasses the 80 foot width of the source plume. Well pairs would be spaced along the axis of the source plume such that the natural groundwater flow rate would move contaminated groundwater into the area of influence of the well pair. In practice, the spacing would be determined by access considerations. The configuration of low yield wells on Figure 4-2 was selected based on the assumption that Whaley Avenue and residential property should be avoided, if possible. The westernmost well pair should be located based on a determination of the extent of contamination beyond MPI-6S that is above 1000 ug/l PCE.

The approximate time that may be required to meet the remedial action objectives (by decreasing PCE concentrations in the source plume to levels detected in the broader plume) is dependent upon the natural groundwater flow velocity of the source plume. Allowing natural groundwater flow to flush 10 source plume volumes through the aquifer



MR. C CLEANERS

would require approximately 12.5 years. This is based on an estimated natural groundwater flow rate along the axis of the source plume of approximately 100 feet/year, and an estimated flow distance of 125 feet between well pairs (see calculations in Appendix B).

The easternmost low yield well pair illustrated in the vicinity of MPI-10B is proposed conditionally pending the performance of a pumping test at operating pumping rates to determine the extent of the influence of a recovery well in test zone A into the low transmissivity zone. If a long-term test on RW-1 shows that the area of influence does not include the source plume underlying the Agway property, a well pair could be installed near MPI-10B as illustrated on Figure 4-2. The benefit of extending the area of influence of the groundwater collection to the Agway property is that the groundwater concentrations beneath the two commercial buildings situated between the Mr. C Cleaners parking lot and the Agway property would be decreased in a shorter period, and the overall period required to reach the concentrations of PCE detected outside of the source plume would be decreased.

Compliance with SCGs -Action-specific SCGs considered applicable for Alternative GW-3 include air emissions regulations (6NYCRR Parts 200, 201, 211, 212 and 257). Hazardous waste manifest system and record keeping requirements (6NYCRR Part 372) for managing spent vapor phase activated carbon would be applicable if the activated carbon is a hazardous waste. Portions of 6NYCRR Part 373-2 (action-specific standards that define acceptable management of hazardous waste described in Section 1.4.1) are considered relevant and appropriate. Groundwater extraction in combination with an effective ex-situ treatment technology (see Section 4.2.3) would be designed to meet action and location-specific SCGs for the site through appropriate environmental permitting, monitoring , and record keeping.

Chemical-specific SCGs include 6NYCRR Part 257 (air quality standards for non-methane hydrocarbons), NYSDOH indoor air quality guidelines for residences over dry cleaners, 6NYCRR Part 703 Groundwater Quality Standards, and Air Guide-1 emissions limits are "to be considered".

The ex-situ treatment system would need to reduce contaminant concentrations in the collected groundwater below the "to be considered" chemical-specific surface water guidance values presented in TOGS 1.1.1. A waiver from chemical-specific SCGs, specifically 6NYCRR Part 703 Groundwater Quality Standards and Guidance Values, would be necessary as outlying reaches of the source plume and the Church area would not be directly remediated, and the time frame for achieving chemical specific SCGs within the source plume area is very long.

Overall Protection of Human Health and the Environment - Human health risks associated with the Mr. C Cleaners source plume would be significantly reduced by groundwater extraction in combination with an effective ex-situ treatment alternative. The groundwater collection system would mitigate further migration of the source plume, thus meeting RAOs. Over time, the groundwater collection system will reduce groundwater contaminant concentrations by removing the most highly contaminated groundwater, which will reduce the potential for VOCs to volatilize into building basements, thus further meeting RAOs. The ex-situ treatment system would need to remove organic compounds from the collected groundwater to non-detectable concentrations prior to discharge to Tannery Brook, to provide protection of both human health and the environment. The air emissions control equipment would need to be protective of human health by removing organic compounds from the air stream to concentrations below Air Guide-1 AGCs and SCGs. The potential for exposure to VOC's during foundation construction, utility excavation and/or from use of irrigation wells will diminish outside the source area at a slow rate through natural attenuation.

Short Term Impacts and Effectiveness - This alternative relies on the installation of wells in contaminated groundwater to effect groundwater collection. The potential for worker/resident exposure to hazards and short-term disruptions to the community during construction is minimal. Well locations are located on commercial property or village rights-of-way, and potentially contaminated drill cuttings are easily containerized during drilling. Excavations for discharge pipes will be temporarily disruptive. However, there are no potential health impacts arising from the pipe installation excavation, because the piping will be buried well above the contaminated groundwater.

Groundwater extraction has been proven to be effective in removing contaminated groundwater. The technology has limited effectiveness in removing very low concentrations of volatile organics derived from residual contamination present in the aquifer matrix; and very high concentrations derived from non-aqueous phase PCE. However, the RAOs can be met by reducing VOC concentrations to moderate levels, and the presence of non-aqueous phase PCE has not been demonstrated. This technology is expected to be effective in achieving the RAO's for the site.

Long Term Effectiveness and Permanence - Groundwater extraction would be part of a permanent remedial solution for the site, operating continuously until concentrations of VOC's in the groundwater diminish to the point that health risks have been mitigated to the extent practicable. The technology will require routine maintenance to ensure continued performance. O&M for a pump and treat system will include routine maintenance of the treatment system, periodic pump and well maintenance, and maintenance of the emissions controls. Long-term management of the site would require groundwater and indoor air monitoring as long as the potential for exposure exists.

Reduction of Toxicity, Mobility, or Volume - Groundwater extraction can be expected to effect the entire area of the source plume. Reduction of the toxicity and the mass of contamination is dependent upon the treatment technologies employed.

Implementability - The groundwater collection wells would be easily implemented using standard drilling techniques. Piping to deliver the collected groundwater to the treatment system and from the treatment system to the storm sewer in Whaley Avenue would be placed in a trench traversing Whaley Avenue. Thus, vehicular and pedestrian traffic along Whaley Avenue, behind the library and in the Agway parking lot would be impacted during pipe trench construction. The Process building could be easily installed using standard construction techniques.

Administratively, the substantive requirements of an air emission Permit to Construct and Certificate to Operate would need to be met for an air stripper system. Likewise, the substantive requirements of a SPDES permit would need to be met for discharge of treated groundwater to Tannery Brook. Easements may need to be obtained to place wells on Agway property and to construct the pipe trench.

Technical implementation associated with the system includes process control and monitoring. The groundwater extraction system will incorporate multiple wells fitted with submersible pumps and level controls, all of which will require interlock with motor starter panels in the treatment building tied in with external alarm relays from the treatment equipment and/or process feed tank level controls (to shut down the pumps in the event of treatment equipment failure). Thus, the larger the number of wells the more sophisticated the process control requirements under a groundwater extraction system.

Potential expansion of the groundwater extraction system is limited by the hydraulic capacity of the treatment system, and possibly the water conveyance system. The limiting factor in the size of the system is the hydraulic capacity of the Whaley Avenue storm sewer. Significant increases in the treated water discharge due to an expansion of the area of remediation or higher pumping rates may reduce the hydraulic capacity of the storm sewer during storm events and cause flooding, or necessitate replacing the existing storm sewer with a larger capacity sewer, or placing the wells on a rotating pumping schedule.

Cost - Preliminary capital costs for ex-situ treatment via a groundwater extraction system are dependent on the type of treatment system selected, which is evaluated below. The estimated capital costs for the groundwater extraction system described above are $109,000. The estimated annual operation and maintenance costs for the groundwater extraction system are $5,000. A cost breakdown is presented in Appendix C

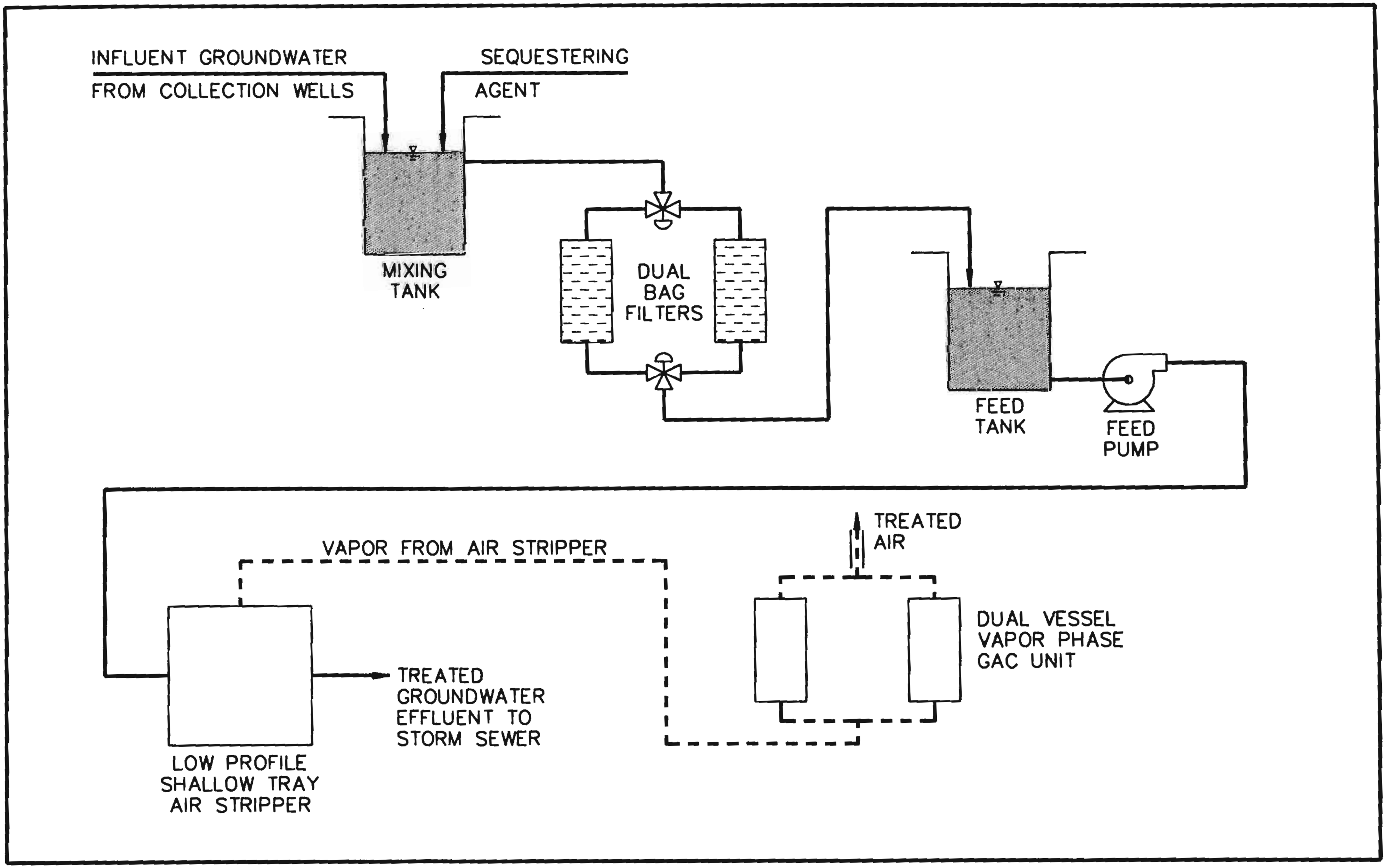
4.2.4 Ex-Situ Treatment

This section presents detailed analysis of the three ex-situ groundwater treatment alternatives that would be used in combination with the groundwater extraction alternative described in Section 4.2.3.

4.2.4.1 Alternative GW-3: Air Stripping

Alternative GW-3 would treat collected groundwater using a low profile air stripper. A block flow diagram of the air stripping alternative is presented in Figure 4-3. Collected groundwater would pass through a bag or cartridge filter upstream of the air stripper to remove suspended solids which could accumulate in the system. A sequestering agent would be added to the groundwater prior to introduction into the air stripper to minimize iron fouling of the stripper's perforated trays. The contaminant-laden air stream from the stripper would be passed through vapor phase activated carbon prior to atmospheric discharge.

Compliance with SCGs -Action-specific SCGs considered applicable for Alternative GW-3 include air emissions regulations (6NYCRR Parts 200, 201, 211, 212 and



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LOW PROFILE AIR STRIPPER
PROCESS SCHEMATIC

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FIGURE 4-3

372) for managing spent vapor phase activated carbon would be applicable if the activated carbon is a hazardous waste. Portions of 6NYCRR Part 373-2 (action-specific standards that define acceptable management of hazardous waste described in Section 1.4.1) are considered relevant and appropriate. The ex-situ air-stripping system would be designed to meet action and location-specific SCGs for the site through appropriate environmental permitting, monitoring, and record keeping.

Chemical-specific SCGs include 6NYCRR Part 257 (air quality standards for non-methane hydrocarbons), the NYSDOH indoor air quality guidelines for residences over dry cleaners, 6NYCRR Part 703 Groundwater Quality Standards, and Air Guide-1 emissions limits which are "to be considered".

The air stripper would reduce contaminant concentrations in the collected groundwater below the "to be considered" chemical-specific surface water guidance values presented in TOGS 1.1.1. A waiver from chemical-specific SCGs, specifically 6NYCRR Part 703 Groundwater Quality Standards and Guidance Values, would be necessary as outlying reaches of the source plume and the Church area would not be directly remediated. Chemical specific SCGs for groundwater may not be achieved within the source plume area within the projected life of the remediation.

Overall Protection of Human Health and the Environment - Human health risks associated with the Mr. C Cleaners source plume would be significantly reduced by air-stripping alternative. The groundwater collection system would mitigate further migration of the source plume, thus meeting RAOs. Over time, the groundwater collection system will reduce groundwater contaminant concentrations by removing the most highly contaminated groundwater, which will reduce the potential for VOCs to volatilize into building basements, thus further meeting RAOs. The air stripping treatment system would need organic compounds from the collected groundwater to non-detectable concentrations prior to discharge to Tannery Brook, thus providing protection of both human health and the environment. The air emissions control equipment would be protective of human health by removing organic compounds from the air stream to concentrations below Air Guide-1 AGCs and SCGs. The potential for exposure to VOC's during foundation construction, utility excavation and use of irrigation wells will diminish outside the source plume area at a slower rate through natural attenuation.

Short-term Impacts and Effectiveness - Construction of the groundwater collection system and an air stripping treatment system would pose virtually no increased risk to the community or the environment. Intrusive activities in contaminated areas would be limited to the installation of nine groundwater pumping wells and construction of the Process Building. Proper use of personal protective equipment would minimize worker risk during well construction and connection piping would be installed above seasonal high groundwater levels. An air-stripping treatment system would immediately be effective in meeting discharge limitations following 2 to 3 months of system start-up and shake down.

Long-term Effectiveness and Permanence - Air-stripping has been shown to be an effective technology for reducing VOC concentrations to below 1 ug/l in the discharge water. The groundwater collection and treatment system would need to operate for an estimated 12 years to remove 10 source plume pore volumes and substantially mitigate exposure pathways that have developed due to contamination in the source plume.

Groundwater contaminants will ultimately be transferred to vapor phase activated carbon. When the adsorptive capacity of the activated carbon is reached, the carbon would be removed from service and regenerated at an off-site facility. Should the activated carbon remain on-line beyond its adsorptive capacity, VOCs may pass through the carbon bed or some compounds may be desorbed from the bed as more strongly adsorbed compounds enter the unit. It is anticipated that 4,500 to 6,500 pounds of vapor phase activated carbon would need to be replaced every month under worst case conditions. Two additional activated carbon filters will be used as backup to prevent VOC break through.

In addition to vapor phase activated carbon replacement, the air stripper trays would require periodic cleaning via a pressure wash or removal with scrubbing to remove iron oxide and hardness deposits. Addition of a sequestering agent would reduce the cleaning frequency. The sequestering agent would need to be replenished approximately 3 times per year. Filter elements (viz., bags or cartridges) would be replaced as needed based on pressure drop across the filter.

Long-term management of the site would include groundwater and indoor air monitoring as long as the potential for exposure to site contaminants exists.

Reduction of Toxicity, Mobility and Volume - The groundwater collection system would significantly reduce the mobility of contaminated groundwater within the source plume. Air stripping treatment would reduce the volume and toxicity of VOCs in the collected groundwater by up to 99.99 percent (i.e., PCE concentration would be reduced from 8,200 ug/l to less than 1 ug/l). The VOCs would be transferred to vapor phase activated carbon for irreversible destruction during regeneration.

Implementability - An air stripping treatment system could be easily implemented using standard construction techniques. Treatment system components (e.g., low profile air strippers and vapor phase activated carbon) are available from numerous suppliers. A treatment system operator could readily be trained to monitor system operation and prepare vapor phase activated carbon for regeneration.

The groundwater collection wells would be easily installed using standard drilling techniques. Piping to deliver the collected groundwater to the treatment system and from the treatment system to the storm sewer in Whaley Avenue would be placed in a trench traversing Whaley Avenue. Thus, vehicular and pedestrian traffic along Whaley Avenue, behind the library and in the Agway parking lot would be impacted during pipe trench construction. The Process building could be easily installed using standard construction techniques.

Administratively, the substantive requirements of an air emission Permit to Construct and Certificate to Operate would need to be met for an air stripper system. Likewise, the substantive requirements of a SPDES permit would need to be met for discharge of treated groundwater to Tannery Brook. Easements may need to be obtained to place wells on Agway property and to construct the pipe trench.

Cost - Estimated capital, operating and maintenance costs for a groundwater collection system and air stripping treatment system are presented in Section 4.4. The estimated total present worth for Alternative GW-3, including 30 years of operation, maintenance and monitoring is $2,101,900. A cost breakdown is provided in Appendix C.

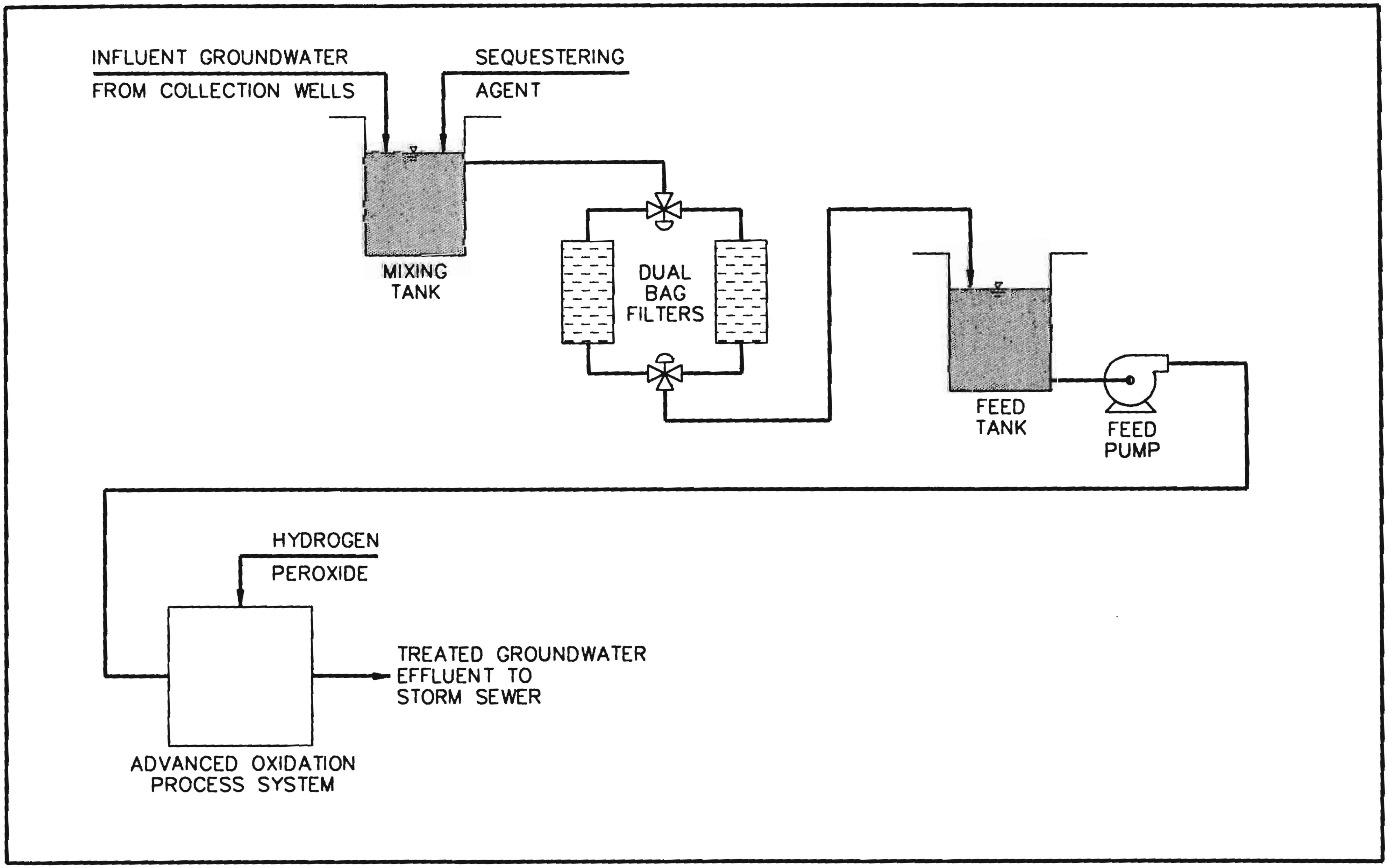
4.2.4.2 Alternative GW-4: Advanced Oxidation Process Treatment

The Advanced Oxidation Process (AOP) is a destruction process which irreversibly breaks down chlorinated organic compounds into chlorides, non-hazardous lower molecular weight organics (typically aldehydes and carboxylic acids), carbon dioxide and water. An AOP treatment system would consist of one skid-mounted AOP 540 kW reactor. A block flow diagram of the AOP treatment alternative is presented in Figure 4-4. Collected groundwater would pass through a filter (bag or cartridge) upstream of the AOP reactor to remove suspended solids which could accumulate in the system. A sequestering agent would be added to the groundwater to minimize iron fouling

Compliance with SCGs - Portions of 6NYCRR Part 373-2 (action-specific standards that define acceptable management of hazardous waste including general facility security, inspection, personnel training, preparedness and prevention, contingency and emergency procedures and closure/post-closure) are considered relevant and appropriate for an AOP groundwater treatment system. Action-specific SCGs regarding handling and storage of hazardous substances in 6NYCRR Parts 595 through 599 are considered applicable for an AOP system since bulk quantities of hydrogen peroxide will be required to operate the system. Hazardous substance storage will be designed to comply with 6NYCRR Parts 595 through 599.

Chemical-specific SCGs include the NYSDOH indoor air quality guidelines for residences over dry cleaners, and 6NYCRR Part 703 Groundwater Quality Standards. The AOP system would reduce contaminant concentrations in the collected groundwater below the "to be considered" chemical-specific surface water guidance values presented in TOGS 1.1.1. A waiver from chemical-specific SCGs, specifically, 6NYCRR Part 703 Groundwater Quality Standards and Guidance Values, would be necessary as outlying reaches of the source plume and the Church area would not be directly remediated, and the time frame for achieving chemical-specific SCGs within the source plume is uncertain.

Overall Protection of Human Health and the Environment - Human health risks associated with the Mr. C Cleaners source plume would be significantly reduced by this alternative. The AOP treatment system would protect human health and the environment by destroying all organic compounds to below direct discharge effluent limits. The AOP



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ADVANCED OXIDATION PROCESS SCHEMATIC

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FIGURE 4-4

system would mitigate further migration of the source plume, thus meeting RAOs. Over time, the AOP system will reduce groundwater contaminant concentrations by removing the most highly contaminated groundwater, which will reduce the potential for VOCs to volatilize into building basements, thus further meeting the RAOs. The potential for exposure to VOCs during foundation construction, utility excavation and/or from use of irrigation wells will diminish outside the source area at a slower rate through natural attenuation.

Short-Term Impacts and Effectiveness - Construction of a groundwater collection system and an AOP treatment system is not expected to present short-term risks to construction personnel, the community or the environment. Intrusive activities in contaminated areas would be limited to the installation of nine groundwater pumping wells and construction of the Process Building. Proper use of personal protective equipment would minimize worker risk during well construction, and connection piping would be installed above seasonal high groundwater levels.

An AOP system would be immediately effective in meeting direct discharge standards following a brief post-construction start-up/shakedown period anticipated to last less than two months.

Long-Term Effectiveness and Permanence - The groundwater collection and AOP treatment system would need to operate for an estimated 12 years to remove 10 source plume pore volumes and substantially mitigate exposure pathways that have developed due to contamination in the source plume. An AOP system will remain effective with on-going maintenance. Ultraviolet (UV) lamps will need to be replaced on a regular basis. An automatic wiper will remove accumulated scale from the protective quartz tube surrounding each UV lamp. Addition of a sequestering agent would reduce the cleaning frequency. The sequestering agent would need to be replenished approximately 3 times per year. Filter elements (viz. Bags or cartridges)would be replaced as needed based on pressure across the filter. Chemical feed systems for hydrogen peroxide would require regular attention to maintain equipment and replenish chemical supplies.

Long term management of the site would include groundwater and indoor air monitoring as long as the potential for exposure to site contaminants exists.

Reduction of Toxicity, Mobility and Volume - AOP will irreversibly reduce both the volume and toxicity of groundwater organic contaminants by 99.99 percent through destruction. Destruction technologies such as AOP receive highest preference in NYSDEC's hierarchy of remedial technologies (NYSDEC TAGM No. 4030, 1990). Based on bench scale testing, AOP is anticipated to be effective in reducing concentrations of all organic contaminants in groundwater to below direct discharge effluent limits. The groundwater collection system will significantly limit the mobility of groundwater contaminants.

Implementability - The AOP treatment alternative is readily implementable using standard construction techniques. Electricity and potable water service would need to be supplied to the process building. System components, including AOP units, are available from a number of suppliers.

The groundwater collection wells would be easily implemented using standard drilling techniques. Piping to deliver the collected groundwater to the treatment system and from the treatment system to the storm sewer in Whaley Avenue would be placed in a trench traversing Whaley Avenue. Thus, vehicular and pedestrian traffic along Whaley Avenue, behind the library and in the Agway parking lot would be impacted during pipe trench construction. The process building could easily be installed using standard construction techniques.

Implementation of the AOP system will require a discharge permit from the Village of East Aurora to discharge treated effluent to the sanitary sewer, or a SPDES permit to discharge treated effluent to Tannery Brook. Easements may need to be obtained to place wells on Agway property and to construct the pipe trench.

Cost - Estimated capital, operating and maintenance costs for an AOP system are presented in Section 4.4. The estimated total present worth for Alternative GW-4 including 30 years of operation, maintenance and monitoring is $5,298,000. A cost breakdown is provided in Appendix C.

4.2.4.3 Alternative GW-5: Advanced Oxidation Process + Air Stripping

Alternative GW-5 would be identical to the AOP treatment alternative with the exception that only one (1) 30 kW AOP reactor would be employed and an air stripper would be placed at the end of the treatment train. The air stripper would act as a polishing step for benzene, xylene, toluene, ethylbenzene and methylene chloride, allowing the AOP system to be downsized. A block flow diagram of the AOP + air stripper treatment alternative is presented in Figure 4-5.

Compliance with SCGs - Portions of 6NYCRR Part 373-2 (action-specific standards that define acceptable management of hazardous waste including general facility security, inspection, personnel training, preparedness and prevention, contingency and emergency procedures and closure/post-closure) are considered relevant and appropriate for an AOP groundwater treatment system. Action-specific SCGs regarding handling and storage of hazardous substances in 6NYCRR Parts 595 through 599 are considered applicable for an AOP system since bulk quantities of hydrogen peroxide will be required to operate the system. Hazardous substance storage will be designed to comply with 6NYCRR Parts 595 through 599.

The AOP system would reduce contaminant concentrations in the collected groundwater below the "to be considered" chemical-specific surface water guidance values presented in TOGS 1.1.1. A waiver from chemical-specific SCGs, specifically, 6NYCRR Part 703 Groundwater Quality Standards and Guidance Values, would be necessary as outlying reaches of the source plume and the Church area would not be directly remediated and the time frame to achieve chemical-specific SCGs within the source plume area is uncertain. Other applicable chemical-specific SCGs include 6NYCRR Part 257 (air quality standards for non-methane hydrocarbons), and Air Guide-1 emissions limits are "to be considered", and are expected to be met by the combined treatment technology.

Overall Protection of Human Health and the Environment - Human health risks associated with the Mr. C Cleaners source plume would be significantly reduced by the AOP + air stripping alternative. The groundwater collection system would mitigate further migration of the source plume, thus meeting RAOs. Over time, the groundwater collection system will reduce groundwater contaminant concentrations by removing the most highly contaminated groundwater, which will reduce the potential for VOCs to volatilize into building basements, thus further meet the RAOs. The AOP + air stripping treatment system would destroy and/or remove organic compounds from the collected groundwater to non-

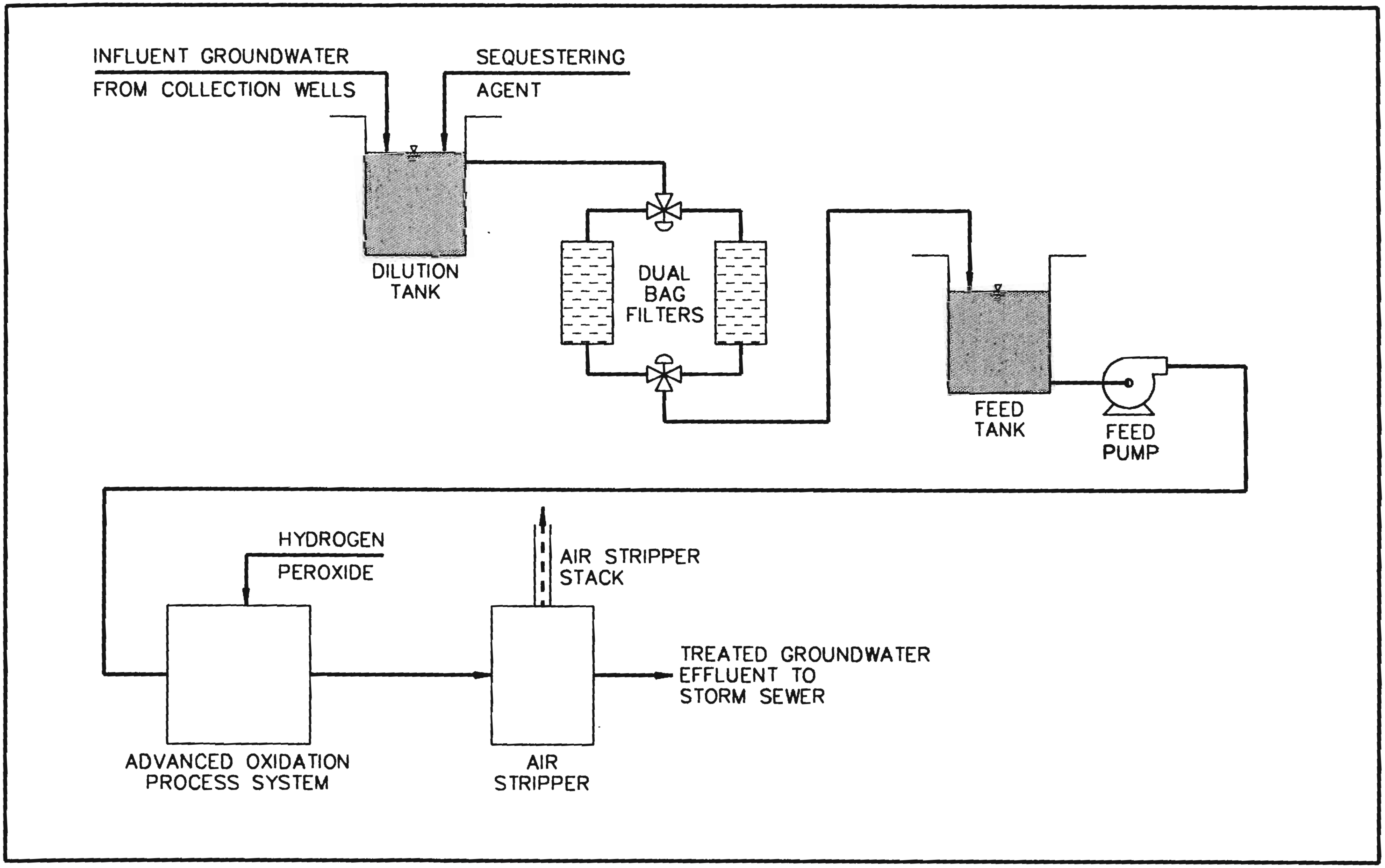

FIGURE 4-5

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AIR STRIPPER PROCESS SCHEMATIC

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detectable concentrations prior to discharge to Tannery Brook, thus providing protection of both human health and the environment. The potential for exposure to VOCs during foundation construction, utility excavation and/or from use of irrigation wells will diminish outside the source plume area at a slower rate through natural attenuation.

Short-Term Impacts and Effectiveness - Construction of the groundwater collection system and an AOP + air stripping treatment would pose virtually no increased risk to the community or the environment. Intrusive activities in contaminated areas would be limited to the installation of nine groundwater pumping wells and construction of the Process Building. Proper use of personal protective equipment would minimize worker risk during well construction, and connection piping would be installed above the seasonal high groundwater level. An AOP and air-stripping treatment system would immediately be effective in meeting discharge limitations following 2 to 3 months at start-up/shakedown.

Long-Term Effectiveness and Permanence - The groundwater collection and treatment system would need to operate for an estimated 12 years to remove 10 source plume pore volumes and substantially mitigate the exposure pathways that have developed due to contamination in the source plume. An AOP system will remain effective with on-going maintenance. Ultraviolet (UV) lamps will need to be replaced on a regular basis. An automatic wiper will remove accumulated scale from the protective quartz tube surrounding each UV lamp. Chemical feed systems for hydrogen peroxide would require regular attention to maintain equipment and replenish chemical supplies.

The air stripper trays would require periodic cleaning via a high pressure wash or brush cleaning to remove iron oxide and hardness deposits. Addition of a sequestering agent would reduce the cleaning frequency. Filter elements (viz., bags or cartridges) would be replaced as needed based on pressure drop across the filter, and may need to be disposed of as hazardous waste.

The AOP + air stripping alternative will permanently reduce organic contaminant concentrations in the collected groundwater below direct discharge effluent limits. The residual risk associated with treated groundwater is insignificant.

Long-term management of the site would include groundwater and indoor air monitoring as long as the potential for exposure to site contaminants exists.

Reduction of Toxicity, Mobility, and Volume - The combination of AOP + air stripping is expected to reduce the volume and toxicity of VOCs in the collected groundwater by up to 99.99 percent. The groundwater collection system will significantly limit the mobility of groundwater contaminants.

Implementability - The Implementability of alternative GW-5 would be the same as the AOP or air stripping treatment alternatives, as described in Section 4.2.3.2 and 4.2.3.3.

Cost - Estimated capital, operating and maintenance costs for a groundwater collection system and AOP + air-stripping treatment system are presented in Section 4.4. The total present worth for alternative GW-5, representing 30 years of operation and maintenance is $1,567,000. A cost breakdown is provided in Appendix C.

4.3 SOIL

The detailed analysis for remediation of the sewer lateral to prevent the leaching of contaminated soil by sewer exfiltration is presented in this section. The No Action alternative is also included.

4.3.1 Alternative SL-1: No Action

The No Action alternative is defined as taking no action to remediate migration of contaminants in the soil due to exfiltration from the sewer lateral. Natural biodegradation would continue to occur.

Compliance with SCGs - Since there are no remedial actions associated with this alternative, action-specific SCGs do not apply.

Overall Protection of Human Health and the Environment - The No Action alternative would not be adequately protective of human health in the source plume area, because the potential for migration of volatile organics to groundwater would persist indefinitely. Degradation of PCE may eventually produce vinyl chloride, which is more toxic than its parent compounds.

Short-Term Impacts and Effectiveness - The No Action Alternative would have no short-term impacts on the community or the environment, since there is no implementation involved with this alternative.

Long-Term Effectiveness and Permanence - All of the human health risks posed by the migration of soil contaminants at the Mr. C Cleaners site would remain. Contaminant migration from soil to groundwater and the potential for worker exposure would continue.

Reduction of Toxicity, Mobility and Volume - The No Action Alternative will not reduce the toxicity, mobility or volume of soil contaminants, aside from the natural biodegradation of contaminants which may occur. The toxicity and mobility of contaminants may actually increase under the No Action alternative due to the interaction between the anaerobic wastewater and PCE. Anaerobic biodegradation of PCE produces vinyl chloride, which is more mobile in the subsurface and more toxic than PCE.

Implementability - Implementation is not required by the No Action Alternative.

Costs - No costs are associated with the No Action Alternative.

4.3.2 Alternative SL-2: Excavation and Replacement of the Existing Lateral

Alternative SL-2 would consist of plugging the existing four-inch sewer lateral in place. A new four-inch sewer lateral would be constructed in the same trench as the groundwater collection discharge pipe or the air collection pipe depending on whether in-situ or ex-situ groundwater treatment is selected. The connection would be to the sanitary sewer line under Whaley Avenue.

Compliance with SCGs - No action-specific SCGs are applicable or relevant and appropriate for the sewer lateral alternative. Chemical-specific SCGs do not apply to sewers since these SCGs focus on media other than site structures (viz., soil, groundwater, surface water, drinking water and air). However, closure of the existing sewer lateral will assist in achieving chemical-specific SCGs for groundwater and soil by eliminating a potential migration pathway.

Overall Protection of Human Health and the Environment - Alternative SL-2 would be protective of human health by reducing contaminant migration to groundwater, and reducing potential exposure to workers.

Short-Term Impacts and Effectiveness - Relocation of the sewer lateral would require trenching through the building floor slab and under the building foundation. The lateral would need to connect with the existing subfloor drain at a location upstream of the dry cleaning operations, and the f low from any sanitary facilities downstream of the new connection would need to be redirected. Therefore, relocation of the lateral would cause a significant, though temporary, disruption to the commercial activities in the building. In addition, traffic along Whaley Avenue would be temporarily disrupted.

Alternative SL-2 would reduce contaminant migration to groundwater, however, some contaminant migration from soil to groundwater would continue to occur due to the natural fluctuation of the watertable.

Long-Term Effectiveness and Permanence - Alternative SL-2 would permanently reduce human health risks by reducing contaminant migration to groundwater. Plugging of the sewer lateral is considered permanent in that it reliably eliminates exfiltration over contaminated soil for greater than 30 years.

Reduction of Toxicity, Mobility and Volume - Remedial actions associated with Alternative SL-2 would reduce eliminating mobility by migration pathway, but would have no impact on toxicity.

Implementability - Alternative SL-2 could be implemented at the site using standard construction equipment and laborers. Easements will need to be obtained to construct the new sewer lateral across private property; however, the easement is also needed for other remedial construction. The sewer lateral will be constructed in a trench that traverse half of Whaley Avenue. Thus, vehicular and pedestrian traffic would be impacted during trench construction and a Town Permit may be required.

Cost - Estimated capital costs for Alternative SL-2 are presented in Section 4.4. There are no operation and maintenance costs associated with this alternative. A cost breakdown is presented in Appendix C.

4.3.3 Alternative SL-3: Modified Groundwater Remedy

Alternative SL-3 is a modification of groundwater alternative GW-2 (in-situ air stripping), and includes the installation of one additional in-situ air stripping well in a location designed to affect contaminated soil beneath the sewer lateral. The radius of influence predicted by EG&G and SBP Technologies for their respective well designs is 50 feet and 40 feet, respectively. A single well located in the site parking lot would not capture groundwater contaminants beneath both the shoe repair/hardware buildings and beneath Mr. C Cleaners. Therefore, one additional well located as close as possible to the existing sewer lateral would be needed.

Soil remediation would be accomplished by a combination of processes including: the flushing of circulating groundwater through the uppermost saturated zone beneath the sewer lateral, which would flush contaminants from the soil; volatilization of soil contaminants by vapor extraction in the zone above the water table; and continued flushing of soil contaminants by exfiltration from the existing sewer lateral. Any wastewater that recharges the water table would be captured and treated in the in-situ air stripping well.

The area of influence of the vacuum produced inside the in-situ air stripping well cannot be estimated without a pilot test. However, the unconsolidated materials in the parking lot are described as fill material with a medium to coarse texture, and are anticipated to be permeable to air flow. A vapor monitoring probe would be installed in the area of known soil contamination beneath the sidewalk in front of Mr. C Cleaners. If no vacuum response is detected at that location, the monitoring probe could be retro-fitted as a vapor extraction well and connected to the vacuum side of the in-situ air stripping system blower.

Compliance with SCGs - Action-specific SCGs considered applicable for Alternative SL-3 include air emissions regulations (6NYCRR Parts 200, 201, 211, 212 and 257). Hazardous waste manifest system and record keeping requirements (6NYCRR Part 372) for managing spent vapor phase activated carbon would be applicable if the activated carbon is a hazardous waste. Portions of 6NYCRR Part 373-2 (action-specific standards that define acceptable management of hazardous waste described in Section 1.4.1) are considered relevant and appropriate. The in-situ air-stripping system would be designed to meet action and location-specific SCGs for the site through appropriate environmental permitting, monitoring and record keeping. Chemical-specific SCGs include 6NYCRR Part 257 (air quality standards for non-methane hydrocarbons), and Air Guide-1 emissions limits.

Chemical specific SCGs are projected to be achieved within the source plume by the in-situ air stripping system vendors within ten years. The combined effect of vapor extraction, flushing the unsaturated zone, and continued exfiltration is expected to remove soil contaminants in a similar time frame.

Overall Protection of Human Health and the Environment -Alternative SL-3 would be protective of human health by reducing contaminant migration to groundwater, and reducing potential exposure to workers. Over time, the system will reduce groundwater contaminant concentrations by removing the most highly contaminated groundwater and soil contamination beneath the sewer lateral, which will reduce the mass of VOCs present in the source plume, thus shortening the time frame of the remediation. The air emissions control equipment would be protective of human health by removing organic compounds from the air stream to concentrations below Air Guide-1 AGCs and SCGs.

Short-Term Impacts and Effectiveness - The in-situ air stripping well requires some subsurface excavation to install posing a potential for worker/resident exposure to hazards and short-term disruptions to the community during construction. These risks can be minimized through proper use of personal protective equipment and worker health and safety procedures, and various measures available to minimize the area exposed during construction.

The UVB and NoVOCs technologies are capable of removing contaminants from groundwater that passes through the well (see section 4.2.2.1). The degree of contaminant removal achieved from soil will depend upon the effectiveness of the flushing and the mass of contaminants in contact with the extracted air. The effectiveness of the modified groundwater remedy depends on the extent of contamination and the nature of the soils directly beneath the sewer lateral. Because these are unknown, the modified groundwater remedy may only be partially effective. Experience with vapor extraction at other contaminated sites indicates that soil specific SCGs will be achieved where airflow is successfully initiated.

Long-Term Effectiveness and Permanence - Alternative SL-3 would permanently reduce human health risks by reducing contaminant migration from soil to groundwater and by reducing the potential for worker exposure. The modified groundwater remedy would be considered a permanent remedial solution for the contaminated soil, operating continuously until concentrations of VOC's in the groundwater diminish to the point that health risks have been mitigated to the extent practicable.

Groundwater contaminants will ultimately be transferred to vapor phase activated carbon. When the adsorptive capacity of the activated carbon is reached, the carbon would be removed from service and regenerated at an off-site facility. Should the activated carbon remain on-line beyond its adsorptive capacity, VOCs may pass through the carbon bed or some compounds may be desorbed from the bed as more strongly adsorbed compounds enter the unit. Two additional activated carbon filters would be used as backup to prevent VOC break through. The modified groundwater remedy will consume additional carbon over that estimated for Alternative GW-2.

Any in-situ treatment wells will require routine maintenance to ensure continued performance. Operation and maintenance for the in-situ treatment well will require screen maintenance (viz., acid cleaning) and routine blower and air emissions control maintenance. However, such maintenance will be required system-wide.

Long-term management of the site would include groundwater and vapor monitoring at the additional well used for the modified groundwater remedy to evaluate the progress of soil remediation.

Reduction of Toxicity, Mobility and Volume - The modified groundwater remedy would significantly reduce the volume of soil contaminants beneath the sewer lateral. It would also reduce the mobility of contaminated groundwater beneath the contaminated soil. Air-stripping and vapor extraction involves the transfer of contamination from the contaminated media to an air stream, which can be treated prior to release to the atmosphere. Emissions controls such as vapor phase granular activated carbon would effectively control the release of contamination to the atmosphere. The VOCs would be transferred to vapor phase activated carbon for irreversible destruction during regeneration.

Implementability - The modified groundwater remedy could be readily implemented at the site using standard construction equipment and laborers. No easements will need to be obtained. The remediation well and associated piping will be constructed in the

Mr. C Cleaners parking lot. However, commercial activities could continue during construction with proper precautions in the immediate work area.

Cost - Estimated capital costs for Alternative SL-3 are presented in Section 4.4. A cost breakdown is presented in Appendix C.

4.4 COMPARISON OF ALTERNATIVES

The comparison of alternatives evaluates the relative performance of each alternative with respect to the seven criteria. The advantages and disadvantages of each alternative are identified so that key trade-offs between the alternatives can be evaluated. A separate comparison will be conducted between the selected ex-situ groundwater treatment alternatives; between ex-situ and in-situ groundwater collection/treatment alternatives; and for soil. Capital, annual operating and maintenance, and present worth costs are presented in Tables 4-1 and 4-2.

4.4.1 Ex-situ Groundwater Treatment

This section presents a comparison of the ex-situ treatment technologies including air stripping (Alternative GW-#), advanced oxidation process (AOP) (Alternative GW-4), and AOP with air stripping (Alternative GW-5).

Compliance with SCGs - Each ex-situ groundwater treatment technology would be designed to meet action and location-specific SCG's for the site through appropriate environmental permitting, monitoring and recordkeeping. All three would meet chemical-specific SCGs for the discharge of treated water to Tannery Brook.

Overall Protection of Human Health and the Environment - Each ex-situ treatment technology would meet treated water effluent goals for Tannery Brook. Alternative GW-3 would be protective of human health and the environment with the use of air emission controls. Air emission controls are not required for alternatives GW-4 and GW-5.

Short Term Impacts and Effectiveness - None of the ex-situ treatment alternatives is expected to pose short-term risks to workers or the community. Each alternative would

TABLE 4-1

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT

EX-SITU GROUNDWATER TREATMENT[1] TECHNOLOGY COSTS

Ex-Situ Treatment Technology	Capital	Annual O&M	Present Worth	Total
Air Stripping with GAC	$ 573,000	$149,100	$1,678,500	$2,401,000
Advanced Oxidation Process	$1,362,000	$433,000	$4,875,000	$6,670,000
Advanced Oxidation Process with Air Stripping	$ 689,000	$101,600	$1,143,800	$1,935,000

(1) Excludes Groundwater Collection and Monitoring Costs, which are the same for each technology.

TABLE 4-2

MR. C CLEANERS SUPERFUND SITE FEASIBILITY STUDY REPORT

SUMMARY OF REMEDIAL ALTERNATIVES

Remedial Technology	Cost		
	Capital	Annual O&M	Present Worth
GROUNDWATER			
GW-1: No Action	$0	$19,700	$241,500
GW-2: In-situ Treatment	$444,600 to 727,000	$106,500	$1,199,000
GW-5: GW Extraction w/AOP Air Stripping	$798,400	$139,200	$1,567,000
SOIL/SEWER LATERAL			
SL-1: No Action	$0	$0	$0
SL-2: Replace Sewer Lateral w/ Whaley Ave. Discharge	$45,000	$0	$0
SL-3: Source Area Soils Remediation	$40,825 to $90,100	$1,765	$52,675

become effective in meeting direct discharge limits for all regulated contaminants following a brief start-up/shakedown period of two to three months.

Long Term Effectiveness and Permanence - All ex-situ treatment technologies would be considered permanent remedial solutions for the site, operating continuously until concentrations of VOC's in the groundwater diminish to the point that health risks have been mitigated to the extent practicable. Each technology requires routine maintenance to ensure continued performance.

The air stripping alternative (GW-3) would require periodic cleaning of the air stripping trays to remove iron and calcium deposits, replenishment of a sequestering agent as needed, replacement of filter bags, and replacement/regeneration of vapor phase carbon. The AOP alternative (GW-4) will require replacement of UV lamps, replenishment of a sequestering agent to limit scaling, replacement of bag filters, and the regular replenishment of hydrogen peroxide. The AOP plus air stripping alternative (GW-5) has all of the maintenance requirements of Alternatives GW-3 and GW-4, excluding the maintenance of air emission controls. The air stripping alternative (GW-3) would have the greatest maintenance requirements based on the vapor phase carbon changeout requirements.

Reduction of Toxicity, Mobility, or Volume - The air stripping alternative would irreversibly destroy VOCs during regeneration of the vapor phase carbon. The AOP alternative is inherently destructive of the contaminants. The AOP with air stripping will irreversibly destroy most contaminants, but will allow some VOCs to be released although at concentrations below the air emission limits.

Implementability - All three ex-situ treatment technologies utilize treatment equipment that is readily available for purchase. Treatment system operators could be easily trained to monitor system operation, perform system maintenance.

Administrative issues common to all technologies include the need to obtain easements for constructing conveyance piping on private and commercial property, and the need to obtain the necessary permits for construction of the process enclosure; the need to obtain a permit to connect to the Whaley Avenue storm sewer. Likewise, the substantial requirements of a SPDES permit must be met for discharge to Tannery Brook. The substantive requirements of an air emission permit to Construct and Operate would need to be met for the air stripping with vapor phase carbon alternative (GW-3).

Cost- Estimated capital, annual operating and maintenance, and present worth costs for the three ex-situ treatment technologies are presented in Table 4-1. Present worth was calculated using a discount rate equal to the current 30 year treasury bond rate (7.85 percent). A 30-year performance period was considered. Present worth for the groundwater alternatives ranges from $1,143,800 for AOP with air stripping technology to $4,875,000 for the AOP technology.

Conclusion

No single ex-situ treatment technology stands apart from the other two in terms of the compliance with SCGs, overall protection of public health and the environment, effectiveness, and implementability. Given this comparison, the comparatively high cost of AOP is not justified. A reduction in volume of VOCs is better achieved by air stripping with vapor phase carbon than by AOP with air stripping, although AOP with air stripping complies with air emission limits. Since air stripping with vapor phase carbon has a higher O & M cost due to the cost of air emissions treatment, the selected ex-situ treatment technology is AOP with air stripping, based on less operator attention and maintenance, required.

4.4.2 Groundwater

This section presents a comparison of the no-action alternative (GW-1), the in-situ treatment alternative (GW-2), and the selected ex-situ collection/treatment alternative (GW-5).

Compliance with SCGs - Both in-situ and ex-situ groundwater treatment technologies would be designed to meet action and location-specific SCG's for the site through appropriate environmental permitting, monitoring and recordkeeping. Both would also be operated until groundwater concentrations which do not cause exceedance of NYSDOH indoor air quality guidance value for tetrachloroethene are achieved. However, a waiver from chemical-specific SCG's, specifically 6NYCRR Part 703 Groundwater Quality

Standards and Guidance Values, would be necessary with both technologies. The No-Action alternative would not mitigate the potential impacts on indoor air quality.

Overall Protection of Human Health and the Environment - Both ex-situ and in-situ treatment technologies will mitigate the potential human health risk associated with exposure to vapors in basements and substructures within the source plume. However, the in-situ treatment alternative is anticipated to achieve there objectives sooner than groundwater extraction and ex-situ treatment. Potential exposure to VOC's during foundation construction, utility excavation and/or from use of irrigation wells located outside of the source plume will diminish at a much slower rate through natural attenuation. The No-Action alternative would not adequately address potential indoor impacts, and would indefinitely prolong the migration of contaminants from the source plume to less contaminated areas.

Short Term Impacts and Effectiveness - Both technologies rely on installation of wells in the contaminated groundwater to effect groundwater remediation by ex-situ or in-situ treatment. Although fewer wells are required under the conceptual in-situ air stripping system (GW-2) than would be required under an equivalent groundwater extraction system (GW-5), the in-situ air stripping wells require significant subsurface excavation to create the infiltration gallery or large diameter boreholes, which generate large volumes of potentially contaminated soil. This poses a greater potential for worker/resident exposure to hazards and short-term disruptions to the community during construction than will conventional pumping wells. Community and worker exposure can be minimized with proper precautions.

Both in-situ and ex-situ treatment technologies are expected to be effective in achieving the RAO's for the site. Alternative GW-2 requires multiple passes of VOC contaminated water through the active stripping portion of the system in order to accomplish the same degree of VOC removal that will be achieved by the ex-situ treatment technologies on a single pass through the system. The potential exists for some of the VOC bearing water to be lost to the aquifer in mid-cycle. However, the degree of VOC removal achieved during the initial two to three cycles is predicted to be sufficient to reduce VOC concentrations to levels already existing outside the source plume. Therefore, the potential for imperfect hydraulic containment of the source plume does not seriously impact the effectiveness of in-situ treatment.

Long Term Effectiveness and Permanence - Both in-situ and ex-situ treatment technologies would be permanent remedial solutions for the site, operating continuously until concentrations of VOC's in the groundwater diminish to the point that health risks have been mitigated to the extent practicable. The time frame of in-situ treatment is predicted to be shorter than for ex-situ treatment, due to the increased contact with adsorbed contaminants achieved by circulating water vertically as well as horizontally. The recent performance cited by both in-situ air stripping technology vendors indicates that the remedial action objectives can be met within two to six years. The historical performance of groundwater extraction with ex-situ treatment indicates remediation times much longer than six years.

Both technologies will require routine maintenance to ensure continued performance. O & M for the ex-situ treatment alternative includes routine cleaning of process equipment, periodic pump and well maintenance, and maintenance of the emissions controls. The AOP with air stripping technology will require replacement of UV lamps, replenishment of a sequestering agent to limit scaling, replacement of bag filters, and the regular replenishment of hydrogen peroxide.

O & M for in-situ air stripping includes regular maintenance of the blowers, periodic well screen cleaning, and replacement/regeneration of vapor phase carbon. The in-situ air stripping wells may require more frequent well maintenance (viz., acid cleaning) because of the potential for fouling of the well screens due to the highly oxygenated water.

All alternatives, including the No-Action alternative require periodic monitoring of groundwater and indoor air.

Reduction of Toxicity, Mobility, or Volume - Both in-situ and ex-situ treatment technologies will effect equivalent areas of contaminated groundwater. The in-situ treatment alternative will involve air stripping of the VOC-laden groundwater to transfer contamination from the groundwater to an air stream with vapor phase carbon treatment that will ultimately destroy the VOCs. Air stripping of the AOP effluent will release low concentrations of VOCs to the atmosphere, but at levels below NYSDEC air quality guidelines.

Implementability- Both the in-situ and ex-situ treatment technologies incorporate collection and treatment equipment that is readily available for purchase. The in-situ air stripping equipment is patented, but in-situ treatment systems that provide similar performance are available from more than one vendor.

Administrative issues common to both technologies include the need to obtain easements for constructing wells and laying pipe on private and commercial property, and the need to obtain the necessary permits for construction of the process enclosure(s). In addition, Alternative GW-5 will require a permit to connect to the Whaley Avenue storm sewer. Likewise, the substantial requirements of a SPDES permit must be met for discharge to Tannery Brook. The substantive requirements of an air emission permit to Construct and Operate would need to be met for the in-situ treatment alternative GW-2.

Technical implementation associated with the systems include process control and monitoring. The groundwater extraction system associated with Alternative GW-5 incorporate multiple wells fitted with submersible pumps and level controls, all of which will require interlock with motor starter panels in the treatment building tied in with external alarm relays from the treatment equipment and/or process feed tank level controls (to shut down the pumps in the event of treatment equipment failure). Because the in-situ air stripping wells will not incorporate mechanical equipment at the wells, process control is limited to the treatment equipment.

The in-situ treatment alternative can be more easily expanded to include additional wells or higher pumping rates, because blower capacity is comparatively simple to upgrade. Whereas, enlargement of the groundwater extraction system requires an accompanying increase in the hydraulic capacity of the treatment system, and the availability of storm sewer capacity for the discharge of treated water.

Cost- Estimated capital, annual operating and maintenance, and present worth costs for the three remaining groundwater alternatives are presented in Table 4-2. Present worth was calculated using a discount rate equal to the current 30 year treasury bond rate (7.85 percent). A 30-year performance period was used for GW-1 and GW-5. However, the present worth calculation for the system O&M for GW-2 was reduced to 10 years due to the recent performance of the in-situ treatment technology. Present worth for the groundwater alternatives ranges from $241,500 for the No-Action alternative to $1,567,000 for Alternative GW-5.

Conclusion - Both in-situ and ex-situ treatment alternatives can lower groundwater concentrations in the source plume to levels at or below concentrations detected in the broader more dispersed contaminant plume. In comparison to the ex-situ treatment alternative, the in-situ treatment alternative avoids complications resulting from the need to discharge treated water including: meeting surface water discharge requirements; and potential storm sewer capacity problems on Whaley Avenue. The in-situ system is more easily expanded if the need arises, since no hydraulic limitations are involved in a system expansion. The projected life of the in-situ treatment alternative is shorter than the groundwater extraction with ex-situ treatment, which will result in lower lifetime operating costs and more immediate protection of the public health. Finally, capital and present worth costs are significantly lower for in-situ treatment. Therefore, the in-situ air stripping alternative (GW-2) is recommended for implementation.

4.4.3 Soil

Compliance with SCGs - No action-specific SCGs are applicable or relevant and appropriate for the sewer lateral alternative. Closure of the existing sewer lateral via Alternative SL-2 will assist in achieving chemical-specific SCGs for groundwater and soil by eliminating a potential migration pathway. Contaminated soil would remain in place under both alternatives, although the objective of Alternative SL-3 would be to minimize the contaminates remaining. The modified groundwater remedy would remove a significant portion of the known soil contamination. Therefore, Alternative SL-3 achieves compliance with SCGs more closely.

The modified groundwater remedy would be designed to meet action and location-specific SCG's for the site through appropriate environmental permitting, monitoring and record keeping. Soil remediation would continue until groundwater concentrations which do not cause exceedance of NYSDOH indoor air quality guidance value for tetrachloroethene are achieved or until vapor monitoring local groundwater concentrations decrease in the vicinity of the contaminated soil. The No-Action alternative would not mitigate the potential impacts on indoor air quality

Overall Protection of Human Health and the Environment - Both Alternatives SL-2 and SL-3 would be protective of human health by reducing contaminant migration to groundwater. However, the modified groundwater remedy is anticipated to reduce the time frame of remediation and help to achieve the RAOs sooner than Alternative SL-2. Potential exposure to VOC's during foundation construction or utility excavation, contributions of contaminant mass to the source plume will diminish at a much slower rate if the sewer lateral is simply closed without any active soil clean-up. The no-action alternative would allow contaminant migration to continue unabated.

Short-Term Impacts and Effectiveness - Alternative SL-2 would pose no risks to site construction workers due to exposure of VOCs, because the sewer trench would be well above the water table. Interior construction work during sewer relocation would disrupt commercial activities in the building. Contaminant migration to groundwater would be reduced, however, contaminant migration from soil to groundwater would continue to occur to some degree due to the natural fluctuation of the watertable.

Alternative SL-3 would require subsurface excavation to create the infiltration gallery or large diameter boreholes, which generate large volumes of potentially contaminated soil. This poses some potential for worker/resident exposure to hazards and short-term disruptions to the community during construction, but less than would be associated with construction of the sewer lateral. Community and worker exposure can be minimized with proper precautions. Alternative SL-3 would more effectively reduce contaminant migration, and therefore, would more effectively help to achieve the RAOs.

Long-Term Effectiveness and Permanence - Both sewer relocation and the modified groundwater remedy would be permanent remedial solutions for the site, operating continuously until concentrations of VOC's in the groundwater diminish to the point that health risks have been mitigated to the extent practicable. The time frame for soil remediation via the modified groundwater remedy is predicted to be shorter than simple closure of the sewer lateral for ex-situ treatment.

The sewer lateral would require no routine maintenance. Whereas, the operation of an additional remediation well will require routine maintenance to ensure continued performance.

All alternatives, including the No-Action alternative require periodic monitoring of groundwater and indoor air.

Reduction of Toxicity, Mobility and Volume - Remedial actions would reduce mobility by partially mitigating a migration pathway, but would have no impact on toxicity or volume. The modified groundwater remedy transfer contamination from the groundwater and soil to an air stream with vapor phase carbon treatment that will ultimately destroy the VOCs.

Implementability - Alternative SL-2 could be readily implemented at the site using standard construction equipment and laborers. Connection to the Whaley Avenue sewer would require easements to construct the new sewer lateral across private property. However, the easements would also need to be obtained for the groundwater remediation.

The substantive requirements of an air emission permit to Construct and Operate would need to be met for the in-situ treatment alternative SL-3, but this would also be required for the recommended groundwater alternative..

Cost - The in-situ treatment technologies incorporate collection and treatment equipment that is readily available for purchase. The in-situ air stripping equipment is patented, but in-situ treatment systems that provide similar performance are available from more than one vendor. Estimated capital costs for the sewer lateral relocation and the modified groundwater remedy are presented in Table 4-2. There are incremental operation and maintenance costs associated with an additional remediation well, but no O & M costs are associated with a sewer.

Conclusion - The elimination of exfiltration from the existing sewer lateral is the least complex means of isolating soil contamination from the groundwater. However, the alternative is comparatively ineffective and poses substantial short term construction impacts. The modified groundwater remedy more completely reduces the migration of soil contaminants due to groundwater; achieves capture of those contaminants that do migrate;

and poses fewer short-term construction impacts. Therefore, Alternative SL-3 is recommended for implementation.

5.0 RECOMMENDED REMEDIAL APPROACH

This section presents the recommended remedial approach for the groundwater and the sewer lateral remediation at the Mr. C Cleaners Site. A summary of the elements of each recommended alternative, and the associated costs is presented below.

5.1 RECOMMENDED REMEDIAL ALTERNATIVE

5.1.1 Groundwater

The recommended remedial alternative for the Mr. C's site consists of remediation of the source plume using in-situ air stripping, with source area soil remediation consisting of one additional in-situ air stripping well as near as possible to the Mr. C's building to flush contaminants from the source area soils. This alternative presents a number of benefits compared to the other alternatives evaluated. Figure 4-1 illustrates the recommended alternative. The historical performance of in-situ air stripping at other sites, and the in-situ air stripping vendors predicted clean-up times indicate that in-situ air stripping will reduce VOC concentrations in the source plume below levels detected in the broader contaminant plume, thus exceeding the Remedial Action Objectives. A waiver from chemical specific SGCs, specifically 6NYCRR Part 703 groundwater quality standards will be required, but a waiver will be required for each alternative.

There is no discharge of treated groundwater. Therefore, it is unnecessary to reduce VOC concentrations to meet SPDES discharge limits; there is no potential impact on storm sewer capacity; and there is no effluent monitoring, although some process monitoring will be performed. The system as a whole can accommodate the addition of wells more easily than the ex-situ treatment alternatives. The in-situ air stripping wells are mechanically less complex than groundwater extraction systems, because there are no pumps or pump controllers. These characteristics taken together translate into relatively low operation and maintenance requirements. Also, noise levels are anticipated to be comparatively lower due to the lower blower capacity. Finally, excluding the No Action alternative, Alternative GW-2 has the lowest capital cost, and the lowest O&M and present worth costs.

Alternative GW-1 is the least expensive of the groundwater remedial alternatives, but cannot be expected to mitigate human health risks associated with exposure to vapors in residential basements, and the source plume may continue to migrate toward residences, and ultimately to discharge in Tannery Brook.

Alternative GW-3, GW-4, and GW-5 would be equally protective of human health in comparison to GW-2. However, the time frame of remediation is expected to be somewhat longer. All three alternatives include the discharge of treated groundwater, which must comply with SPDES requirements for Tannery Brook.

Ex-situ treatment alternatives all have substantial O & M costs. Alternative GW-3 requires the replacement/regeneration of large quantities of vapor phase carbon air emission controls. Alternative GW-4 has high electrical usage, process chemical usage, and equipment maintenance costs, which translate to very high O & M costs.

The in-situ air stripping well added to remediate the source area soils beneath the Mr. C's building provides the greatest measure of direct remediation of the soil, and with the least accompanying disruption of the community.

5.2 COSTS

Costs for the recommended alternative GW-2 were derived from two sources, including: a range of preliminary costs for a conceptual in-situ treatment remediation plan provided by EG&G Environmental and SBP Technologies; and supplemental expenses estimated by Malcolm Pirnie for items not included in the vendor cost estimate. Supplemental capital cost items include the process building with utilities, extending the air lines across Whaley Avenue, treatment of well development water, contaminated soil disposal, vapor phase carbon for air emission controls engineering, and contingency. Supplemental O & M items include operation and maintenance labor, well screen cleaning, replacement of vapor phase carbon, and groundwater and indoor air sampling. The capital cost of GW-2 is $444,600 to $727,000 depending on the vendor selected O & M costs are $106,500 with a present worth cost of $1,199,000.

Capital costs for Alternative SL-3 are $40,825 to $90,100 depending on the vendor selected with annual O&M costs of $1,765. Thus the total remedial capital cost is estimated to range from $485,400 to $817,100.

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MALCOLM
PIRNIE

APPENDIX A

VENDOR SUBMITTALS

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT

VENDOR SUBMITTALS

Item	Remedial Scenario	Vendor Name
Low Profile Air Stripper	Remedial Scenario 1 @ 85 gpm Remedial Scenario 2 @ 135 gpm & 40 gpm	Northeast Environmental Products, Inc.
Low Profile Air Stripper	Remedial Scenario 1 @ 95 gpm	
Low Profile Air Stripper	Remedial Scenario 1 @ 95 gpm	
AOP Treatability Study	Remedial Scenario 1 @ 55 gpm and 100 gpm	Vulcan Peroxidation System, Inc.
Pretreatment System	Remedial Scenario 1 @ 95 gpm	Water Solutions, Inc.
In-Situ Air Stripper NOVOCs™	Remedial Scenario 1	EG&G Environmental, Inc.
In-Situ Air Stripper UVB-400™	Remedial Scenario 1	SBP Technologies, Inc.
Granular Activated Carbon-Vapor Phase	Remedial Scenario 1 (Capital Cost & Usage)	Carbon Services Company
Granular Activated Carbon-Liquid Phase	Remedial Scenario 1 (Usage)	

file 0264-31-4. C

North East
Environmental Products, Inc.
17 Technology Drive West Lebanon NH 03784
(603) 298-7061 Fax (603) 298-7063

November 2, 1995

Kathy McCue
Malcolm Pirnie
S-3515 Abbott Road
Orchard Park, NY 14127

RE: Proposal #1095908-1
Site I.D. Mr. C. Cleaners

Dear Kathy,

In response to your request, North East Environmental Products is pleased to propose the following revised options for your water treatment application.:

Option #1- Model 41231 Water flow rate of 85 gpm.

Performance:

To meet the influent/effluent requirements at the design flowrate of 85 gpm, we offer our Model 41241 ShallowTray low profile air stripper. Designed operation range is 8-360 gpm, fresh air inlet rate 2400 cfm.

The price for the ShallowTray Model 41231, with optional components, is listed below:

Basic System Model 41231 Sump tank & 1 tray, 304L stainless steel fabrication 2 Additional tray(s), 304L stainless steel fabrication Forced Draft Blower, 3 tray, 20 hp, 2400 cfm @ 14wc, 3 Ø, 460V, 60Hz, TEFC Inlet screen & damper, 304L SS mist eliminator, spray nozzle(s), sight tube, gaskets, SS latches, Sched 80 PVC piping, and tray cleanout & inspection ports w/caps.		
Basic System Price Model 41231		**$42,223**
Options		
Skid Mounting: Fabricated Frame with Control & Instrument Stanchion	1	$2,021
Gravity discharge piping with vacuum relief valve	0	$0
Air pressure gauge, pneumatic	0	$0
Feed Pump	0	$0
Discharge pump, 200 gpm, 50 tdh, 7.5 hp, 3 Ø, 460V, TEFC	1	$1,390
NEMA 3R Control Panel, w/Pump level controls, main disconnect switch, alarm interlocks, motor starter, & panel light, UL listed	1	$2,324
Panel Option: Intermittent operation circuitry	1	$336
Low Air pressure alarm/shutdown switch, pneumatic, EXP	1	$171
High water level alarm/shutdown float switch	1	$70
Pump level control float switch(es)	1	$70
Water pressure gauge, stripper influent	0	$0
Digital Water Flow Indicator/Totalizer	0	$0
Air flow meter, insertion pitot tube w/pressure gauge, pneumatic	0	$0
Temperature gauge, stripper influent	0	$0
Viewport set, (1) 4 inch & (1) 8 inch Lexan viewport	0	$0
Line sampling ports, inlet and/or discharge	0	$0
Air blower silencer, fan inlet	0	$0
Washer wand, with high pressure spray nozzle	1	No Charge
Options Subtotal		$6,382
Total Model 41231 System Price, With Options, US$ Each:		**$48,605**

Option #2- Model 41241, Water flow rate of 135 gpm:

Performance:

To meet the influent/effluent requirements at the design flowrate of 135 gpm, we offer our Model 41241 ShallowTray low profile air stripper. Expected performance for the Model 41241 ShallowTray air stripper operating at **135 gpm** and 50°F is attached (designed operation range is 8-360 gpm, fresh air inlet rate 2400 cfm).

The price for the stainless steel ShallowTray Model 41241:

Basic System Model 41241	
Sump tank & 1 tray, 304L stainless steel fabrication	
3 Additional tray(s), 304L stainless steel fabrication	
Forced Draft Blower, 4 tray, 20 hp, 2400 cfm @ 18wc, 3 Ø, 460V, 60Hz, TEFC	
Inlet screen & damper, 304L SS mist eliminator, spray nozzle(s), sight tube, gaskets, SS latches, Sched 80 PVC piping, and tray cleanout & inspection ports w/caps.	
Basic System Price Model 41241	**$49,482**

Options		
Skid Mounting: Fabricated Frame with Control & Instrument Stanchion	1	$2,021
Gravity discharge piping with vacuum relief valve	0	$0
Air pressure gauge, pneumatic	0	$0
Feed Pump	0	$0
Discharge pump, 200 gpm, 50 tdh, 7.5 hp, 3 Ø, 460V, TEFC	1	$1,390
NEMA 3R Control Panel, w/Pump level controls, main disconnect switch, alarm interlocks, motor starter, & panel light, UL listed	1	$2,324
Panel Option: Intermittent operation circuitry	1	$336
Low Air pressure alarm/shutdown switch, pneumatic, EXP	1	$171
High water level alarm/shutdown float switch	1	$70
Pump level control float switch(es)	1	$70
Water pressure gauge, stripper influent	0	$0
Digital Water Flow Indicator/Totalizer	0	$0
Air flow meter, insertion pitot tube w/pressure gauge, pneumatic	0	$0
Temperature gauge, stripper influent	0	$0
Viewport set, (1) 4 inch & (1) 8 inch Lexan viewport	0	$0
Line sampling ports, inlet and/or discharge	0	$0
Air blower silencer, fan inlet	0	$0
Washer wand, with high pressure spray nozzle	1	No Charge
Options Subtotal		$6,382
Total Model 41241 System Price, Including Options, US$ Each:		**$55,864**

Option #3- Model 2631, Water flow rate of 40 gpm:

Performance:

To meet the influent/effluent requirements at the design flowrate of 40 gpm, we offer our Model 2631 ShallowTray low profile air stripper. Expected performance for the Model 2631 ShallowTray air stripper operating at **40 gpm** and 50°F is attached (designed operation range is 2-90 gpm, fresh air inlet rate 300 cfm).

The price for the stainless steel ShallowTray Model 2631, with optional components:

Basic System Model 2631	
Sump tank & 1 tray, 304L stainless steel fabrication	
2 Additional tray(s), 304L stainless steel fabrication	
Forced Draft Blower, 3 tray, 5 hp, 600 cfm @ 14wc, 3 Ø, 230V, 60Hz, TEFC	
Inlet screen & damper, 304L SS mist eliminator, spray nozzle(s), sight tube, gaskets, SS latches, Sched 80 PVC piping, and tray cleanout & inspection ports w/caps.	
Basic System Price Model 2631	**$16,169**

Options		
Skid Mounting: Fabricated Frame with Control & Instrument Stanchion	1	$788
Gravity discharge piping with vacuum relief valve	0	$0
Air pressure gauge, pneumatic	0	$0
Feed Pump	0	$0
Discharge pump, 60 gpm, 50 tdh, 2 hp, 3 Ø, 230V, TEFC	1	$508
NEMA 3R Control Panel, w/Pump level controls, main disconnect switch, alarm interlocks, motor starter, & panel light, UL listed	1	$2,324
Panel Option: Intermittent operation circuitry	1	$336
Low Air pressure alarm/shutdown switch, pneumatic, EXP	1	$171
High water level alarm/shutdown float switch	1	$70
Pump level control float switch(es)	1	$70
Water pressure gauge, stripper influent	0	$0
Digital Water Flow Indicator/Totalizer	0	$0
Air flow meter, insertion pitot tube w/pressure gauge, pneumatic	0	$0
Temperature gauge, stripper influent	0	$0
Viewport set, (1) 4 inch & (1) 8 inch Lexan viewport	0	$0
Line sampling ports, inlet and/or discharge	0	$0
Air blower silencer, fan inlet	0	$0
Options Subtotal		$4,266
Total Model 2631 System Price, Including Options, US$ Each:		**$20,435**

ShallowTray systems are more tolerant of inorganics than other types of aeration equipment, however, high concentrations can cause operational difficulties if proper precautions are not taken.

Please Review:

- *Does the power available at the site concur with the designed power listed above?*
- *Do the influent and effluent concentrations meet your design criteria?*
- *Do the selected options meet your system design needs?*
- *Will there be back pressure on the discharge air stream due to off-gas treatment?*

The power requirements as specified are 230 volt, 3 Ø, 4 wire plus ground. The system blower has not been sized for air exhaust stream friction losses or downstream treatment processes. If additional air discharge pressure is required or if the site power requirements differ, please contact our office.

All systems are shipped pre-assembled and factory tested and an O&M manual and system start-up video are included with each unit. Normal shipment is approximately 8 weeks from receipt of order. Purchase terms are net 30 days from delivery, FOB West Lebanon, NH, with approved credit. Prices are valid for 90 days only. I look forward to working with you on this project. Once again, thank you for your interest in our products.

Sincerely,

David Steele
Customer Service

File: Malcolm Pimie/1095908-1

ShallowTray™
low profile air strippers

System Performance Estimate

Client & Proposal Information:

Malcolm Pirnie
Site ID: Mr. C. CLeaners
Proposal #:1095908-1

Model chosen:	41200
Water Flow Rate:	135.0 gpm
Air Flow Rate:	2400 cfm
Water Temp:	50.0 °F
Air temp:	40.0 °F
A/W Ratio:	133.0
Safety Factor	None

Contaminant	Untreated Influent Effluent Target	Model 41211 Effluent Water Air(lbs/hr) % removal	Model 41221 Effluent Water Air(lbs/hr) % removal	Model 41231 Effluent Water Air(lbs/hr) % removal	Model 41241 Effluent Water Air(lbs/hr) % removal
1,1,1-Trichloroethane	**14 ppb** 1 ppb	**1 ppb** 0.000878 95.6803%	**<1 ppb** 0.000944 99.8134%	**<1 ppb** 0.000945 99.9919%	**<1 ppb** 0.000945 99.9996%
1,1-Dichloroethylene	**19 ppb** 1 ppb	**1 ppb** 0.001216 97.8181%	**<1 ppb** 0.001282 99.9524%	**<1 ppb** 0.001283 99.9990%	**<1 ppb** 0.001283 100.0000%
Benzene	**3200 ppb** 1 ppb	**271 ppb** 0.197795 91.5568%	**23 ppb** 0.214542 99.2871%	**2 ppb** 0.215960 99.9398%	**<1 ppb** 0.216084 99.9949%
Ethyl Benzene	**430 ppb** 1 ppb	**33 ppb** 0.026809 92.4698%	**3 ppb** 0.028835 99.4330%	**<1 ppb** 0.029025 99.9573%	**<1 ppb** 0.029037 99.9968%
Methylene Chloride	**120 ppb** --	**20 ppb** 0.006753 83.6050%	**4 ppb** 0.007833 97.3120%	**1 ppb** 0.008036 99.5593%	**<1 ppb** 0.008098 99.9277%
p-Xylene	**1900 ppb** 1 ppb	**156 ppb** 0.117772 91.8095%	**13 ppb** 0.127429 99.3292%	**2 ppb** 0.128171 99.9451%	**<1 ppb** 0.128301 99.9955%
t-1,2-Dichloroethylene	**82 ppb** 1 ppb	**3 ppb** 0.005335 96.6785%	**<1 ppb** 0.005531 99.8897%	**<1 ppb** 0.005537 99.9963%	**<1 ppb** 0.005537 99.9999%
Tetrachloroethylene	**8200 ppb** 1 ppb	**132 ppb** 0.544830 98.3980%	**3 ppb** 0.553541 99.9743%	**<1 ppb** 0.553742 99.9996%	**<1 ppb** 0.553744 100.0000%
Toluene	**740 ppb** 1 ppb	**72 ppb** 0.045110 90.3217%	**7 ppb** 0.049499 99.0633%	**1 ppb** 0.049904 99.9093%	**<1 ppb** 0.049968 99.9912%
Trichloroethylene	**280 ppb** 1 ppb	**7 ppb** 0.018436 97.5851%	**<1 ppb** 0.018897 99.9417%	**<1 ppb** 0.018908 99.9986%	**<1 ppb** 0.018908 100.0000%
Vinyl Chloride	**240 ppb** 1 ppb	**1 ppb** 0.016140 99.6880%	**<1 ppb** 0.016207 99.9990%	**<1 ppb** 0.016207 100.0000%	**<1 ppb** 0.016207 100.0000%

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ShallowTray™
low profile air strippers

System Performance Estimate

Client & Proposal Information:

Malcolm Pirnie
Site ID: Mr. C. CLeaners
Proposal #:1095908-1

Model chosen:	2600
Water Flow Rate:	40.0 gpm
Air Flow Rate:	600 cfm
Water Temp:	50.0 °F
Air temp:	40.0 °F
A/W Ratio:	112.2
Safety Factor	None

Contaminant	**Untreated Influent** Effluent Target	**Model 2611 Effluent** **Water** Air(lbs/hr) % removal	**Model 2621 Effluent** **Water** Air(lbs/hr) % removal	**Model 2631 Effluent** **Water** Air(lbs/hr) % removal	**Model 2641 Effluent** **Water** Air(lbs/hr) % removal	**Model 2 Efflue** **Wate** Air(lbs % rem
Methylene Chloride	**14 ppb**	**4 ppb**	**1 ppb**	**<1 ppb**	**<1 ppb**	**<1**
	1 ppb	0.000200	0.000260	0.000276	0.000279	0 0002
		76.0020%	94.2410%	98.6180%	99.6683%	99.920
t-1,2-Dichloroethylene	**82 ppb**	**5 ppb**	**<1 ppb**	**<1 ppb**	**<1 ppb**	**<1**
	1 ppb	0.001541	0.001636	0.001640	0.001641	0.0016
		94.6940%	99.7185%	99.9851%	99.9992%	100.00
Tetrachloroethylene	**520 ppb**	**15 ppb**	**1 ppb**	**<1 ppb**	**<1 ppb**	**<1**
	1 ppb	0.010104	0.010385	0.010404	0.010405	0.0104
		97.1691%	99.9199%	99.9977%	99.9999%	100.00
Trichloroethylene	**20 ppb**	**1 ppb**	**<1 ppb**	**<1 ppb**	**<1 ppb**	**<1**
	1 ppb	0.000380	0.000400	0.000400	0.000400	0.0004
		95.9683%	99.8375%	99.9934%	99.9997%	100.00

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ShallowTray™

low profile air strippers

System Performance Estimate

Client & Proposal Information:

Malcolm Pirnie: Mary Christie
Mr. C Cleaners: Buffalo, NY
#1095908-2 95 GPM

Model chosen: 41200
Water Flow Rate: 95.0 gpm
Air Flow Rate: 2400 cfm
Water Temp: 50.0 °F
Air temp: 40.0 °F
A/W Ratio: 189.0
Safety Factor 25%

Contaminant	**Untreated Influent** Effluent Target	**Model 41211 Effluent** **Water** Air(lbs/hr) % removal	**Model 41221 Effluent** **Water** Air(lbs/hr) % removal	**Model 41231 Effluent** **Water** Air(lbs/hr) % removal
1,1,1-Trichloroethane	**14 ppb** 1 ppb	**0.482 ppb** 0.000642 96.5550%	**0.017 ppb** 0.000655 99.8813%	**0.001 ppb** 0.000665 99.9959%
1,1-Dichloroethylene	**19 ppb** 1 ppb	**0.328 ppb** 0.000887 98.2745%	**0.006 ppb** 0.000903 99.9702%	**0.000 ppb** 0.000903 99.9995%
Benzene	**3200 ppb** 1 ppb	**150 ppb** 0.144939 95.3378%	**7 ppb** 0.151734 99.7826%	**0.324 ppb** 0.152052 99.9899%
Ethyl Benzene	**430 ppb** 1 ppb	**18 ppb** 0.019579 95.9978%	**0.689 ppb** 0.020401 99.8398%	**0.028 ppb** 0.020433 99.9936%
Methylene Chloride	**120 ppb** --	**10 ppb** 0.005227 92.1049%	**0.748 ppb** 0.005667 99.3767%	**0.059 ppb** 0.005700 99.9508%
p-Xylene	**1900 ppb** 1 ppb	**86 ppb** 0.086203 95.5230%	**4 ppb** 0.090100 99.7996%	**0.170 ppb** 0.090282 99.9910%
t-1,2-Dichloroethylene	**82 ppb** 1 ppb	**1.429 ppb** 0.003829 98.2574%	**0.025 ppb** 0.003896 99.9696%	**0.000 ppb** 0.003897 99.9995%
Tetrachloroethylene	**8200 ppb** 1 ppb	**58 ppb** 0.386915 99.3038%	**0.397 ppb** 0.389653 99.9952%	**0.003 ppb** 0.389671 100.0000%
Toluene	**740 ppb** 1 ppb	**42 ppb** 0.033170 94.4064%	**3 ppb** 0.035023 99.6371%	**0.130 ppb** 0.035159 99.9825%
Trichloroethylene	**280 ppb** 1 ppb	**4 ppb** 0.013116 98.8332%	**0.038 ppb** 0.013304 99.9864%	**0.000 ppb** 0.013306 99.9998%
Vinyl Chloride	**240 ppb** 1 ppb	**0.213 ppb** 0.011395 99.9111%	**0.000 ppb** 0.011405 99.9999%	**0.000 ppb** 0.011405 100.0000%

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ ONE
To MARY CHRISTIE | From DON SHEATROUSE
Co. MALCOLM PIRNIE | Co. NEEP
Dept. 95 GPM: SAME 41231 | Phone # 603 298 7061
Fax # 716 828 0431 | Fax # 7063

Report generated: 05/10/96

ShallowTray™

low profile air strippers

System Performance Estimate

Client & Proposal Information:

Malcolm Pirnie: Mary Christie
Mr. C Cleaners: Buffalo, NY
#1095908-3 95 GPM

Model chosen:	41200
Water Flow Rate:	95.0 gpm
Air Flow Rate:	2400 cfm
Water Temp:	50.0 °F
Air temp:	40.0 °F
A/W Ratio:	189.0
Safety Factor	None

Contaminant	**Untreated Influent** Effluent Target	**Model 41211 Effluent** **Water** Air(lbs/hr) % removal	**Model 41221 Effluent** **Water** Air(lbs/hr) % removal	**Model 41231 Effluent** **Water** Air(lbs/hr) % removal
1,1,1-Trichloroethane	**10 ppb** 1 ppb	**1 ppb** 0.000428 97.2440%	**<1 ppb** 0.000475 99.9240%	**<1 ppb** 0.000475 99.9979%
1,1-Dichloroethylene	**19 ppb** 1 ppb	**1 ppb** 0.000855 98.6196%	**<1 ppb** 0.000903 99.9809%	**<1 ppb** 0.000903 99.9997%
Acetone	**67 ppb** --	**59 ppb** 0.000380 12.8380%	**51 ppb** 0.000760 24.0278%	**45 ppb** 0.001045 33.7811%
	Due to its miscibility with water, acetone removal is difficult to predict. Call your NEEP representative for more informa			
Benzene	**970 ppb** 1 ppb	**37 ppb** 0.044337 96.2702%	**2 ppb** 0.046000 99.8609%	**<1 ppb** 0.046093 99.9948%
Chlorobenzene	**1 ppb** --	**<1 ppb** 0.000044 92.7903%	**<1 ppb** 0.000047 99.4802%	**<1 ppb** 0.000048 99.9625%
Chloroform	**2 ppb** --	**<1 ppb** 0.000092 97.2209%	**<1 ppb** 0.000095 99.9228%	**<1 ppb** 0.000095 99.9979%
Ethyl Benzene	**150 ppb** 1 ppb	**5 ppb** 0.006891 96.7983%	**<1 ppb** 0.007121 99.8975%	**<1 ppb** 0.007128 99.9967%
MEK	**2 ppb** --	**2 ppb** <.000001 18.9131%	**2 ppb** <.000001 34.2491%	**2 ppb** <.000001 46.6646%
	Due to its high solubility, MEK removal is difficult to predict. Call your NEEP representative for more information.			
Methylene Chloride	**89 ppb** --	**6 ppb** 0.003944 93.6839%	**1 ppb** 0.004182 99.6011%	**<1 ppb** 0.004228 99.9748%

p-Xylene	**665 ppb** 1 ppb	**24 ppb** 0.030461 96.4184%	**1 ppb** 0.031554 99.8717%	**<1 ppb** 0.031600 99.9954%
t-1,2-Dichloroethylene	**1 ppb** 1 ppb	**<1 ppb** 0.000047 98.6060%	**<1 ppb** 0.000048 99.9806%	**<1 ppb** 0.000048 99.9997%
Tetrachloroethylene	**8200 ppb** 1 ppb	**46 ppb** 0.387486 99.4430%	**1 ppb** 0.389624 99.9969%	**<1 ppb** 0.389672 100.0000%
Toluene	**259 ppb** 1 ppb	**12 ppb** 0.011738 95.5251%	**1 ppb** 0.012260 99.7998%	**<1 ppb** 0.012307 99.9910%
Trichloroethylene	**20 ppb** 1 ppb	**<1 ppb** 0.000942 99.0665%	**<1 ppb** 0.000950 99.9913%	**<1 ppb** 0.000950 99.9999%
Vinyl Chloride	**1 ppb** 1 ppb	**<1 ppb** 0.000047 99.9289%	**<1 ppb** 0.000048 99.9999%	**<1 ppb** 0.000048 100.0000%

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Post-it™ brand fax transmittal memo 7671	# of pages ▸ ~~ONE~~ TWO
To MARY CHRISTIE	From DON SHEAROUSE
Co. MALCOLM PIRNIE	Co. NEEP
Dept 95 GPM: SAME 4/23	Phone # 603 298 7061
Fax # 716 828 0431	Fax # 7063

MALCOLM PIRNIE

FACSIMILE TRANSMITTAL

Malcolm Pirnie, Buffalo
S-3515 Abbott Rd. P.O. Box 1938
Buffalo, NY 14219-0138
TEL: (716) 828-1300
FAX: (716) 828-0431

TO: Don Shearouse

OF: Northeast Environmental

FAX NO.: (603) 298-7063

RE: Mr. C Cleaners Site

FROM: Mary L. Christie

DATE: May 14, 1996

TIME: 9:00 a.m.

PROJECT NUMBER: 0266-314-005

NUMBER OF PAGES: *(including this sheet)* 2

RETURN ORIGINALS TO SENDER: *(circle one)* [✓ Yes] No

MESSAGE: Please reference your proposal #1095908-1.

Attached please find alternate scenario influent concentrations and the influent flow rate to an air stripper system. Can you please look over this information and determine what size unit we would need to eliminate all contaminants. If it is a unit that we do not already have a cost for (in the above referenced proposal), can you please provide a budgetary total cost. We can talk about detailed costs at a later time if necessary. We are rushing to pull together cost estimates, so a prompt response would be greatly appreciated! Please call me if there will be a problem obtaining this information by tomorrow. Also call me if you need any other information or have any question. Thank you for your help!

If you do not receive all pages or if portions are illegible
*please call **(716) 828-1300** for retransmission*

Flow rate = 95 gpm

Contaminant	Concentration (μg/l)
Trichloroethene	20
1,2 Dichloroethene	1
Vinyl Chloride	1
Benezene	970
Toluene	259
Ethylbenzene	150
Xylene	665
Chlorobenzene	1
1,1,1 Trichloroethane	10
Acetone	67
Chloroform	2
Methylene Chloride	89
Methyl Ethyl Ketone	2
1,2 Dichloropropane	2

perox-pure™

ORGANIC DESTRUCTION PROCESS

Confidential Process Assessment

Assessment of the perox-pure™ Process for the Destruction of Organic Contaminants in Groundwater

prepared for

MALCOLM PIRNIE, INC.
Buffalo, New York
VPSI Project No. 0493

Submitted by

Vulcan Peroxidation Systems, Inc.
5151 E. Broadway, Suite 600
Tucson, Arizona 85711

September 20, 1995

Peroxidation Systems Inc.

September 21, 1995

Ms Kathy McCue
Malcolm Pirnie, Inc.
P.O. Box 1938
Buffalo, New York 14219

RE: **perox-pure**™ Performance Testing of the Mr.C Cleaners Groundwater
PSI Project No. 0493

Dear Ms. McCue:

Enclosed please find two (2) bound copies of the Process Assessment Report for the above referenced site entitled, "Process Assessment of the **perox-pure**™ Process for the Destruction of Organic Contaminants in Groundwater."

If you have any questions regarding this report, please contact either Bob Scherrer at our Pittsburgh, Pennsylvania office at (412) 934-2240 or myself at (602) 790-8383.

Thank you for your continued interest in our products and services!

Sincerely,

VULCAN PEROXIDATION SYSTEMS, INC.

Lisa M. Thornton

Lisa M. Thornton
Process Engineering

cc: Vince Brunotts, VPSI
Doug Jacobs, VPSI
Jeff Prellberg, VPSI
Bob Scherrer, VPSI
VPSI File

Peroxidation Systems
Vulcan Peroxidation Systems Inc., a Vulcan Chemicals Company
5151 E. Broadway, Suite 600 Tucson, Arizona 85711 520-790-8383 FAX 520-790-8008

CONFIDENTIAL PROCESS ASSESSMENT

ASSESSMENT OF THE **perox-pure™** PROCESS FOR THE DESTRUCTION OF ORGANIC CONTAMINANTS IN GROUNDWATER

prepared for

Malcolm Pirnie, Inc.
Buffalo, New York
VPSI Project No. 0493

by

Vulcan Peroxidation Systems, Inc.
5151 East Broadway, Suite 600
Tucson, Arizona 85711

September 20, 1995

The information contained in this report includes descriptions and procedures which are confidential to Vulcan Peroxidation Systems, Inc. The report shall not be copied nor released to third parties without prior approval from Vulcan Peroxidation Systems, Inc.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Vulcan Peroxidation Systems, Inc. (VPSI) has performed a bench-scale evaluation for Malcolm Pirnie to determine the effectiveness of the **perox-pure™** Process in destroying the organic contaminants in the groundwater from Mr. C Cleaners site in New York. The groundwater reportedly contained Volatile Organic Compounds (VOCs) at a maximum observed concentration of 10 μg/l of methylene chloride (MeCl), 12 μg/l of 1,2-dichloroethene (DCE), 3 μg/l of 1,1,1-trichloroethane (TCA), 3 μg/l of trichloroethene (TCE), and 8,200 μg/l of tetrachloroethene (PCE). The groundwater as received contained approximately 30 μg/l of DCE and 800 μg/l of PCE.

The treatment objectives specified by Malcolm Pirnie were the treatment of DCE to 30 μg/l and the other reported VOCs to 10 μg/l at a full-scale flow rate of 55 gpm (Case 1) and 100 gpm (Case 2).

Successful full-scale treatment of the groundwater at the specified flow rates of 55 and 100 gpm is projected to occur with a power requirement of 17 kW and 30 kW, respectively. The budgetary capital investment for the **perox-pure™** equipment is $77,000 for both Cases 1 and 2. Including electricity, H_2O_2, and maintenance, the treatment cost is estimated to be $1.17 and $0.99 per 1000 gallons, respectively, excluding capital amortization.

As an alternative to equipment purchase, VPSI offers the **perox-pure™** equipment under a Full Service Agreement. The Full Service Agreement includes lease of the **perox-pure™** system and the H_2O_2 storage and feed module, regular equipment maintenance, replacement parts, regular service visits, 24 hour emergency service, and a guarantee of performance. The treatment cost for the groundwater with the Full Service Agreement, including electricity and chemicals, is estimated to be $2.50 per 1000 gallons for Case 1 and $1.72 per 1000 gallons for Case 2.

The **perox-pure™** Process offers the advantages of a proven, cost-effective treatment system that creates no air emissions, or generation of secondary waste products and is backed by the security of more than 100 successful full-scale installations world-wide.

1.0 INTRODUCTION

Vulcan Peroxidation Systems Inc. (VPSI) was contracted by Malcolm Pirnie, Inc. (Malcolm Pirnie) to perform a **perox-pure™** UV/Oxidation Treatability Study on contaminated groundwater from the Mr. C Cleaners Site in East Aurora, New York. The groundwater reportedly contained Volatile Organic Compounds (VOCs) at a maximum observed concentration of 10 μg/l of methylene chloride (MeCl), 12 μg/l of 1,2-dichloroethene (DCE), 3 μg/l of 1,1,1-trichloroethane (TCA), 3 μg/l of trichloroethene (TCE), and 8,200 μg/l of tetrachloroethene (PCE). The groundwater as received contained approximately 30 μg/l of DCE and 800 μg/l of PCE. The treatment objectives specified by Malcolm Pirnie were the treatment of DCE to 30 μg/l and the other reported VOCs to 10 μg/l at a full-scale flow rate of 55 and 100 gpm. Because PCE was the primary contaminant of concern, and it was detected at a level ten times less than expected, VPSI spiked PCE into solution prior to testing to simulate the reported groundwater levels.

The bench-scale treatability study was conducted on the groundwater during September 1995 at the VPSI Testing Laboratory in Tucson, Arizona. These tests were designed to determine the optimal **perox-pure™** Process conditions for meeting the treatment objectives, and to provide a range of data from which full-scale treatment costs could be projected.

2.0 PROCESS DESCRIPTION

The **perox-pure™** UV/Oxidation Process destroys dissolved organic contaminants in water by means of photochemical oxidation. Ultraviolet (UV) light catalyzes the chemical oxidation of organic contaminants by direct photocatalysis, and its reaction with hydrogen peroxide (H_2O_2). Many organic contaminants absorb UV light and may undergo a change in their chemical structure leading to direct photo degradation or may become more reactive with chemical oxidants. More importantly, UV light at less than 300 nm wavelengths reacts with H_2O_2 molecules to form hydroxyl radicals. These powerful chemical oxidants then react with the organic contaminants in the water. If carried to completion the reaction products of hydrocarbon oxidation with the **perox-pure™** Process are carbon dioxide and water.

Optimization of the **perox-pure™** Process is focused on developing process conditions which achieve the fastest rate of destruction of the target contaminants. The destruction rate of the target contaminants is measured in terms of a rate constant, and is calculated using a pseudo-first order rate equation. An increase in the magnitude of the destruction rate constant relates to a faster destruction rate of target contaminants and, in general, reduced treatment costs.

There are several process variables which can be used to optimize the **perox-pure™** UV treatment processes. The variables associated with the water quality may include pH adjustment, and pretreatment for the removal of suspended solids, iron, and sometimes background TOC or COD constituents. Other process variables may include the use of proprietary **perox-pure™** catalysts used to increase the destruction rate of target contaminants, and the optimization of different UV lamp types.

The **perox-pure™** bench-scale testing equipment and procedures are capable of evaluating each of the process variables in order to arrive at the most cost-effective **perox-pure™** Process design.

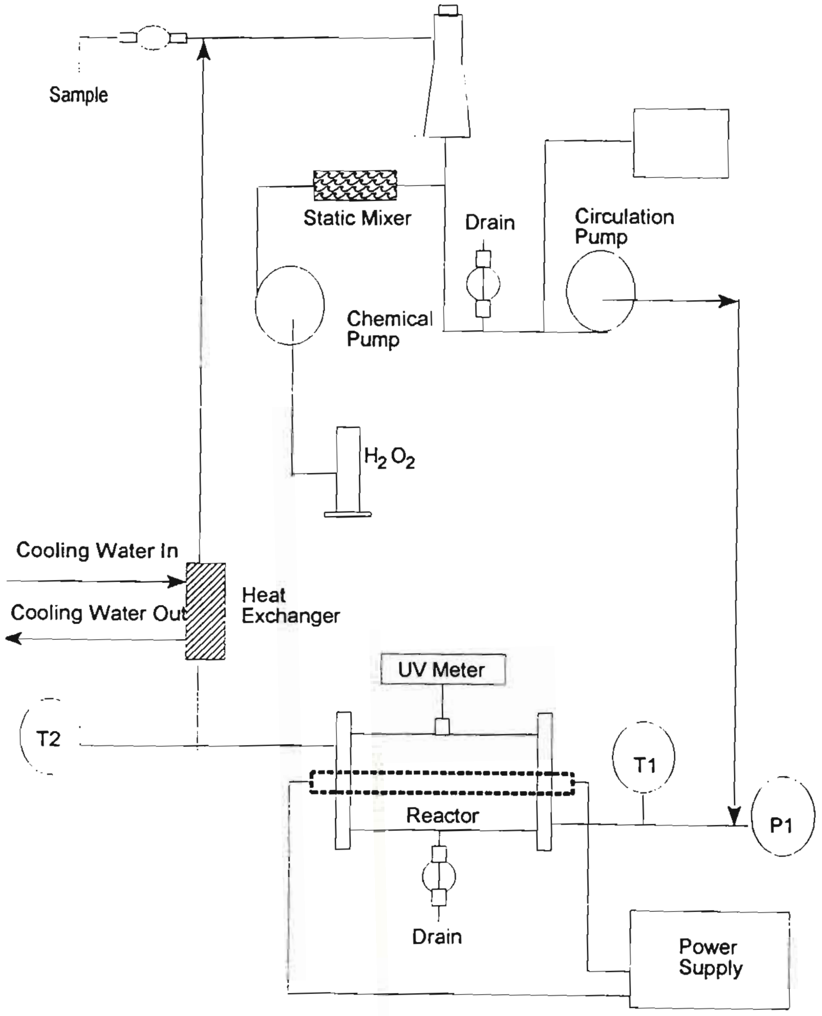
3.0 BENCH-SCALE TREATABILITY TESTING

3.1 Testing Procedures

3.1.1 Bench-Scale Test Unit

A schematic of the Bench-Scale Test Unit is shown in Figure 1. The main components consist of a UV reactor, lamp power supply system, a recycle reservoir, a recycle pump, and a H_2O_2 feed pump. The total volume of the system used for testing was approximately 2 gallons. The bench-scale test unit is designed for maximum flexibility in testing process variables such as pH adjustment, catalyst addition, H_2O_2 dosage, and UV dosage. The reactor is operated as a closed system and has been experimentally tested to verify that volatilization of VOCs does not take place during testing procedures. In addition, the UV lamps utilized for testing purposes maintain the same power output and spectral characteristics as in the full-scale equipment.

FIGURE 1



3.1.2 Testing Protocol

The bench-scale test unit was charged by placing an aliquot of the sample water into a recycle reservoir. A recirculation pump was started which circulated the water through the reactor and back into the reservoir at a rate of 5 gpm (2.5 volumes per minute) providing continual mixing in the closed system. Chemical addition for pH adjustment was then performed if necessary. The UV lamp was illuminated and warmed up for 1 minute to start a test. Hydrogen peroxide and any catalytic additives were then added as required. If required, H_2O_2 was fed into solution during the test to maintain a constant residual concentration. All materials in contact with the water were glass, quartz, stainless steel, viton or teflon.

After the appropriate retention times, samples of treated water were collected in 40 ml septum vials. An untreated sample was also collected the same way. These samples were analyzed by VPSI for VOCs using EPA Method 601 protocols.

3.1.3 Chemical Spiking

Chemical spiking of the Mr. C Cleaners groundwater was performed to increase the concentration of PCE closer to the reported level of 8200 μg/l. This was done by spiking five gallons of groundwater with the appropriate amount of neat PCE stock and then mixing continuously for one hour. The resulting solution was then used for testing purposes.

3.2 Groundwater Testing Results

3.2.1 Groundwater Characterization

On August 30, 1995, approximately 20 gallons of groundwater were received from Malcolm Pirnie at the VPSI Laboratory in Tucson, Arizona. The water was contained in amber glass bottles and was received cold with no headspace. Upon receipt, and throughout the course of the treatability study, the water was kept refrigerated at 4°C, except when in use for testing purposes.

The characterization of the groundwater was performed by VPSI to determine water quality parameters which are important to the UV/Oxidation Treatment Process. The results are shown below in Table 1.

Table 1

Sample Characterization Results Mr. C Cleaners Groundwater	
Visual Appearance, Color	Clear, Colorless
pH	7.9
TDS (mg/l)	510
Alkalinity (mg/l as $CaCO_3$)	310
Hardness (mg/l as $CaCO_3$)	220
Chloride (mg/l)	100
Total Iron (mg/l)	<0.1
Turbidity (NTU)	<1.0
COD (mg/l)	28
TOC (mg/l)	3.5
TSS (mg/l)	<5
Nitrate (mg/l as NO_3)	0.44

As shown in Table 1 the groundwater was of very good treatment quality with respect to UV/Oxidation requirements - i.e. low levels of iron, TSS, TOC and COD. The alkalinity was the only borderline constituent at a level of 310 mg/l. Alkalinity in the form most common to groundwaters is comprised of carbonate (CO_3^{-2}) and bicarbonate (HCO_3^{-1}) ions which act as hydroxyl radical scavengers which can significantly slow down contaminant destruction rates. Therefore, evaluation of treatment at a reduced pH was performed.

3.2.2 perox-pure™ Process Testing

Three (3) **perox-pure™** treatment tests were performed by VPSI on the Mr.C Cleaners groundwater. The test conditions and results are shown in Table 2. The tests were designed to evaluate the effects of pH adjustment and H_2O_2 dosage on the rate of contaminant destruction. As seen by the treatment results, the influent PCE concentration was rapidly destroyed to below the treatment objective of 10 μg/l within 0.5 minutes of oxidation time in each test. Comparing the test results, there is no benefit to reduced pH or increased H_2O_2 dosage above 50 mg/l. Although the PCE spike resulted in a concentration which was less than the expected level, the pseudo first order destruction rates can be extrapolated to a full-scale design at the higher influent concentrations.

Table 2
Bench-Scale perox-pure™ Treatment Conditions and Results
Mr. C Cleaners Groundwater

Test 1 **50 mg/l H_2O_2; pH 8.0**	
Oxidation Time (min)	**PCE (μg/l)**
Influent	3,744
0.5	<10
1.0	<10
2.0	<10

Test 2 **50 mg/l H_2O_2; pH 4.9**	
Oxidation Time (min)	**PCE (μg/l)**
Influent	NS(1)
0.5	<10
1.0	<10
2.0	<10

Test 3 **100 mg/l H_2O_2; pH 5.0**	
Oxidation Time (min)	**PCE (μg/l)**
Influent	NS
0.5	<10
1.0	<10
2.0	<10

(1) NS - Sample not collected; Test 1 influent used for design evaluation.

4.0 FULL-SCALE PROCESS ASSESSMENT

4.1 Treatment Objectives

The full-scale treatment objectives and design flow rate specified by Malcolm Pirnie are shown below. The influent contaminant concentration was specified by Malcom Pirnie.

Design Flow Rate	
Case 1	55 gpm
Case 2	100 gpm

Contaminants	Influent	Effluent
PCE	8200 μg/l	10 μg/l

4.2 Recommended Process Conditions

Full-scale **perox-pure**™ Process Conditions are projected in Table 3. The results from Test 1, along with contaminant destruction rates calculated from actual full-scale operating experience treating PCE in similar groundwaters was used as the design basis. The H_2O_2 dosage listed in Table 3 was calculated based on a concentration of 50 mg/l (Test 1).

Table 3

Full-Scale **perox-pure**™ Process Conditions
Mr. C Cleaners Groundwater

perox-pure™ Process Conditions	**Case 1** **55 gpm**	**Case 2** **100 gpm**
Power Demand (KW)	20	30
50% H_2O_2 (lbs/1000 gal)	0.83	0.83

4.3 Discussion of Equipment

The bench-scale testing indicates that the PCE in the groundwater is oxidized to below the effluent levels specified by Malcolm Pirnie with 0.5 minutes of oxidation time. At the specified flow rates of 55 gpm (Case 1) and 100 gpm (Case 2), the **perox-pure™** unit which can best accommodate the treatment requirements is a Model S-30 for both Cases.

A 50% H_2O_2 dosage of 0.83 pounds per 1,000 gallons is projected for both Cases 1 and 2 from the bench-scale testing. This results in a 50% H_2O_2 usage of approximately 200 gallons per month for Case 1 and 365 gallons for Case 2. VPSI therefore recommends that a 500 gallon H_2O_2 storage and feed module be used to support the **perox-pure™** system.

The only utilities required include potable water for the safety shower, and 60 amps of 3 phase, 60 cycle, 480 volt electrical power. Compressed air at 80 to 100 psig is also required for operation of the automatic valves.

VPSI's **perox-pure™** system is a complete skid mounted system with all required controls enclosed. Only a minimal foundation with containment dike, and electrical and plumbing connections are necessary. The equipment can operate with infrequent attention from the operator. It does require occasional servicing which VPSI can provide under several service agreement options.

5.0 INVESTMENT OPTIONS

Discussion of Investment Options

VPSI offers the **perox-pure**™ system under either a Full Service Agreement with no capital investment or through direct purchase.

Option I - Full Service Agreement

VPSI will provide the **perox-pure**™ system under a Full Service Agreement program, which includes the **perox-pure**™ unit and H_2O_2 feed module, regular equipment maintenance, replacement parts, 24-hour emergency service, and regular service visits. VPSI will provide a written guarantee that the performance of the system will meet the agreed upon effluent specifications.

VPSI's qualified technical personnel will visit the site on a regular basis to monitor the operation, perform necessary maintenance and provide a monthly report on the system. Other operator attention is not normally required.

All of these services are included in one monthly service fee. In addition, if the process conditions change, such as an increase in flow rate or organic contaminant levels, the customer can request equipment replacement. In this way, the facility is always provided with an optimally sized unit, providing minimum operating costs for current site conditions.

If desired, the Full Service Subscriber may purchase the equipment at any time during the course of the Agreement.

Option II - Equipment Purchase

Alternatively, VPSI can supply the **perox-pure**™ treatment system through equipment purchase, with or without a separate Technical Services Agreement. The Technical Services Agreement provides a program which includes the H_2O_2 storage and feed module, equipment maintenance, replacement parts, 24-hour emergency service and regular service visits. VPSI will provide a written guarantee that the performance of the system will meet the agreed upon effluent specifications.

VPSI's qualified technical personnel will visit the site on a regular basis to monitor the operation, perform necessary maintenance and provide a monthly report on the system. Other operator attention is not normally required.

6.0 CONCLUSION

The **perox-pure™** Process can provide effective treatment of the contaminated groundwater to the effluent limits specified by Malcolm Pirnie as detailed in the process assessment presented herein. The **perox-pure™** Process offers the advantages of a proven, cost effective treatment system that creates no air emissions, or generation of secondary waste products and is available under purchase or lease arrangements.

5.1 Capital Investment

The budgetary capital investment for both a customer owned system and a VPSI owned system with a Full Service Agreement are shown below. The customer is responsible for freight costs, site preparation and foundation, power to the battery limit, influent/effluent pipes, pretreatment or post-treatment, taxes, special permits, pumps and tanks.

	VPSI Owned System w/FSA	**Customer Owned System**
Capital Investment	Included	$77,000
H_2O_2 Storage & Feed System$^{(1)}$	Included	Included
Start-up/Training	$5,000	$5,000
Total	$5,000	$82,000

$^{(1)}$ No capital investment when H_2O_2 is purchased from VPSI.

5.1.1 Treatment Costs for Customer Owned System

The projected costs for **perox-pure™** treatment of the Mr. C Cleaners groundwater are shown below. The energy cost was assumed to be $0.06/kWh. The maintenance costs are estimated at 10% of the capital investment per year.

	Case 1 ($/1000 gallons)	**Case 2 ($/1000 gallons)**
Annual Maintenance (@ 10%)	$0.27	$0.15
Electrical Power (@ $0.06/kWh)	$0.36	$0.30
50% H_2O_2 (@ $0.65/lb)$^{(1)}$	$0.54	$0.54
TOTAL PER 1000 GALLONS	$1.17	$0.99

$^{(1)}$ The hydrogen peroxide cost is a delivered price and includes a hydrogen peroxide feed module which contains a bulk storage tank, safety shower, two feed pumps, and the controls.

5.1.2 Treatment Costs with Full Service Agreement

Alternately, VPSI will provide the **perox-pure™** system under the Full Service Agreement program, which includes the unit and H_2O_2 storage and feed module, maintenance, replacement parts, emergency service, and regular service visits. VPSI guarantees that the performance of the system will meet the agreed upon effluent specifications. Thus, the Full Service Agreement offers guaranteed performance at a guaranteed monthly cost.

	Case 1 ($/1000 gallons)	**Case 2 ($/1000 gallons)**
Full Service Agreement Fee (@$3,800/mo for 60 months)	$1.60	$0.88
Electrical Power (@ $0.06/kWh)	$0.36	$0.30
50% H_2O_2 (@ $0.65/lb)(1)	$0.54	$0.54
TOTAL PER 1000 GALLONS	$2.50	$1.72

(1) The hydrogen peroxide cost is a delivered price and includes a hydrogen peroxide feed module which contains a bulk storage tank, safety shower, two feed pumps, and the controls.

ATTACHMENT A

Specifications for **perox-pure**^{TM} Equipment

SPECIFICATION

Ultraviolet Light/Hydrogen Peroxide Oxidation System

1. General

This specification describes the **perox-pure™** ultraviolet light (UV) - hydrogen peroxide (H_2O_2) oxidation system capable of destroying soluble toxic organic contaminants in water. These specifications are subject to change without notice.

Unloading, handling, installation, excavation, concrete work, finish painting, connecting piping, and electrical hookup are the responsibility of others.

2. Principle of Operation

The System utilizes the chemistry of UV/H_2O_2 reactions, which involves generation of hydroxyl radicals, and other reactive species, by the photochemical action of ultraviolet light on hydrogen peroxide. The hydroxyl radicals attack organic species.

The final products of the noted reaction are carbon dioxide, water, and inorganic ions.

3. Applicable Codes - (Latest Editions)

Uniform Building Code	National Electric Code
Uniform Plumbing Code	NFPA
Uniform Mechanical Code	OSHA

Note: Operating pressure is not to exceed 15 psig, ASME Code does not apply.

4. Equipment Description

UV/H_2O_2 Oxidation Module -

Maximum Inlet Pressure:	15 psig
Power Requirement:	3ph/60Hz/480V
Air Requirement:	80-120 psig, 4 ACFM (During tube cleaning operation only)

Materials of Construction -

UV/H_2O_2 oxidation chamber, fluorocarbon lined 6063-T6 aluminum or 316L stainless steel.
Chemical tubing - type 316 stainless steel with compression fittings.

Process Piping - Sch. 80 CPVC.
Structural Steel Skids and Supports - carbon steel.
  ASTM A-36 with chemical and weather resistant paint.
Electrical Enclosures - Enamelled carbon steel.
Wetted non-metallic components - Quartz, fluoroelastomers, or polymers resistant
  to UV, H_2O_2 and all chemicals present.

Design Features -

Oxidation Chamber

Lamps shall be horizontally mounted and removable without draining the oxidation chamber.

The lamp end enclosures shall be provided with hinged and gasketed doors.

All UV sensitive materials shall be shielded from the UV rays by material reflective of, or resistant to, UV.

The UV lamps shall be protected against contact with the fluid in the event of a leak.

Water shall be separated from contact with the UV lamps by quartz tubes sized for optimimum lamp operating temperature.

The UV oxidation chamber shall be designed to efficiently distribute and collect the process water throughout the entire oxidation chamber in order to eliminate an uneven flow pattern or short-circuiting. Piping connections shall be designed so that the UV oxidation chamber will remain full of fluid after shutdown.

The oxidation chamber shall not have chamber penetrations for automatic quartz tube cleaner actuation mechanism.

Electrical Enclosures

Electrical enclosures shall have hinged and lockable doors.

Electrical enclosure cabinets shall be weatherproof. Lamp drive enclosures will be provided with intake air cooling fans to control the inside temperature. The fans shall operate continuously when the unit is running.

Access doors shall have limit switches to shut the power off should the doors be opened.

Circuitry

All wiring and electrical connections shall be protected against moisture to prevent electrical short or failure. Pressure indicators and temperature switches shall be in weatherproof housings.

All wiring and electrical components within the system shall be designed, constructed and installed in accordance with the latest edition of the National Electrical Code and all applicable State and local electrical codes.

Circuitry within the lamp drive enclosure shall be protected and disconnected by pre-wired circuit breaker rated at 30,000 amp minimum AIC with external ground fault sensor and shunt trip.

Lamp drives shall be of the high-power factor type.

Instrumentation and Controls

The UV system shall be controlled via a touch-screen interface to a programmable logic controller (PLC). Standard PLC is Siemens Model TI 435 or TI 545. The Model of the PLC will vary with the size of the UV system. Controls shall be provided to allow on/off operation of individual UV lamps, on/off operation of (1) chemical feed pump, and shut-down of the UV system.

Alarm contact closures shall be provided on:

1) high temperature in lamp drive enclosure
2) low water flow (adjustable)
3) high water temperature
4) moisture in lamp end enclosure
5) access door opening
6) remote contact closure (10 amp, 120 VAC)
7) low peroxide pressure
8) low peroxide splitter flow (if splitter is provided)
9) overpressure relief flow
10) low oxidation chamber water level
11) tube cleaning system failure
12) lamp low current detection (shut-down optional)
13) lamp contactor failure
14) Emergency Stop
15) Primary Ground Fault
16) Secondary Ground Fault

Alarm conditions shall be displayed on the touchscreen with "First Out" indicator.
Flow indicator calibrated in gpm, with totalizer, shall be provided.
A system to indicate the operating status of each lamp shall be provided.

An elapsed timer meter shall be provided to indicate the number of hours of module operation. Timer shall be resettable with access codes.

H_2O_2 Feed

Connections for injection of H_2O_2 in quantities suitable for the process shall be provided. If required by the process, means for complete mixing of the H_2O_2 and process water, and for variable, staged injection shall be provided.

Automatic Cleaner

The UV oxidation system shall incorporate an automatic quartz tube cleaning system, programmable by the user for variable operation period frequency and duration dependent upon the requirements of the installation. Cleaner shall be constructed of stainless steel and/or UV resistant materials. The tube cleaner control system shall be capable of changes in both frequency of operation cycles and duration of each cycle. It shall also be capable of automatic variation of these cycles in response to changes in flow rate or signals from a remote control system based on, for example, effluent contaminant concentration.

The tube cleaner mechanism shall not require sliding shaft seals through the wall of the oxidation chamber. It shall effectively wipe the lamp tube to prevent accumulation of deposits that interfere with transmittance of UV light from the lamp. To prevent accumulation of deposits on the wall of the oxidation chamber the wiper shall also clean the inside of the oxidation chamber. The interior of the oxidation chamber shall be finished in a manner to minimize deposits of material.

The wiper mechanism shall wipe any point opposite the UV lamp a minimum of 4 times per pass. For extended tube wiper life, the wiper shall be retained in a recess away from the UV lamps so that it is shielded from UV light during the period between cycles. For even wiper wear distribution, the wiper shall be free to rotate around the longitudinal axis of the quartz tube.

Assembly

Oxidation chamber, control enclosures, instrumentation, controls, and piping shall be shop assembled on a skid and disassembled only as necessary for shipment. Lamps and supports to be shipped separately.

5. Installation, Start-up, and Operator Training

Supplier will supervise initial placement of all equipment provided in this specification.

The mechanical and electrical hookups by others shall be completed per schedule mutually agreed upon by all parties.

Upon completion of installation the equipment supplier shall hydrostatically test all pressure systems provided by this specification. If leaks occur, necessary corrections shall be made and retested until completed without any evidence of leakage. All electrical circuits and equipment shall be tested for continuity and functional performance.

All surfaces to be contacted by H_2O_2 shall be properly passivated by the equipment supplier.

In addition to the above, during a scheduled start-up period of five (5) calendar days, the equipment supplier shall provide start-up operation of the systems furnished by this specification. The Field Service Engineer shall operate the equipment, make all adjustments and calibrations necessary to allow operation at full load for a 24-hour period. Representative samples will be taken as required to determine performance. During this period, the owner's operating personnel are to be trained in the operation and maintenance of this equipment. Any materials deemed defective during this period are to be replaced.

6. Certified Dimension Drawings

Two (2) sets of certified dimension drawings will be furnished.

7. Operation and Maintenance Instructions

Three (3) complete Operation and Maintenance Instruction Manuals will be furnished.

8. Safety

Formal safety policies and procedures for laboratory, manufacturing and field operations activities shall be documented. Supplier shall have a Safety Committee which meets regularly to review and establish safety policies. All equipment shall be designed and constructed to adhere to regulatory requirements and practical consideration. Consideration shall be given to personnel safety during both operation and maintenance of the equipment. The following information outlines the safety features.

1. Changing Lamps and Quartz Tubes. Both lamps and tubes are reliable when handled by proper procedures. However, being quartz they are subject to breakage

if dropped or struck on another object. Accordingly, all maintenance on lamps and tubes is done by a technician without the need for ladders, scaffolds or other elevation means.

2. Changing ballasts. Ballasts which may weigh up to 250 pounds are quite reliable and are infrequently changed. If changing is necessary, the unit is to be equipped with a slide out mechanism to eliminate potential personnel problems with moving and securing the ballast.

3. Opening Enclosures. All electrical enclosures are to be built with interlock high voltage position switches which will shut down power to the unit if they are opened.

4. UV Exposure. The units shall be designed such that operators cannot be subjected to UV light.

5. Ground Fault Projection. In addition to conventional grounding and insulation, the unit shall employ an external groundfault sensor and a shunt trip. The shunt trip will activate when the primary or secondary exhibits a electrical short of 4 amps or greater.

6. Hydrogen Peroxide. H_2O_2 is a powerful oxidizing agent which is safe when handled properly. Safety training on handling and use of H_2O_2 is to be provided by Supplier to on-site personnel. In addition, standard H_2O_2 storage and feed equipment is to be equipped with a shower and eyewash station for personnel safety.

7. Equipment Protection. An extensive series or safety interlocks are to be designed into each module to guarantee the safety of the equipment if operating variables should significantly change during operation.

9. Quality

The equipment shall be produced under a versatile quality program that employs resolution inspections and pretested equipment which meets and complies with Quality Assurance/Quality Control Programs.

Supplier shall have a program in compliance with requirements of:

- NQA-1 - Nuclear Quality Assurance
- ANSI/ASME - American National Standard Institute/
  American Society of Mechanical Engineers
- AWWS Specifications - American Water Works Standards
- NASA Specifications - National Aeronautics and Space Administration

- Military Specifications

Supplier's program shall be an on-going QA/QC program to satisfy the provisions and requirements of:

- ASQC Q90 - American Society for Quality Control
- ISO 9000 Series - International Standards Organization

Supplier shall have qualified QA/QC personnel and a system of procedures, checks, audits and corrective activities to ensure that all research, design and performance, environmental monitoring, sampling, plus other technical and reporting actions, are of the highest reasonably achievable quality.

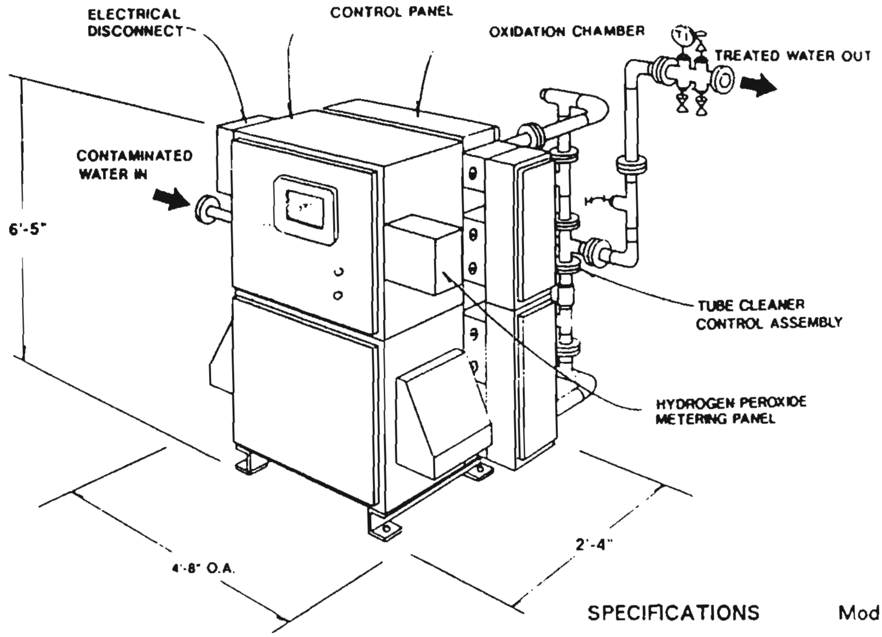
ATTACHMENT B

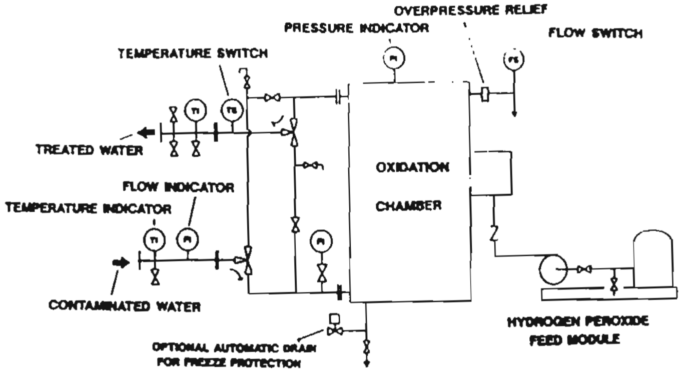
Equipment Cut-Sheet

perox-pure™
ORGANIC DESTRUCTION PROCESS

MODULAR TREATMENT SYSTEMS

MODEL S-30





SPECIFICATIONS	Model S-30	
Flow Rate:		
Maximum	60 gpm	100 gpm
Connections:	150# Flange	150# Flange
Inlet:	1 1/2"	2"
Outlet:	2"	2"
Power Supply:	3 pH/60Hz/480V, 30KW, 40 Amps	
Electrical Encl.:	NEMA 3R	
Material -		
Wetted Parts:	316 SS, Quartz, Fluoroelastomers, TFE	
External Parts:	Enameled Steel	
Weight -		
Shipping:	1500 lbs.	
Operating:	2000 lbs.	

The **perox-pure**™ chemical oxidation system consists of modular, skid-mounted equipment designed to treat water contaminated by dissolved organic compounds. Bench-scale process evaluations will determine pretreatment requirements (if any) and the oxidation time necessary for the desired treatment level. Full-scale oxidation chamber volume, UV requirements and oxidant dosage are then selected.

The **perox-pure**™ system incorporates corrosion resistant fluorocarbon-lined oxidation chambers and horizontally mounted medium pressure UV lamps. Indicators are provided to monitor performance of each lamp. A sequential hydrogen peroxide addition feature provides easy process optimization for maximum economy. In addition, a patented tube cleaning device maximizes performance and minimizes maintenance time. The cleaning device is automatic and self propelled, requiring no external actuating mechanism or sliding shaft seals. Other design features include shop-wired and tested control panels interlocked with personnel and process safety features to shut off power and display the cause at preset conditions. Installation is quick and easy.

The **perox-pure**™ system and its components are covered by numerous issued and pending patents.

Peroxidation Systems
Vulcan Peroxidation Systems Inc., a Vulcan Chemicals Company
5151 E. Broadway, Suite 600 Tucson, Arizona 85711 520-790-8383 FAX 520-790-8008

WATER SOLUTIONS
Water Quality Consultants

May 10, 1996

Ms. Mary Christie
Malcolm Pirnie, Inc.
S. 3515 Abbott Road
P.O. Box 1938
Buffalo, NY 14219

Dear Mary,

I would like to thank you for your inquiry as to the treatment potential of the Mr. C. Cleaners site.

I find the water quality you provided to be exceptionally high in calcium, iron and manganese to the point where treatment is most definitely going to be required.

Please find a proposal for pretreating this site with AQUA-MAG as a means of preventing fouling.

If you have any questions pertaining to this proposal, please contact me.

Sincerely,

WATER SOLUTIONS

Bill Co

William T. Cornish

WTC/asc
Enclosures

P.O. Box 208
Mattapoisett, MA 02739
508 758-6126
FAX: 508 758-6128
Northeast distributor of Aqua Mag

AQUA-MAG PRETREATMENT PROPOSAL

SITE: MR. C. CLEANERS

AQUA-MAG DOSAGE:

5.46 ppm as PO4

AQUA-MAG USAGE:

Continuous water flow of 95 GPM: 3.42 Gallons Daily
1,248.00 Gallons Yearly

AQUA-MAG PRICING:

(23) 55-Gallon Drums: $17,480.00 Annually
Bulk (500 Gallons Minimum Per Delivery): $13,728.00 Annually

ALL ORDERS FOB-BELOIT, WISCONSIN

WTC/asc

AIR STRIPPER PACKING CONDITIONER

WATER SOLUTIONS
Water Quality Consultants
P.O. Box 208
Mattapoisett, MA 02739
508-758-6126
FAX: 508-758-6128
Northeast Distributor of Aqua Mag

Product Information

AQUA MAG

High Performance

Aqua Mag is a liquid inorganic phosphate complex providing superior sequestering, dispersing, and buffering action, meeting potable requirements. Aqua Mag enhances the transfer to air of the ground water contamination by keeping tower packing clean. Systems affected by bacterial contamination are disinfected with an additional chlorine bleach or hydrogen peroxide feed pump, following the Aqua Mag injection.

Treatment Steps

- Ground water analysis by Kjell Certified Laboratory.
- Dosage determination according to water quality.
- Installation of Aqua Mag feed pump and initial “clean up” injection rate (30-60 days).
- Aqua Mag dosage reduced to an ongoing maintenance rate.
- Program monitoring through on-site inspection and Kjell Laboratory analysis of water samples.

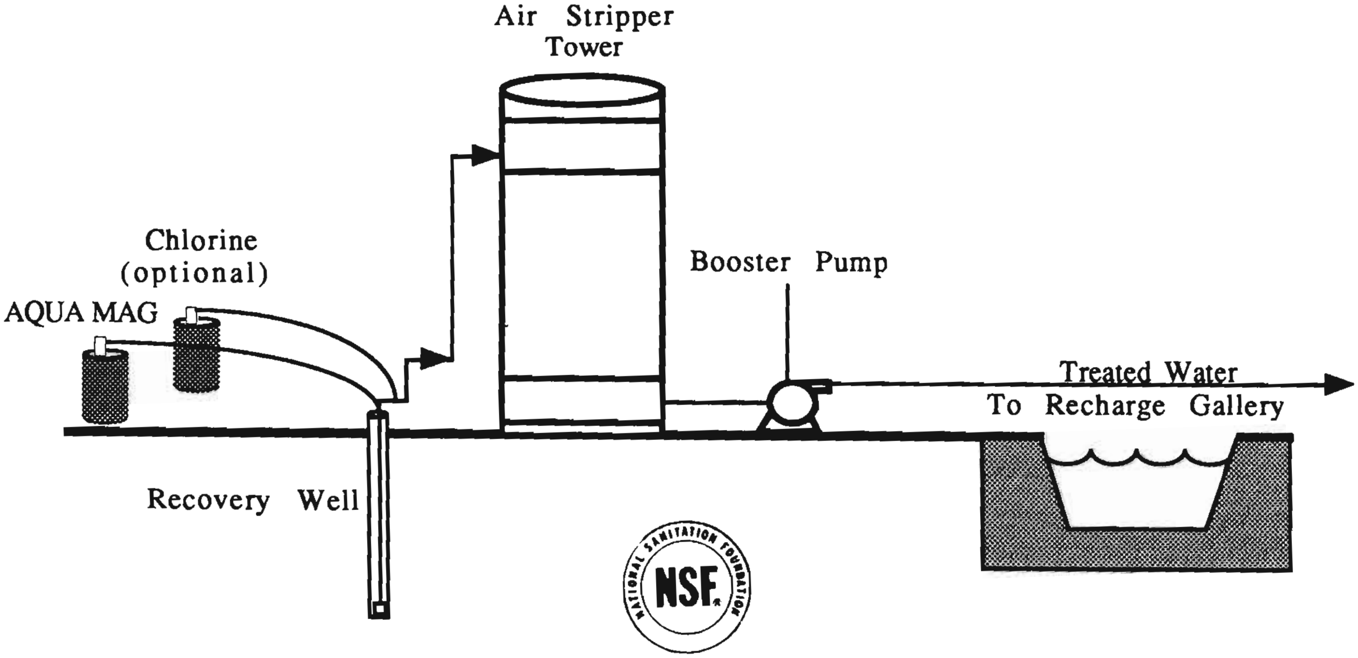
Shipping and Handling

Aqua Mag is available in a variety of container sizes suitable for all applications and distributed nationwide. Aqua Mag is easily dispensed from the shipping container (no mixing required).

Historical Results

Continuous system protection from iron, calcium, scale and bacterial slime in the:

- Recovery well
- Air stripper tower and packing
- Recharge galleries
- Booster pumps
- Distribution system



NATIONAL SANITATION FOUNDATION
NSF

WATER SOLUTIONS
Water Quality Consultants
P.O. Box 208 • Mattapoisett, MA 02739 • Tel: (508) 758-6126 • Fax: (508) 758-6128

Product Information

AQUA-MAG...10 WAYS TO BETTER WATER QUALITY

1. *CORROSION CONTROL:* Aqua-Mag inhibits corrosion of steel distribution system water lines, iron and galvanized piping, domestic lead and copper plumbing, and brass faucet fixtures by complexing to form a microscopic film on the inside of these metallic surfaces.

2. *IRON & MANGANESE CONTROL:* Aqua-Mag sequesters minerals and light metals to reduce discoloration, staining and mineral buildup throughout the water system.

3. *CALCIUM SCALE CONTROL:* Aqua-Mag inhibits excessive calcium and magnesium carbonate scale from hard water supplies while promoting a protective film type scale in corrosive low hardness water qualities. Excess calcium scale deposits are typically seen in hot water lines and heaters.

4. *BIOFILM REDUCTION:* Aqua-Mag enhances disinfectant penetration into biofilm contamination, tuberculation, and scale formation inside water pipes.

5. *CHLORINE SAVINGS:* Aqua-Mag sequesters chlorine consuming minerals and slows the deposition of scale by-products to improve available chlorine residuals and system disinfection.

6. *PRETREATMENT AID:* Aqua-Mag's unique molecular structure performs as a secondary coagulant aid to improve sedimentation rates and particle formation prior to filtration. The residual effect after coagulation will aid filtration capacity and backwash efficiency.

7. *CATALYZE H_2S REMOVAL:* Aqua-Mag expedites the oxidation process to remove annoying odors and the rotten-egg smell from hydrogen sulfide present in many ground water supplies. Aqua-Mag's residual effect controls the potential sulfide odor from redeveloping in residential hot water heaters.

8. *SAVE MONEY:* Aqua-Mag provides the highest rate of return on investment (ROI) for money spent on any operational and maintenance chemical in the water plant. Savings from reduced corrosion and scale, less chlorine demand, fewer failures and leaks, less hydrant flushing and fewer consumer complaints will average $10 savings for every $1 spent on Aqua-Mag.

9. *FOOD GRADE PRODUCT:* Aqua-Mag is fully certified by the ANSI/NSF Standard #60, the USDA, and the USEPA. It is produced in a food grade FDA inspected facility using statistical process control (SPC) to guarantee the highest level of product quality and purity. Aqua-Mag is 100% made in the U.S.A.

10. *TECHNICAL SERVICE:* Aqua-Mag dosage rates, water analysis, on-site inspection, and professional consultation are available from Water Solutions, the Northeast region distributor of Aqua-Mag.

Northeast Distributor of Aqua-Mag

WATER SOLUTIONS
Water Quality Consultants
P.O. Box 208 • Mattapoisett, MA 02739 • Tel: (508) 758-6126 • Fax: (508) 758-6128

Product Information

AQUA-MAG

AQUA-MAG is a water treatment additive designed to control corrosion of metallic piping in water distribution systems and sequester trace levels of dissolved minerals in water supplies. Manufactured as a liquid concentrate of inorganic phosphates through a process technology of thermal reactions, AQUA-MAG is a product of superior purity, stability, and performance. It is fully certified by the ANSI/NSF Standard #60, the USDA, the USEPA, and is produced in a food grade FDA inspected facility using statistical process control (SPC) to guarantee the highest level of product quality and purity. To protect our nation's most valuable asset of public drinking water, AQUA-MAG provides the following features:

- Lead and Copper corrosion control and compliance
- Biofilm penetration for enhanced disinfection
- Improved chlorine residuals through mineral sequestration
- Gradual removal of scale and tuberculation
- Calcium scale control and protective film formation
- Stain and color control by sequestering iron and manganese
- Cost savings in operational and maintenance expense

Applications

AQUA-MAG dosage rates are determined by water quality advisors based on current water analysis, field observations, and computer modeling reports. AQUA-MAG is easily dispensed directly from the shipping container and injected into the water flow with a standard chemical metering pump. No mixing or transfer is necessary, saving additional time and labor expense. For additional details call Water Solutions at (508) 758-6126.

Shipping • Handling • Storage

AQUA-MAG is available nationwide in all container sizes from the manufacturing facility, convenient warehousing, or bulk terminals. Water Solutions is the authorized chemical distributor for the Northeast region. Refer to the Material Safety Data Sheet (MSDS) for safety and handling requirements. Store the product in a clean, dry area protected from freezing and extreme heat.

Properties

- ANSI/NSF #60 Compliance
- Extended shelf life
- Totally soluble in any dilution
- Freeze/thaw stable
- 11.4 pounds per gallon
- pH (1% solution) - 6.5
- Contains no zinc
- 100% Made in U.S.A.

Northeast Distributor of Aqua-Mag

In Case of Chemical Emergency   Call Chemtrec at 1-800-424-9300

MATERIAL SAFETY DATA SHEET

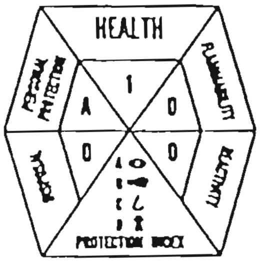
THE KJELL CORPORATION
PO BOX 834
BELOIT, WISCONSIN 53512-0834
(800) 356-0422   (608) 755-0422

Product Name: **AQUA MAG**

Date Prepared: June, 1986

Last Revision: June 8, 1995

PRODUCT INFORMATION



FROM MATERIAL SAFETY DATA SHEET, ENTER HAZARD RATING IN APPROPRIATE BOX

HAZARD RATING

0 - MINIMAL HAZARD
1 - SLIGHT HAZARD
2 - MODERATE HAZARD
3 - SERIOUS HAZARD
4 - SEVERE HAZARD

Synonyms: Blended Sodium Phosphate
Chemical Family: Liquid phosphate blend
Formula: Proprietary
Maximum Use: 23.4 mg/L

Note: Use of an asterick (*) or other designation indicates that there may be chronic health effects present. See Safety file on the product.

PRECAUTIONARY INFORMATION

Precautionary Statement: (As defined by OSHA Hazard Communications Standard): No Significant Health Effects Reported from manufacturing locations

INGREDIENTS/COMPONENTS

Chemical Identity: Sodium ortho/polyphosphate blend
OSHA PEL: Not listed
ACGIH TLV: Not listed
CAS #: 68915-31-1
Hazard Class: None

PHYSICAL DATA

Boiling Point: Above 212 degrees F.
Melting Point: Not Applicable
Vapor Pressure: Not Applicable
Vapor Density (Air = 1): Not Applicable
Specific Gravity (H_2O = 1): 1.367
Evaporation Rate (Butyl Acetate = 1): Non-Volatile
Solubility in Water by Weight: Complete
pH (neat): 5.5
Appearance: Clear Liquid
Odor: Slight

FIRE AND EXPLOSION DATA

Flash Point:		Non-Combustible
Flammable Limites -	Upper:	Not Applicable
	Lower:	Not Applicable
Extinguishing Media:		Not Applicable
Special Fire Fighting Procedures:		Not Applicable
Unusual Fire & Explosion Hazards:		None

REACTIVITY DATA

Stability:	Stable
Incompatibility:	Concentrated Chlorine and Concentrated Mineral Acids
Hazardous Polymerization:	Will not occur
Conditions to Avoid:	Direct mixing of Concentrates of Chlorine and Mineral Acids
Hazardous Decomposition By Products:	Heat, Chlorine and Sulfur Dioxide

HEALTH HAZARD DATA

Routes of Exposure -

Eyes:	No published data
Skin Contact:	No published data
Skin Absorption:	No published data
Inhalation:	No published data
Ingestion:	No published data

Effects of Overexposure -

Acute Exposure:	No Published Data
Chronic Exposure:	When good industrial Hygiene practices are followed no significant inhalation hazard or skin irritation.

Other Health Effects -

Medical Conditions Aggravated by Exposure:	None known
Carcinogenic Potential:	
NTP Annual Report:	Not listed
IARC Monographs:	Not listed
OSHA 29CFR Part 1910 Sub z:	Not listed

Additional Regulatory Information -

FDA:	GRAS List; permitted in food
USDA:	Listed as acceptable if followed by a potable water rinse
NSF International:	Certified to meet Ansi NSF Standard 60. Underwriters Laboratory certified to meet Ansi NSF Standard 60.

Emergency and First Aid Procedures -

Eyes:	Flush with water. If irritation occurs seek medical attention
Skin:	Wash with water. If irritation occurs seek medical attention
Inhalation:	Remove from exposure.
Ingestion:	Rinse mouth and dilute stomach contents with water or milk if available.
Decontamination Procedure:	Wash with water.
Notes to Physicians:	Large doses may cause nausea and diarrhea.

==========STORAGE AND HANDLING==========

Spill or Leak Procedures:	Material should be wiped up for salvage or disposal. Flush with water.
Waste Disposal Method:	If not salvaged, dispose in a landfill in accordance with local, state, and federal regulations.
Precautions in Storing:	Should be stored in clean area for quality assurance. Keep container closed when not in use. Protect from freezing and extreme heat.

==========SPECIAL PROTECTION==========

Respiratory:	None required
Eye:	Not mandatory
Protective Gloves:	Not mandatory
Clothing & Equipment:	No special requirements
Ventilation Requirements:	No special requirements
Work/Hygienic Practices:	No special requirements. Follow good industrial hygiene practices.

==========TRANSPORTATION DATA==========

DOT Proper Shipping Name:	Sodium phosphate solution
DOT Classification:	Not regulated
DOT Labels:	Not required
DOT Placards:	Not required
Emergency Accident Precautions & Procedures:	Not hazardous - See instructions above for release or spill.

==========MANUFACTURER'S DISCLAIMER==========

While The Kjell Corporation will make every effort to insure the validity of this information, we must rely on the information supplied to us by our suppliers and thus make no warranty express or implied as to the validity of this data.

Any use of this product or method of application which is not described in the Product Data Sheet is the responsibility of the user.

NSF International (NSF)
OFFICIAL LISTING

This is a Certification by NSF that these products conform to the requirements of
NSF Standard 60 - Drinking Water Treatment Chemicals - Health Effects

This is your Official Listing as we have it on record at this time.

January 11, 1995 CC: 02 04

KJELL CORPORATION, INC., THE
P.O. BOX 834
BELOIT, WI 53511

Plant At: JANESVILLE, WI

Chemical/ Trade Designation	Category	Max Use
Blended Phosphates		
Aqua-Mag	Corrosion & Scale Control Sequestering	23.4 mg/L
Aqua-Mag-S	Corrosion & Scale Control Sequestering	22 mg/L
Magichem	Corrosion & Scale Control Sequestering	30.2 mg/L
Magichem-S	Corrosion & Scale Control Sequestering	29 mg/L
F-26	Corrosion & Scale Control Sequestering	11 mg/L
F-26-S	Corrosion & Scale Control Sequestering	10 mg/L
K-5	Corrosion & Scale Control Sequestering	30.2 mg/L
K-5-S	Corrosion & Scale Control Sequestering	29.2 mg/L
F-25	Corrosion & Scale Control Sequestering	30.2 mg/L
F-25-S	Corrosion & Scale Control Sequestering	29.2 mg/L
F-35	Corrosion & Scale Control Sequestering	23.4 mg/L
Aqua-Mag S/P-31	Corrosion & Scale Control	30.2 mg/L
Aqua-Mag S/P-11	Corrosion & Scale Control	30.2 mg/L
Aqua-Mag HP	Corrosion & Scale Control	30.2 mg/L
Econophos	Corrosion & Scale Control Sequestering	30.2 mg/L
Aqua-Mag LP	Corrosion & Scale Control Sequestering	30.2 mg/L
Sodium Polyphosphates, Glassy		
Aqua-Mag C-10	Corrosion & Scale Control Sequestering	32 mg/L
Zinc Orthophosphate		
Aqua-Mag ZP 31	Corrosion & Scale Control Sequestering	10 mg/L

Continued on page 2

Additions Cannot Be Made To
This Listing Without Prior
Evaluation And Acceptance By NSF
Issued by Certification Records

Based on an evaluation of health effects data, the level of zinc in the finished drinking water should not exceed 2.0 mg/L.

Dipotassium Orthophosphate		
Aqua-Mag DP	Corrosion & Scale Control	30.2 mg/L
Tetrapotassium Pyophosphate		
Aqua-Mag KP	Corrosion & Scale Control	30.2 mg/L
Aqua-Mag TK	Corrosion & Scale Control	32 mg/L
Miscellaneous Corrosion Chemicals		
Aqua-Mag ZP 21	Corrosion & Scale Control Sequestering	10 mg/L

Plant At: #1 USA

Chemical/ Trade Designation	Category	Max Use
Phosphoric Acid		
Kjell Ortho	Corrosion & Scale Control Sequestering	26.3 mg/L

EG&G

EG&G ENVIRONMENTAL
FOSTER PLAZA 6, SUITE 400
681 ANDERSEN DRIVE
PITTSBURGH, PA 15220
PHONE: (412) 920-5401

October 17, 1995

Mr. Robert O'Laskey
Malcom Pirnie, Inc.
S. 3515 Abbott Road
P.O. Box 1938
Buffalo, NY 14219

Dear Mr. O'Laskey;

I am pleased to submit the enclosed proposal to you for the Mr. C Dry Cleaner site in East Aurora, New York. I trust that you will agree that we have developed an excellent treatment solution for the PCE plume there.

Our NoVOCs system described in the enclosed proposal consists of three wells and a set of blowers on each side of Whaley Avenue. The portion of the plume on the east side of Whaley Avenue should be cleaned up in 12 months or less, while the portion of the plume on the west side of Whaley Avenue should be cleaned up in one to two years.

This proposal is a firm, fixed price proposal. We can deliver a completed final design package to you in 30 to 60 days after receipt of your order. We are willing to offer you a performance guarantee for the system described in the enclosed proposal.

I will be out of the office Wednesday and Thursday of this week, 10/18 & 10/19. So, you may call me Friday or afterwards to discuss this proposal. Thank you for you assistance in preparing this proposal. We appreciate the privilege of working with you while preparing our proposal, and we look forward to the possibility of working with you on the implementation of our proposed NoVOCs system.

Sincerely,

Dick Samuels

Dick Samuels
Sales Engineer

MR. C CLEANERS SITE, EAST AURORA, NEW YORK
NoVOCs™ PROPOSAL

EG&G Environmental, Inc. (EG&GE) has prepared a preliminary design for a NoVOCs™ groundwater cleanup system for the Mr. C Cleaners site in East Aurora, New York. By means of this proposal, EG&G Environmental, Inc. is offering to design, provide and install the NoVOCs system described below for the fixed price described below. The system will consist of six NoVOCs™ wells and associated air handling equipment. This system is designed to treat a groundwater plume containing perchloroethylene (PCE), related degradation products, and BTEX contaminants.

The following summarizes the design basis and features for the proposed system. This design is based on information provided to EG&GE by Malcolm Pirnie, Inc. Section 1.0 summarizes this design information. The NoVOCs system specifications are presented in Section 2.0 and the system price is presented in Section 3.0. Although not part of this proposal, an estimate of the annual operating and maintenance (O&M) costs is included in Section 3.0, for information purposes.

1.0 DESIGN INFORMATION

Information needed to design a NoVOCs™ groundwater treatment system includes characteristics of the contaminant plume, cleanup levels, and geohydrologic characteristics. Design information relevant to the Mr. C Cleaners site is described below.

1.1 Plume Characteristics

Groundwater contamination at the Mr. C Cleaners site consists of shallow PCE and petroleum product plumes as well as a deep PCE plume. The extent of contamination to be addressed by this proposal was identified in the information provided by Malcolm Pirnie, Inc. The area of interest was described as the deep PCE plume and the shallow contaminated zone by the source area. The plume dimensions provided are approximately 500 ft long by 80 ft wide by 18 ft deep. The plume is oriented in a southeast to northwest direction.

1.2 Contaminant Concentrations and Cleanup Levels

The primary contaminants of concern are perchloroethylene (PCE) and associated degradation products and contaminants. The area of concern is characterized by PCE concentrations greater than 1,000 µg/L. PCE degradation products/contaminants detected at the site above cleanup levels include trichloroethylene (TCE), 1,2-dichloroethylene (12DCE), 1,1-dichloroethylene (11DCE), and vinyl chloride (VC). Maximum concentrations and cleanup levels are presented in Table 1.

An alternate cleanup level considered for PCE is 50 µg/L. This level was considered to evaluate potential cost savings compared to treatment to 5 µg/L.

Table 1. Groundwater Contaminants, Maximum Concentrations, and Cleanup Levels

Contaminant	Maximum Concentration, µg/L	Cleanup Level, µg/L	Cleanup Level Reference
PCE	8,200	5	NYS Class GA groundwater quality standard
TCE	280	5	Federal MCL
12DCE	82	70	Federal MCL
11DCE	19	7	Federal MCL
VC	240	2	Federal MCL

1.3 Geohydrologic Characteristics

Geohydrologic characteristics needed to design the NoVOCs™ system are stratigraphy, depth to groundwater, horizontal hydraulic conductivity, anisotropy ratio (ratio of horizontal to vertical hydraulic conductivity), hydraulic gradient, and porosity.

Stratigraphy. Stratigraphic units observed at the Mr. C Cleaners site and their thicknesses include:

- Glacial till (8 to 10 ft)
- Outwash sand, including
    - sand and gravel (3 to 18 ft)
    - silty fine sand (10 to 15 ft)
- Lacustrine laminated silt and fine sand (12 to 14 ft)
- Glacial till (greater than 40 ft)

The stratigraphy is variable along the axis of the PCE plume.

Depth to Groundwater. The depth to groundwater reportedly ranges seasonally from 10 to 11 ft. A value of 10 ft was used for design.

Horizontal Hydraulic Conductivity. Hydraulic conductivity at the site was determined from pump and slug tests. The hydraulic conductivity near the dry cleaners reportedly ranges from 5 x 10^{-2} cm/sec (140 ft/day) to 9 x 10^{-2} cm/sec (260 ft/day). The well used for the pump test at this location yielded 55 gpm with a drawdown of 2.4 ft. Near the Agway building, which is approximately 150 ft downgradient from the cleaners, the conductivity was reported to be 4 x 10^{-3} cm/sec (11 ft/day). Near the Library, which is approximately 250 ft downgradient from the cleaners, the conductivity was reported to be 2.6 x 10^{-3} cm/sec (7.4 ft/day). The well used for the pump test at this location yielded 5 gpm with a drawdown of 7.5 ft.

The horizontal hydraulic conductivity has a large impact on the design of the NoVOCs™ well. Because of the large range of conductivities reported for this site, the entire range was considered during the design process.

Anisotropy Ratio. A value of for anisotropy ratio was not reported for this site. Based on the description of the stratigraphy, a value of 10:1 was assumed for design.

Hydraulic Gradient. A value of 0.004 was reported for the hydraulic conductivity.

Porosity. A value for porosity was not reported. A value of 0.25 was assumed for the design.

2.0 SYSTEM DESIGN

This section describes the design of the NoVOCs™ system proposed for the Mr. C Cleaner site.

2.1 Number and Locations of Wells

The NoVOCs™ system will consist of six wells placed along the axis of the plume. Tentative locations are as follows:

- East of the shoe repair shop, near existing recovery well RW-1;
- North of the Agway office near existing monitoring well MW-7;
- Along the right-of-way on the east side of Whaley Avenue, approximately 20 ft north of existing monitoring well MW-2;
- Along the north side of the Library property, approximately 20 ft west of the right-of-way along the west side of Whaley Avenue;
- South of House 23; and
- West of House 23 near existing recovery well RW-3.

The final locations will depend on access considerations. As much as possible, we tried to select well locations near existing wells, assuming that access to these locations will be possible.

The design of the well network is based on a calculated region of influence having a longitudinal spacing of approximately 100 ft. This value allows the entire plume to be treated using only five wells, if the wells can be optimally located. This optimal design, however, would require locating a well in Whaley Avenue. We assumed that this was not possible, therefore we designed a six well system.

The lateral influence of the NoVOCs wells is greater than their longitudinal influence. The lateral influence, therefore, will be greater than the 80-ft plume width, permitting the NoVOCs wells to be located away from the axis of the plume, if needed.

The 100 ft longitudinal influence was selected through numerous iterations to achieve the optimal system design. With NoVOCs™ wells, there is initially a rapid increase in the radius of influence accompanying an increase in the pumping rate. However, the rate of increase of the radius of influence then begins to decrease and ultimately flatten out at progressively higher pumping rates. At this site, to increase the region of longitudinal influence beyond 100 ft would require an excessive increase in the pumping rate.

2.2 Well Design

The pumping rate that will be required to achieve the 100-ft longitudinal influence will depend on the hydraulic conductivity at the well location. As noted previously, the hydraulic conductivity varies across the site. The required pumping rate would range from approximately 4 gpm for a hydraulic conductivity of 2 x 10^{-3} cm/sec to 140 gpm for a conductivity of 9 x 10^{-2} cm/sec.

Because of the range of possible pumping rates, more than one well design was necessary. Several factors had to be considered in developing the designs for different pumping rates. The primary factor was the mass transfer (i.e., stripping) efficiency. The in-well distance available for stripping is limited by the thickness of the vadose zone and aquifer. As the pumping rate increases, it is necessary to increase the diameter of the well to accomplish the necessary mass transfer within the available distance. The well diameter and pumping rate also impact the efficiency of the air-lift pumping. If the well diameter is too large in relation to the pumping rate, the efficiency of the pumping is decreased. This decreased efficiency results in higher air injection pressures and higher power costs.

Based on these considerations, the following well designs were developed. For flow rates greater than 40 gpm, the well will have an eight inch diameter. For flow rates less than 40 gpm, the well will have a six inch diameter. For flow rates less than 15 gpm, the six inch diameter well will be fitted with a four inch diameter eductor pipe. All wells will have a lower screen from the interval 23 to 28 ft bgs and an upper screen from the interval one to ten ft bgs. The six and eight inch wells will be equipped with two inch diameter air lines. The wells with the four inch eductors will be equipped with 1.5 inch diameter air lines. The length of the air line will depend on the pumping rate and required submergence. The static submergence should range from 8 to 10 ft for most pumping rates, resulting in-well air line lengths of 17 to 19 ft. The well head will be located in a vault completed at grade. General schematics of the two well designs are presented in Figures 1 and 2.

Boring logs from the site indicate that the vadose zone material is generally less permeable than the aquifer material. For this reason, recharge of treated water is a concern. To enhance recharge, the wells will be constructed with a high permeability infiltration gallery in the vadose zone around the wells. To construct the infiltration galleries, the vadose zone material will be excavated to the water table. The excavation will have nominal dimensions of five feet by five feet by ten feet. After the excavation is completed, a length of temporary casing will be set from the water table to the surface. The excavation will then be backfilled with clean gravel. The borehole for the NoVOCs™ well will be drilled through the temporary casing. The temporary casing will be pulled when the NoVOCs well is completed.

A monitoring point will be installed to sample the water flowing into the well. For the six inch diameter wells, the monitoring point will be placed immediately outside and adjacent to the well casing and will be screened in the same interval as the NoVOCs™ well. For the eight inch diameter well, the monitoring point will be placed inside the well and will not be screened. A monitoring point will also be installed in the infiltration gallery of each well to sample effluent and monitor the water level in the infiltration gallery. Pitot tubes will be installed below the bubble diffusers to measure pumping rates in each well.

2.3 Pumping Rates and Treatment Efficiency

Three different pumping rates are specified by the design for this proposal -- 5, 20, and 80 gpm. These pumping rates correspond to the range of hydraulic conductivities reported for the site. The 5 gpm pumping rate will use a six inch well with a four inch eductor pipe and will operate with an air to water ratio (AWR) of 20:1. The 20 gpm pumping rate will use a six inch well with no eductor pipe and have an AWR of 15:1. The 80 gpm pumping rate will use an eight inch well and have an AWR of 15:1.

The contaminant removal efficiencies per treatment cycle for these designs are presented in Table 2. These removal efficiencies are high enough to reduce all contaminants to the target cleanup levels. The design was based on meeting cleanup levels with only four treatment cycles. The pumping rates and aquifer characteristics are expected to result in a much higher number of treatment cycles, in the range of 12 to 15. This results in a high safety factor for mass removal. With more treatment cycles, it is possible to use lower AWRs to meet the cleanup goals. However, lower AWRs will reduce the air-lift pumping efficiency and result in higher operating costs.

If the 50 µg/L alternate cleanup goal for PCE is used instead of 5 µg/L, the cleanup goal will be achieved sooner. This will result in O&M cost savings because of the shorter operating period. However, there will be no savings in capital costs, as the higher cleanup goal will not change the system design.

The time required for one treatment cycle will depend on the hydraulic conductivity and, hence, the pumping rate. The expected cycle times for these designs range from approximately six days for the 80 gpm well to 90 days for the 5 gpm wells.

The initial contaminant mass removal rates for the various flow rates are summarized in Table 3. These rates will decrease as treatment progresses.

2.4 Associated Equipment

For this proposal, we assumed that it will not be possible to run air lines across Whaley Avenue, so two separate air handling systems will be required. One will serve the three wells located east of Whaley Avenue and the other will serve the three wells located west of Whaley Avenue. Each system will consist of a regenerative blower for air injection, a regenerative blower for vacuum, a moisture separator, associated valves, controls, and piping. This equipment may be housed in trailers, sheds, cargo containers, or skids, depending on access considerations, aesthetics, and vandalism protection requirements. For this conceptual design, we assumed that trailers will be used.

For the conceptual design, we assumed that off-gas treatment will not be required. Initial estimated concentrations of contaminants in off gas are presented in Table 4. If these levels are high enough to require treatment, granular activated carbon (GAC) units can be placed in the equipment trailers. Also, because of the presence of petroleum product contamination at this site, we assumed that explosion-proof electrical equipment will be required.

Table 2. Summary of Contaminant Removal Efficiencies for Various Flow Rates

Flow Rates	6-in. Well With 4-in. Eductor	6-in. Well	8-in. Well
Pumping Rate, gpm	5	20	80
AWR	20	15	15
Removal Efficiency per Treatment Cycle			
PCE	89%	86%	86%
TCE	82%	77%	77%
11DCE	98%	98%	98%
12DCE	83%	78%	78%
VC	95%	94%	94%

Table 3. Summary of Initial Contaminant Removal Rates

Flow Rates	6-in. Well With 4-in. Eductor	6-in. Well	8-in. Well
Pumping Rate, gpm	5	20	80
AWR	20	15	15
Removal Rate, lb/day per well			
PCE	0.44	1.7	6.78
TCE	0.014	0.052	0.21
11DCE	0.0011	0.0045	0.018
12DCE	0.0041	0.015	0.061
VC	0.014	0.054	0.22

Table 4. Summary of Estimated Initial Contaminant Concentrations in Off Gas

	Eastern System	Western System
Air Flow Rate, cfm	260	44
Contaminant Concentration, ppmv		
PCE	66	52
TCE	3	2
11DCE	<1	<1
12DCE	<1	<1
VC	6	4

The locations of the air equipment trailers will depend on site access considerations. For this proposal, we assumed that the system for the three wells east of Whaley Avenue will be located near the center well, north of the Agway office. The air injection and vacuum lines to the western-most of the three wells (along Whaley Avenue) will be buried underground. The air injection and vacuum lines to the eastern-most of the three wells (near existing well RW-1) will run above-ground around the Dubois Hardware and Shoe Repair buildings. We assumed that the trailer for the three wells west of Whaley Avenue will be located at the northwest corner of the Library property, at the location of the western-most of the three wells (near existing well RW3). Air injection and vacuum lines to the other two wells will be buried underground.

2.5 Retrofit

We evaluated the possibility of retrofitting the existing recovery well RW-1 to a NoVOCs™ design. Unfortunately, the design of this well does not lend itself to easy retrofit. The problem will be in installing a recharge screen. If the existing screen extended from the bottom of the aquifer to the water table, it would be possible to use the bottom portion of the screen for intake and the top portion for recharge. The zone between these two intervals would then be packed off and an eductor pipe placed in the well for stripping.

With the limited screen length of the existing well, it is necessary to install an upper screen interval. This would involve excavating the material away from the well in the vadose zone and replacing the existing casing with screen. Alternately, the top several feet of the well could be removed and lateral drainage lines installed for recharge. A potential problem with the use of drainage lines at this site is the presence of silt and clay layers in the vadose zone. These layers could interfere with recharge. It would be necessary to excavate through these layers and backfill with more permeable material.

Another limitation to the use of well RW-1 is its size (six inch). The pump test and boring log information for this location indicate that high pumping rates (i.e., greater than 50 gpm) are expected. The treatment and pumping efficiency of a six inch well will be limited with these pumping rates.

In summary, because of the costs and limitations associated with the retrofit design, retrofit is not a practical option for well RW-1.

3.0 PRICE

The price for the system described above in this proposal is **$150,540**. This estimate is based on the best available design information and includes:

- well drilling, installation, and development
- all air handling equipment
- labor to provide design specifications and drawings, oversee well installation and system startup, and provide technical support as needed during operation.

In developing the design for this proposal, we assumed that the three wells east of Whaley Avenue will consist of one eight inch, 80 gpm well and two six inch, 20 gpm wells. We assumed that the three wells west of Whaley Avenue will all be six inch with four inch eductor pipes, and 5 gpm each. Because of the flexibility of the well design, differences in pumping rates will have little impact on well price. The basic six inch well design can accommodate flows from less than 5 gpm up to 40 gpm. Based on review of the boring logs, we determined that the only location that will require the larger eight inch well is at the southeast end of the plume, near existing recovery well RW-1. Changes in pumping rates may result in changes in blower sizes. For the range of flows considered, however, price impacts should be minimal.

As described in Section 2.4, our proposed price is based on several assumptions for air handling equipment. Because our knowledge of the site is limited, we generally assumed the worst case. If these assumptions are too conservative, it may be possible to reduce the price for this equipment. For example, if the equipment can be housed in cargo containers rather than trailers, the price could be reduced approximately $10,000. If explosion-proof equipment is not required, the price could be reduced approximately $3,000. If it is possible to run buried air lines across Whaley Avenue and use one set of air equipment instead of two, the price could be reduced approximately $15,000.

The estimate includes the cost for containerizing drill cuttings and development water but does not include disposal costs for these materials. Also, we assumed that 220-volt, 3-phase power is available at each of the two equipment sites. The maximum power requirements will be 12.5 kw for the site east of Whaley Avenue and 2.7 kw for the site west of Whaley Avenue.

The estimated operating and maintenance (O&M) cost for this system is **$12,600/yr**. This cost includes only electrical costs, as no off gas treatment was included in the proposed design. The cost of electricity is assumed to be $0.10/kwh. This O&M cost does not include monitoring or inspections.

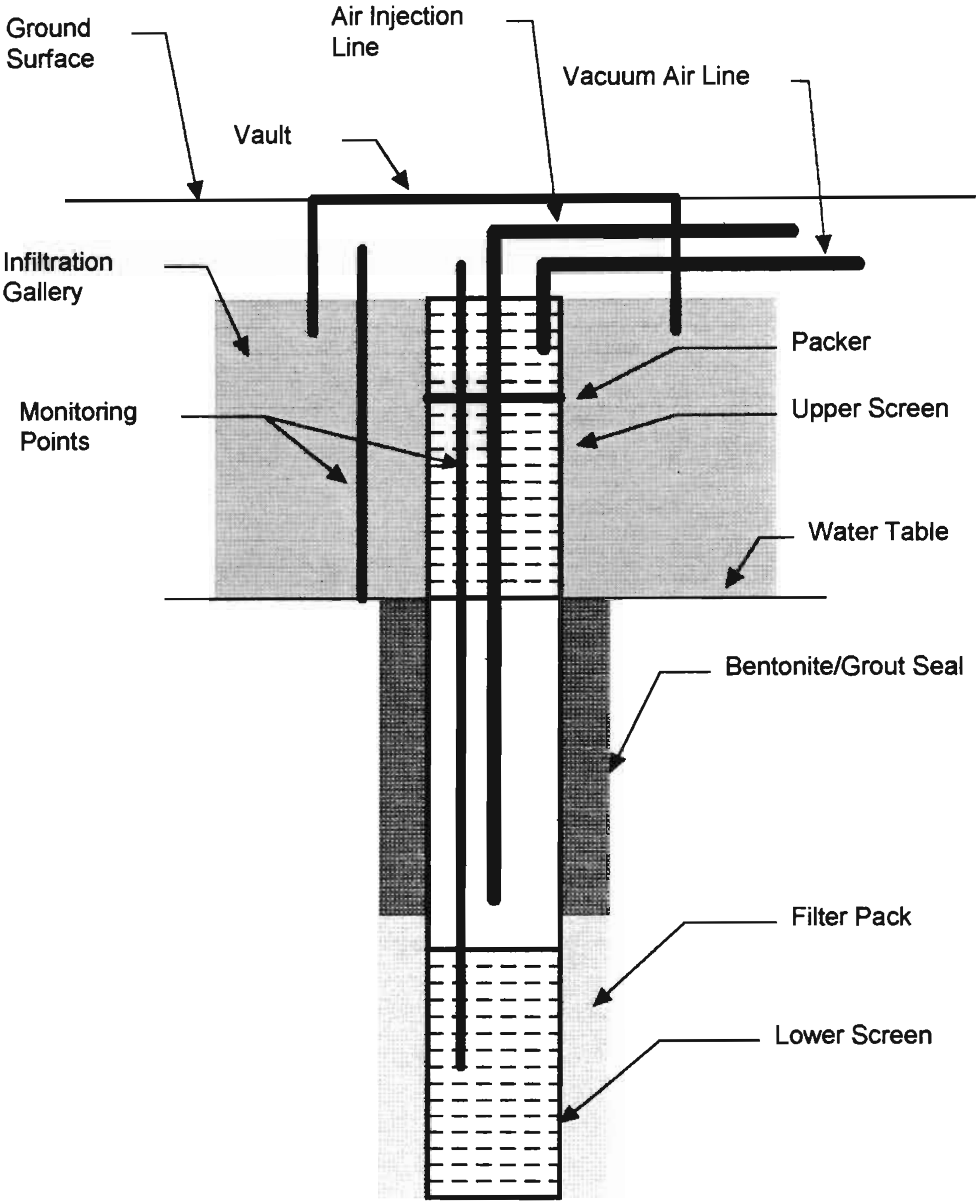


Figure 1. Schematic of 8-in. (High Flow) Well Design (Not to Scale)

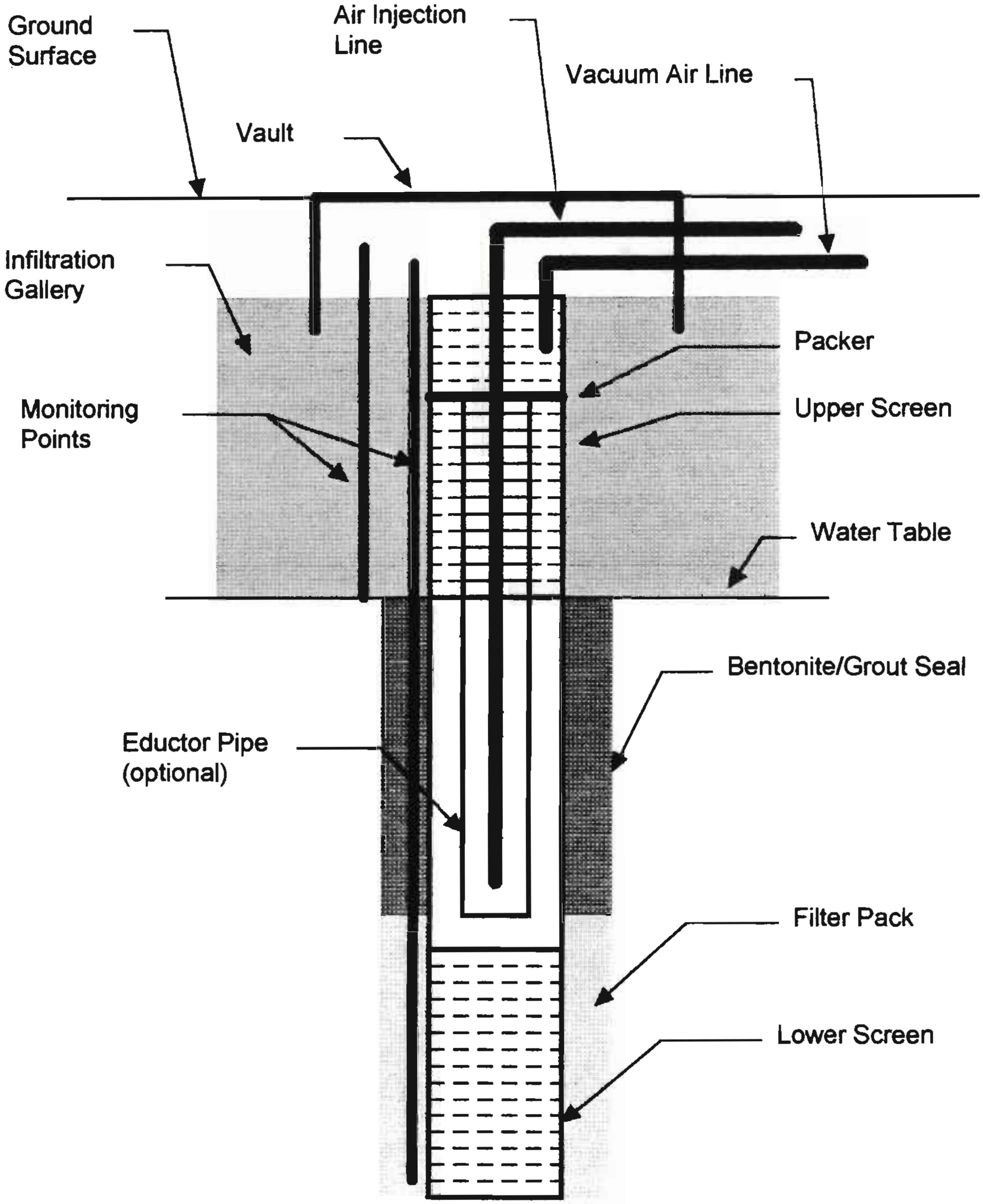
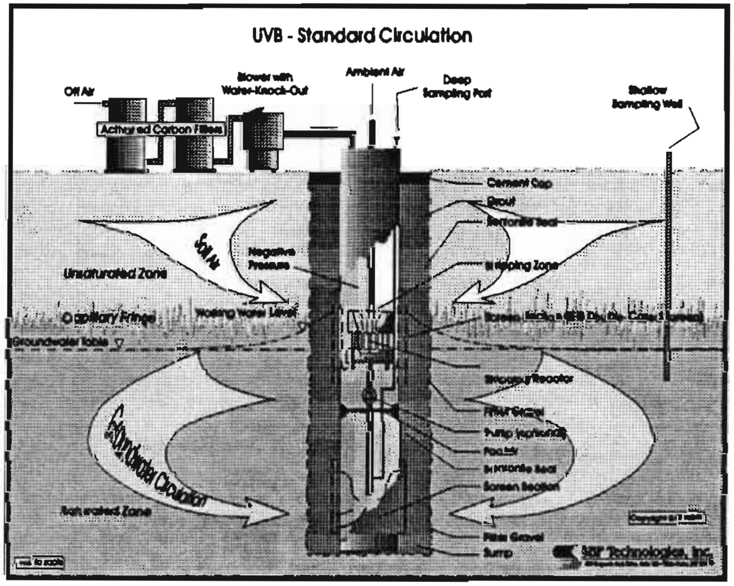


Figure 2. Schematic of 6-in. (Low Flow) Well Design (Not to Scale)

MR. "C" DRY CLEANERS
EAST AURORA, NEW YORK

Vertical Circulation Well Technologies



Vacuum Vaporizer Well (UVB)

SBP Technologies, Inc.
Environmental Engineers and Bioremediation Specialists

SBP Technologies, Inc.
142 Temple Street • New Haven, Connecticut 06510 • (203) 789-1260 • FAX (203) 789-8261

May 30, 1996

Mr. Robert O'Laskey
Malcolm Pirnie, Inc.
South 3515 Abbott Road
P.O. Box 1938
Buffalo, New York 14219

RE: Mr. "C" Dry Cleaners Site
East Aurora, New York
SBP #N6417.00

Dear Mr. O'Laskey:

SBP Technologies, Inc. (SBP) has reviewed the data which you submitted on May 22, 1996 regarding the above referenced site. SBP understands that the remediation action objectives are to:

- Mitigate human health risk by reducing the potential for vapor inhalation in off-site basements.
- To reduce the total volatile organic concentration in groundwater to less than 100 μg/l. This cleanup objective was identified in your correspondences to be sufficient to reduce risk.

The primary contaminant of concern (COC) is tetrachloroethene (PCE) and its associated biodegradation by-products. The reported source of the PCE was a sewer lateral connecting the dry cleaners with the Main Street sanitary sewer. The hydrogeologic conditions defined in your correspondences are summarized in Table 1.0 and were used as the basis of our conceptual concept and cost estimate.

Pursuant to our telephone conversation on May 28, 1996, SBP understands that the main area of interest is where the COCs are greater than 1,000 μg/l. The location of the plume extends from the source and has migrated to the northwest beneath residential homes and public property (i.e. library). Access may be an issue on the residential site but not on the library or at Mr. "C" Dry Cleaners. These issues were evaluated along with the action objectives to provide this preliminary conceptual concept.

SBP proposes to install three UVB-400 vertical groundwater circulation cells to be installed at the following locations:

- At the source area of the COC located at the upper (southeast) portion of the plume. Installation will be on the source property where access will not be an issue.
- At the northwesterly extent of the 1,000 μg/l plume boundary. The system would be installed in the small publically owned property west of the residential home.
- In the center of the plume just west of the access way on the upgradient side of the plume.

The placement of the three UVB systems (see attached) will provide: 1) source control; 2) prevent further migration of the plume; and 3) remediate groundwater concentrations directly upgradient of the residential home(s) reducing the COC concentration levels. The size of each UVB unit will have an effective radius of approximately forty feet based upon IEG's calculations. This configuration will provide contaminant containment and treatment for 240 linear feet of the estimated 500 linear feet of the plume where concentrations exceed 1,000 μg/l. The selection of these three locations was based upon the proximity of building and potential vapor migration routes. This concept allows for attenuation and dilution between the treatment circulation cells. An additional three units would be required to fully capture the entire plume, however a three UVB concept will reduce the contamination. In addition, the placement of the well screens can be designed so that the upper screen can be exposed to the vadose zone providing one way vapor extraction of the COC vapors. This multi-functional approach will meet the objective as you outlined.

SBP has provided a preliminary cost estimate for your review as shown in Table 2.0 based on our conversation. We have also estimated other costs (i.e. drilling, electric), however, these are not based on actual quotes and are considered preliminary. Once you have reviewed this conceptual concept and preliminary cost estimate, please do not hesitate to contact us if you have any questions at (203) 789-1260.

Very truly yours,

Robert G. Wasp, P.E.
Vice President/General Manager
Northeast Division

Richard J. Desrosiers
Senior Project Hydrogeologist

RJD/jd
1292K

Attachments

TABLE 1.0
SITE INFORMATION

- Depth to static water is 10 to 11 feet
- Water Table gradient is 0.004
- Horizontal hydraulic conductivity is 2.6 x 10^{-3} cm/sec in vicinity of library
- Vertical hydraulic conductivity is estimated to be 2.6 x 10^{-4} cm/sec in vicinity of library
- Average horizontal hydraulic conductivity 7 x 10^{-2} cm/sec in vicinity of dry cleaners
- Average vertical hydraulic conductivity 7 x 10^{-3} cm/sec in vicinity of dry cleaners
- Assumed direction of groundwater flow northwest
- Saturated thickness of the outwash aquifer 18 feet
- Stratigraphic location of outwash aquifer is 10 to 28 feet below land surface
- Outwash Aquifer is semi-confined to confined
- No LNAPL has been found at the site to date
- The lithology of the outwash aquifer ranges from silty fine sand to sand and gravel
- Maximum concentration of PCE is 8,200 ppb at monitoring well MPI-65
- Plume area designated as remediation zone is 500 feet by 80 feet by 18 feet

TABLE 2.0
UVB INSTALLATION AND OPERATING COSTS
MR. "C" DRY CLEANERS
East Aurora, New York

TASK	SBP Professional Fees	System Costs	Other Direct Expenses	Technical Support (IEG)	Laboratory Fees	Estimate Contracto Costs
PHASE I DESIGN INSTALLATION/STARTUP						
Task 1 - Remediation Strategy Meeting, Preparation of RAP	$2,500	--	$500	$1,000	--	
Task 2 - Preparation of HASP	$2,000	--	--	--	--	
Task 3 - Final Design	$15,000	--	--	$3,000	--	
Task 4 - Installation of 3 UVB-400 Systems (2 weeks)[1]	$27,000	$247,800	$5,000	$4,000	$2,500	$42,000 ($0,000 ($6,000 (
Task 5 - Baseline Sampling (System Sampling)	$2,500	--	$1,000	--	$1,000	
Task 6 - Permitting (by client)	$2,000	--	--	--	--	
Task 7 - System Startup (1 week)	$7,500	--	$1,000	--	--	
SUBTOTAL	$58,500	$247,800	$7,500	$8,000	$3,500	
				TOTAL PHASE I	$325,300	
PHASE II ANNUAL OPERATION/QUARTERLY MAINTENANCE/MONITORING						
Task 1 - Effectiveness Monitoring and Sampling[2]	--	--	--	--	--	
Task 2 - Operation and Maintenance (3 quarterly visits)	$18,000	--	$2,500	--	--	
Task 3 - Progress Reporting/Project Management/ Data Tabulation	$24,000	--	$500	--	--	
SUBTOTAL	$42,000	$0	$3,000	$0	$0	
				TOTAL PHASE II	$45,000	

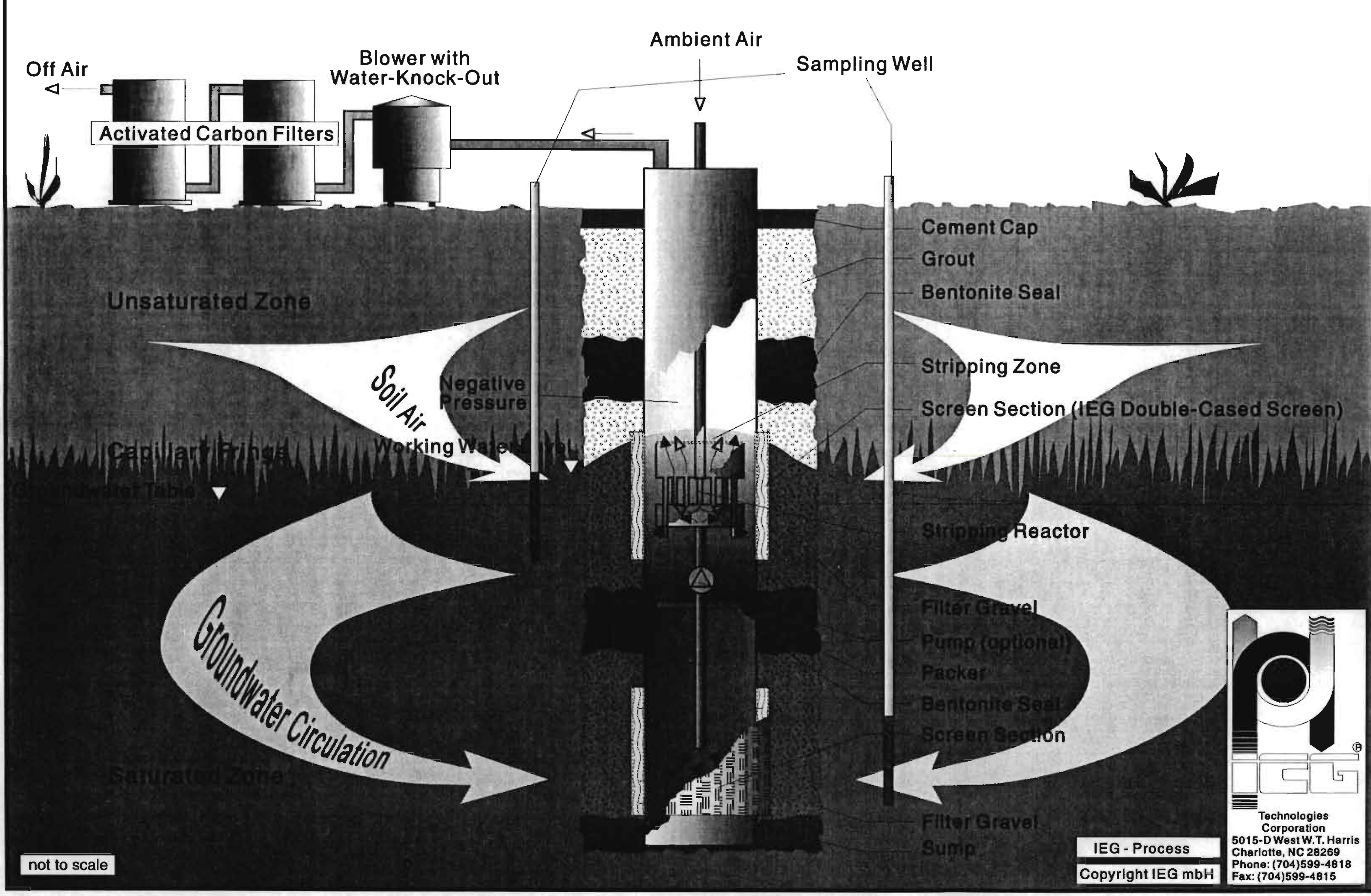
Notes:

[1] Costs based on 3 UVB wells, assume adequate monitoring network.

[2] Sampling completed by client.

Estimated Contractor Costs
- (D) Drilling Contractor ($400-$500/LF)
- (C) Granular Activated Carbon not estimated; carbon us will be evaluated based on off-gas permit requireme
- (E) Electrical Contractor (estimated at $2,000/unit); assumes three phase power is available at the well

UVB - Standard Circulation



UVB (Vacuum Vaporizer Well)

Possible Areas of Application
The UVB is an in situ system for remediation of contaminated aquifers, especially those contaminated with volatile and semi-volatile hydrocarbons or heavy metals, and uses a combination of chemical, physical and biological processes. UVB is a process patented by IEG® Industrie-Engineering-GmbH, Reutlingen, Germany.

Description of Method

Primary Components
A UVB system consists of a specially adapted groundwater well, a negative pressure stripping reactor, an above-ground mounted blower, and a waste air decontamination system, for example disposable filters or regenerative activated carbon filters.

Principle of Operation
The water level rises inside the well due to a negative pressure generated by a blower. Fresh air is drawn into the system through a pipe leading to the stripping reactor and pearls up through the raised water. The rising air bubbles enhance the suction effect at the well bottom (air-lift pump).

Dry Air
As a result of the concentration gradient, the contaminants vaporize into the air bubbles and are removed from the well by the air flow. The continuous expansion of the air bubbles when passing through the stripping zone causes adiabatic cooling, which results in a decrease of the relative humidity of the withdrawn air.

Efficient Use of Activated Carbon Filter
When the contaminated exhaust air passes through the activated carbon filter, no water condensation occurs due to the low humidity of the air. Therefore, a significantly greater part of the activated carbon filter can by utilized for adsorption of pollutants as compared to conventional air stripping.

Air-Lift-Effect
The rising of the air bubbles supplements the lifting effect of the negative pressure and further elevates the groundwater within the well. The subsequent fall of the groundwater along the walls of the well produces a significant hydraulic pressure.

Transport within the Well
By adding a support pump to the UVB system, a specific flow direction can be induced, which produces a vertical flow either upward or downward within the well. The oscillating hydraulic pressure forces the water horizontally into the aquifer through the top screened segment of the well. In the surrounding aquifer, a circulation develops with water entering at the base of the well and leaving through the upper screened segment or vice versa, depending on the desired flow direction.

Sphere of Influence
A flow pattern with a calculable horizontal and vertical component is produced in the aquifer to compensate for the directed water flow within the UVB well. Non linear frequencies produced by the bursting air bubbles inside the well are transmitted as pressure waves to the surrounding subsoil. They enhance diffusion of contaminants into the groundwater, which are subsequently incorporated into the UVB circulation and then treated in the well. Thus, treated groundwater circulates through the sphere of influence (within the aquifer) before returning to the well.

Simultaneous Soil Air Venting
The UVB method is capable of extracting soil air during groundwater treatment. The amount of soil air and groundwater passing through the decontamination system can be adjusted according to the type of contamination and the well construction.

Carbon Service Company

Carbon Service & Equipment Company

P.O. Box 838 • Donora, PA 15033 • Phone 412-379-8032 • Fax 412-379-7780

FAX COVER SHEET

TO: Mary Christie

FROM: Bob Wright

DATE: May 13, 1996

PAGES:

SUBJECT: Mr. C Cleaners project

Mary

Here's what I worked on a couple of months ago w/ Beena.
Call if I can help with anything.

Bob

MALCOLM PIRNIE, INC.
S. 3515 Abbott Road
P.O. Box 1938
Buffalo, New York 14219
Tele: 716/828-1300
FAX: 716/828-0431

TO: BOB WRIGHT.

OF: Carbon Svc. Co.

FAX NO.: 412 379 7780.

RE: Groundwater Remediation Project.

FROM: BEENA PRABHU.

DATE: 1/30/96.

TIME:

JOB NUMBER:

NUMBER OF PAGES (INCLUDING THIS SHEET): 2

RETURN ORIGINALS TO SENDER (CIRCLE ONE) [✓ YES] NO

MESSAGE: Bob:

Attached is information on the Air stripper that will be used. It gives you information on contaminants and max loadings to air that will have to be handled by the carbon system. Pl. recommend a system and give us capital and all other related costs. Pl. call me if you have any questions.

Beena

PRIVILEGE AND CONFIDENTIALITY NOTICE

If you do not receive all pages or if portions are illegible please call 716-828-1300 for retransmission.

MR. C CLEANERS SITE
COMPARISON OF ANTICIPATED STACK CONCENTRATIONS TO DRAFT AIR GUIDE 1 LIMITS

STANDARD POINT SOURCE METHOD (1)

STACK HEIGHT = 90 FEET

GROUNDWATER AVERAGE FLOW RATE 95 GPM

MAXIMUM HISTORICALLY OBSERVED INFLUENT CONTAMINANT CONCENTRATIONS

SINGLE TREATMENT SYSTEM

10A

CONTAMINANT	MAXIMUM INFLUENT WATER CONC. (mg/l)	EFFLUENT WATER CONC. (mg/l)	NET (mg/l)	MAX WATER FLOW RATE (GPM)	MASS TRANSFER TO AIR (mg/min)	BLOWER CAP. (cfm)	STACK AIR CONC. (mg/cu m)	Q MASS TRANSFER TO AIR (lbs/hr)	STACK HT (2) (FT)
PCE	8.200	0	8.200	95	2950.76	2400	43.401	3.90E-01	90
Vinyl Chloride	0.240	0	0.240	95	86.36	2400	1.270	1.14E-02	90
1,1-Dichloroethene	0.019	0	0.019	95	6.84	2400	0.101	9.04E-04	90
1,2-DCE (Total)	0.082	0	0.082	95	29.51	2400	0.434	3.90E-03	90
TCE	0.280	0	0.280	95	100.76	2400	1.482	1.33E-02	90
1,2-dichloropropane	0.003	0	0.003	95	1.08	2400	0.016	1.43E-04	90
1,1,1-TCA	0.014	0	0.014	95	5.04	2400	0.074	6.66E-04	90
Benzene	3.200	0	3.200	95	1151.52	2400	16.937	1.52E-01	90
Toluene	0.740	0	0.740	95	266.29	2400	3.917	3.52E-02	90
Ethylbenzene	0.430	0	0.430	95	154.73	2400	2.276	2.05E-02	90
Xylene	1.900	0	1.900	95	683.71	2400	10.056	9.04E-02	90
Chlorobenzene	0.003	0	0.003	95	1.08	2400	0.016	1.43E-04	90
Chloroform	0.003	0	0.003	95	1.08	2400	0.016	1.43E-04	90
Methylene Chloride	0.120	0	0.120	95	43.16	2400	0.635	5.71E-03	90

(1) NYSDEC Air Guide-1 Appendix B, Revised April 4, 1994.

(2) Stack height is greater than or equal to 2.5 times the building height, thus, maximum actual and potential impacts are reduced by 60% (i.e., Ca and Cp are multiplied by 0.4).

(3) Ca = (6.0*Qa/h**2.25)*0.4

Where:

Ca = Maximum Actual Annual Impact

Qa = Annual Emission Rate (lb/yr), assumed to be hourly emission rate*8760 hour/yr

h = Effective Stack Height

(4) Cp = (52500*Q/h**2.25)*0.4

Where:

Cp = Maximum Potential Annual Impact

Q = Hourly Emission Rate (lb/hr)

h = Effective Stack Height

(5) AGC = Air Guide-1 Annual Guidance Concentration

(6) SGC = Air Guide-1 Short Term Guidance Concentration

Carbon Service & Equipment Company

P.O. Box 838 • Donora, PA 15033 • Phone 412-379-8032 • Fax 412-379-7780

FAX COVER SHEET

TO: Beena Prabhu

FROM: Bob Wright

DATE: February 2, 1996

PAGES:

SUBJECT: Mr. C cleaners project

Beena

Sorry for the delay in responding, but was quite backed up when you called. Anyway, we are looking at a mass of about 525 lbs. of organic per month for treatment. We believe Benzene may be the limiting factor, in terms of organic breakthrough and have based our calculations accordingly. We wold estimate 4,500 to 6,500 lbs. of carbon consumption each month, if the concentrations are accurate and the system runs continuously. Also, the relatively high flow rate of 2,400 cfm is a design factor. We have two choices for your initial consideration.

The least expensive scenario is the use of (2) AIR 5000 POLY adsorbers operating in a parallel, single stage mode. The cost is $ 22,000.00 for (2) units delivered to the site with reactivated carbon fill to M-P direct. We have a lead time of (4-6) weeks for fabrication, prior to delivery.

The second choice is a single, AIR 10,000 vapor phase adsorber, manufactured from steel. This single unit can adequately handle the 2,400 cfm without significant pressure drop. The cost for an AIR 10,000 delivered to the site with reactivated carbon fill is $ 41,600.00 and there is a lead time of (8) weeks from order. We will need a crane to unload and fill the unit at the site and this cost is not included.

Call if I can help with questions.

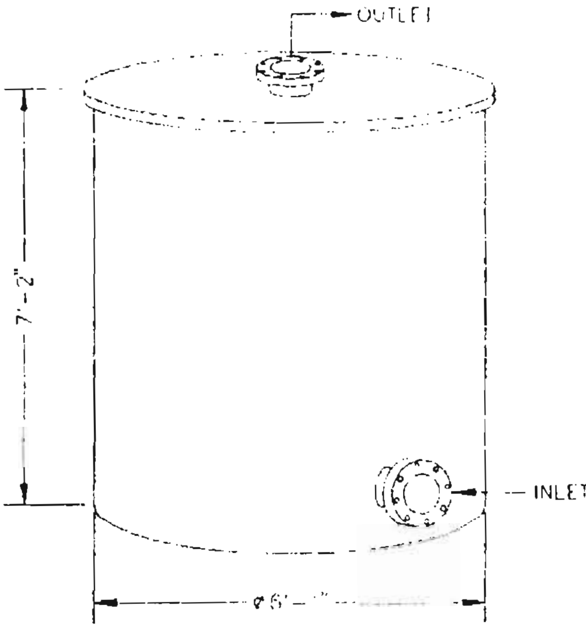
Bob

Carbon Service Company

AIR 5000 POLY

Vapor Phase Adsorber

TYPICAL FLOWS	300 to 1,800 cfm
MAXIMUM SUGGESTED FLOW#	2,400 cfm
MAXIMUM PRESSURE	1.5 psi
MAXIMUM TEMPERATURE	150°F



STANDARD FEATURES

- 5,000 lbs. domestic source virgin 4 x 10 mesh carbon, coal or coconut base, 60 min. CCl_4 activity.
- Heavy duty corrosion resistant vessel available only from CSC.
- Over 4,180 in^2 of surface area for superior air distribution and the lowest pressure drops.
- 8" flange inlet and outlet connections.
- 100% carbon utilization for increased service life and lower maintenance costs.

OPTIONAL FEATURES

- Top quality reactivated 4 x 10 mesh coal or coconut base carbon. (-$ 2,000.00
- Condensate drain line. (+$ 75.00)
- Alternate custom connections available.
- Hard piping systems. Call for details.
- Flexible hose assemblies.
  - 8" x 10' (+$ 185.00)
  - 8" x 20' (+$ 270.00)

(#) Based on minimum accepted contact times and single stage operation. May not be effective in all applications.

P.O. Box 838 • Donora, Pennsylvania 15033 • Phone 412-379-8032 • Fax 412-379-7780

Carbon
Service
Company

AIR SERIES POLY

Vapor Phase Adsorbers

Carbon Service & **Equipment Company** manufactures [illegible] vapor phase activated carbon adsorbers to benefit today's popular applications like low profile air strippers, and soil vent off-gas treatment. AIR Series POLY units offer the lowest cost vapor phase adsorbers available, without sacrificing performance and quality. The product line features our "false bottom" engineering and are manufactured to achieve the lowest possible pressure drops. This is accomplished without the use of expensive gimmicks, like radial flow designs. The vessels are fabricated HDPE and utilize the same design features as our original steel AIR Series equipment. Refer to the application chart below or call today to discuss how we may assist your environmental efforts.

MODEL	TYPICAL FLOW ☺ RATES	PRICE with Virgin 4 x 10 Coal or Coconut CARBON	PRICE with Reactivated 4 x 10 Coal or Coconut CARBON	DELIVERY & SET-UP CHARGE*
AIR 1000 POLY	100-800 cfm	$ 3,500.00	$ 3,100.00	$ 450.00/unit
AIR 1500 POLY	150-1,000 cfm	$ 5,025.00	$ 4,425.00	$ 550.00/unit
AIR 2000 POLY	200-1,400 cfm	$ 6,200.00	$ 5,400.00	$ 650.00/unit
AIR 3000 POLY	250-1,750 cfm	$ 8,650.00	$ 7,450.00	$ 800.00/unit
AIR 5000 POLY	300-1,800 cfm	$ 13,075.00	$ 11,075.00	$ 1,050.00/unit
AIR 8000 POLY	300-1,500 cfm	$ 17,800.00	$ 15,400.00	$ 1,400.00/unit

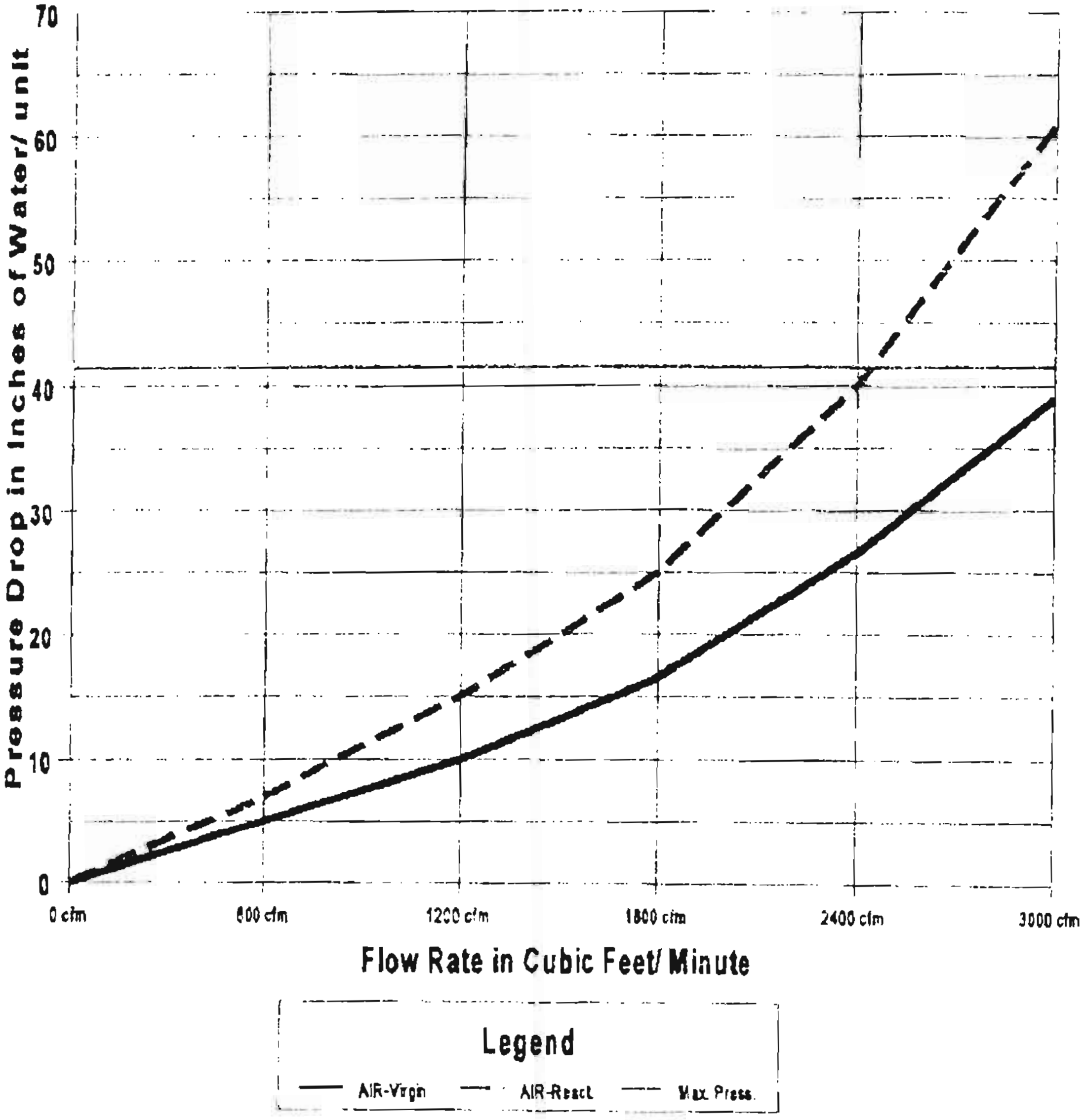
Ship point: Donora, PA 15033. Prices effective 1-1-95 and are subject to change.

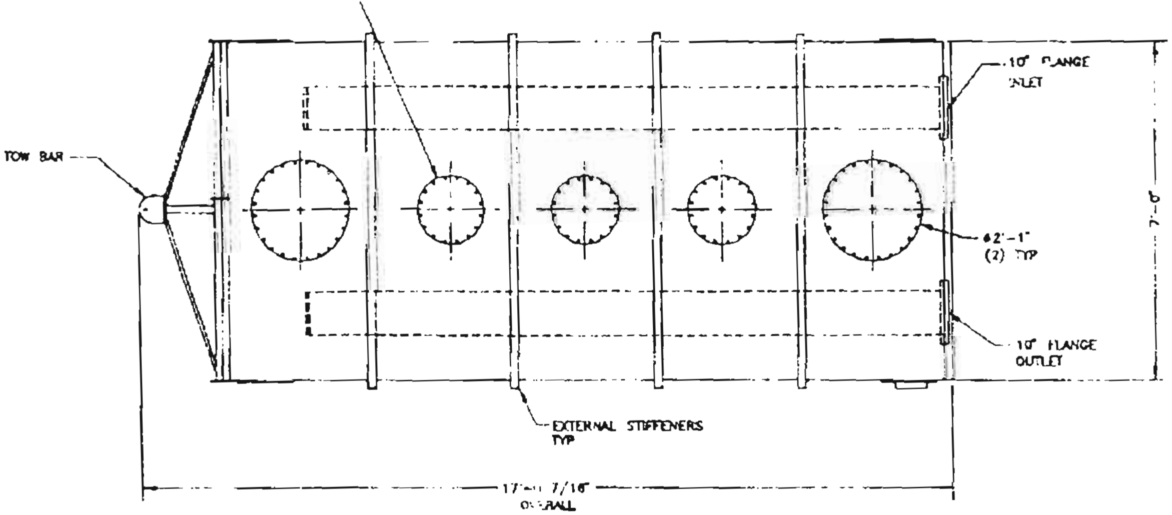
(☺) Rates shown are typical application for our standard AIR Series POLY equipment. The AIR POLY High Flow units can process higher flows. See the AIR Series POLY High Flow specification sheets for details.

(*) Please refer to the **Service Zone** bulletin (page II) in the front section of the **catalog** for our liftgate delivery and set-up zone. Discounts apply to local work. Deliveries outside our service zone are also available at additional cost.

AIR 5000 Poly

Pressure Drop Curve



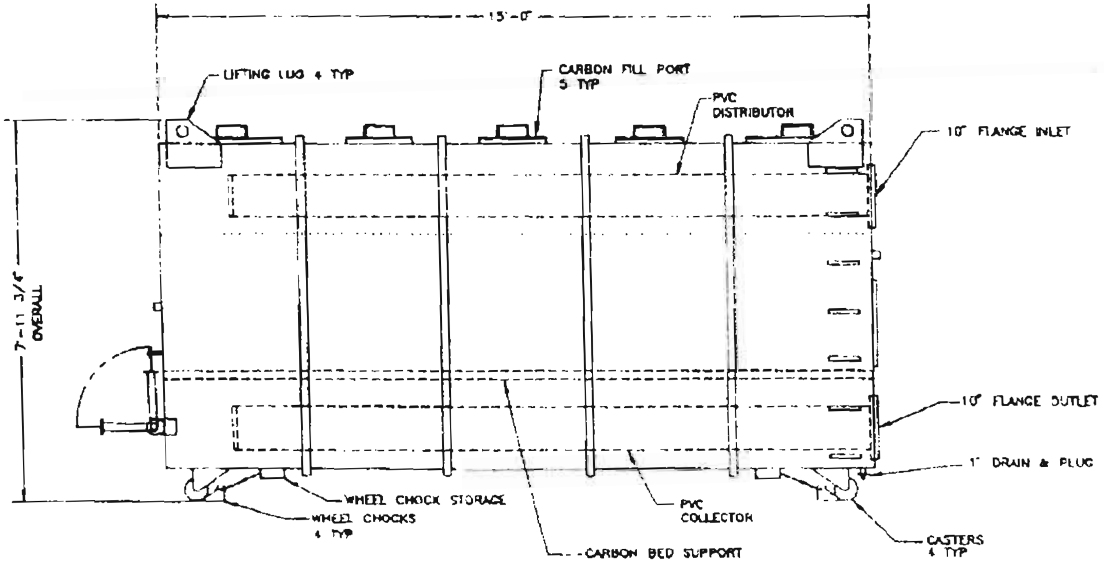


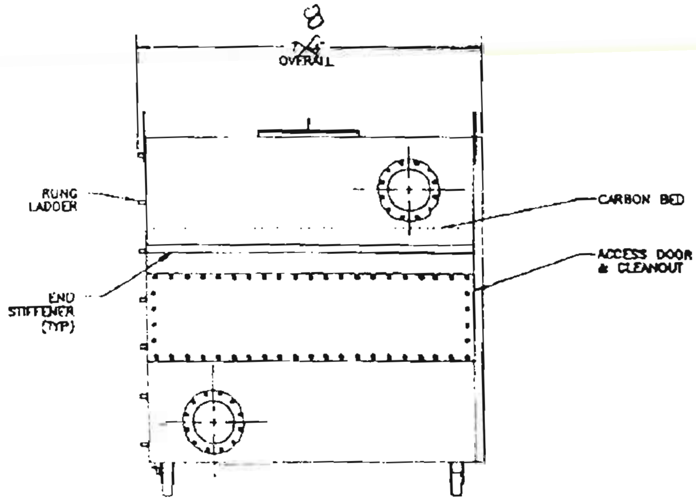
NOTES:
1) ESTIMATED WEIGHTS
DRY WEIGHT 5500 LBS.
OPERATING WEIGHT 15500 LBS.

2) PAINT SPECIFICATIONS, INTERIOR AND EXTERIOR
EXTERIOR SURFACE PREPARATION SP-5
ONE COAT SHERWIN-WILLIAMS PRIMER
ONE FINISH COAT INDUSTRIAL TILE CLAD II
COLOR SLATE GRAY MC-71

3) DESIGN FLOW: 1500 SCFM
DESIGN PRESSURE: ± 10" W.C.

4) CARBON FILL: 2000 LBS. PER PORT
10000 LBS.TOTAL





DRAWN CB DATE 10/27/91
CHECKED
APPROVED

ENCOTECH
1st & Washington [illegible] Industrial Park
Donora, PA 15033 412-379-[illegible]

10,000# VAPOR PHASE
ACTIVATED CARBON
ADSORBER

SCALE NTS
DRAWING NO. GP-10000
SHEET 1 of 1
REV. 00

Carbon
Service
Company

AIR SERIES EQUIPMENT

Carbon Service & Equipment Company manufactures **Air Series** vapor phase activated carbon adsorbers to meet the needs of many demanding applications. The Air Series product line features our "false bottom" engineering and are manufactured to offer the highest flow rates, without expensive gimmicks like radial design. Another benefit of false bottom engineering is the lowest possible pressure drops. Our design eliminates the need for expensive auxiliary blowers to overcome the excessive pressure drop associated with many competitive units. Total utilization of the carbon is another benefit of this technology. These features are intended to assists popular applications like soil venting and air stripper off-gas treatment, where flow rates and carbon consumption can be critical. Refer to the application chart below or call today to discuss how we may assist your environmental efforts.

MODEL	TYPICAL FLOW RATES	PRICE with Virgin 4 x 10 Coal or Coconut CARBON	PRICE with Reactivated 4 x 10 Coal or Coconut CARBON	DELIVERY & SET-Up CHARGE*
AIR 175	5-100 cfm	$ 505.00	$ 440.00	$ 80.00/unit
AIR 275	20-150 cfm	$ 830.00	$ 720.00	$ 100.00/unit
AIR 375	40-250 cfm	$ 1,030.00	$ 880.00	$ 125.00/unit
AIR 1000	50-1,000 cfm	$ 4,695.00	$ 4,295.00	$ 450.00⊠
AIR 1800	50-1,000 cfm	$ 6,960.00	$ 5,980.00	$ 600.00⊠
AIR 2500	100-2,000 cfm	$ 8,725.00	$ 7,825.00	$ 750.00⊠

Ship point: Donora, PA 15033. Prices effective 1-1-95 and are subject to change.

( ) Rates shown are typical application for our standard AIR Series equipment. The High Flow Series can process higher flows. See individual specification sheets for details.

(*) Please refer to the **Service Zone** bulletin (Page II) of the catalog for our liftgate delivery and set-up zone. Discounts apply to local work. Deliveries outside our service zone are also available at additional cost.

(⊠) Fork truck required to deliver and install this equipment.

Carbon Service Company
Carbon Service & Equipment Company
P.O. Box 838 • Donora, PA 15033 • Phone 412-379-8032 • Fax 412-379-7780

FAX COVER SHEET

TO: Mary Christie

FROM: Bob Wright

DATE: May 15, 1996

SUBJECT: On-site carbon changeout service for the Mr. C project

Mary

We can offer a complete package of freight, labor and materials to keep the system up and running. We offer on-site carbon changeout service, based on the vacuum removal of the spent carbon. We vacuum the spent directly from the adsorbers into steel vacuum tanks or RCRA rated steel drums, which we supply. We are anticipating a RCRA Hazardous Waste classification for the spent carbon, based on the chlorinated organics present and their close scrutiny under the regulations. Our service is based as such. We can expect to have to store spent carbon on-site for about a month, from the time of the first changeout, until the reactivation facility can accept the new Waste stream. Our RCRA steel drums are typically used for this process and ultimately to ship the spent off-site for thermal reactivation. Future loads of spent can be managed for prompt shipment, after initial acceptance is complete. We will supply OSHA 40 hr. Certified technicians to perform the work and all activities will be scheduled in advance.

The price for a complete changeout service with RCRA freight and reactivation is $ 12,600.00 on a 10,000 lb. project. The price is based on reactivated coal base replacement carbon supply. The price for the same work with virgin coal base replacement carbon is $ 17,100.00. The same work with virgin coconut shell carbon is priced at $ 17,900.00 complete. Initial acceptance fee for reactivation is approximately $ 1,150.00.

Please call if I can help with any questions.

Bob

Carbon Service Company

Carbon Service & Equipment Company

P.O. Box 838 • Donora, PA 15033 • Phone 412-379-8032 • Fax 412-379-7780

FAX COVER SHEET

TO: Tom Forbes

FROM: Bob Wright

DATE: May 23, 1996

PAGES:

SUBJECT: Mr. C's project - Carbon Usage w/ In-Situ Air Stripping

Tom

350 cfm ? ✓

We would expect 2,500-4,000 lbs. of carbon consumption per month, with vinyl chloride being the limiting factor for the system. The usage rate is lower than before, but because it is still reasonably high, I don't know that I would switch from the original system of (2) AIR 5000 POLY adsorbers. Given the likelihood of a RCRA Hazardous spent carbon classification, we need to minimize service and freight expenses by putting larger equipment on-line.

Call if I can help with any questions.

Bob

Pittsburgh, Pennsylvania • Jacksonville, Florida • New Haven, Connecticut

Table 2. Summary of Contaminant Removal Efficiencies for Various Flow Rates

Flow Rates	**6-in. Well With 4-in. Eductor**	**6-in. Well**	**8-in. Well**
Pumping Rate, gpm	5	20	80
AWR	20	15	15
Removal Efficiency per Treatment Cycle			
PCE	89%	86%	86%
TCE	82%	77%	77%
11DCE	98%	98%	98%
12DCE	83%	78%	78%
VC	95%	94%	94%

Table 3. Summary of Initial Contaminant Removal Rates

Flow Rates	**6-in. Well With 4-in. Eductor**	**6-in. Well**	**8-in. Well**
Pumping Rate, gpm	5	20	80
AWR	20	15	15
Removal Rate, lb/day per well			
PCE	0.44	1.7	6.78
TCE	0.014	0.052	0.21
11DCE	0.0011	0.0045	0.018
12DCE	0.0041	0.015	0.061
VC	0.014	0.054	0.22

Table 4. Summary of Estimated Initial Contaminant Concentrations in Off Gas

	Eastern System	**Western System**
Air Flow Rate, cfm	260	44
Contaminant Concentration, ppmv		
PCE	66	52
TCE	3	2
11DCE	<1	<1
12DCE	<1	<1
VC	6	4

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RHO DATE 5-23-96 SHEET NO. .... OF ....

CHKD. BY .... DATE .... JOB NO. ....

SUBJECT NoVOCs Air Emission Costs

Basis: Predicted loading to air stream calculated by EG + G for 6 NoVOCs wells

350 CFM Blower

Carbon Services Company estimate - Bob Wright.

Capital Costs:

Assume: (2) AIR 5000 POLY leading canisters operating in parallel and

(2) AIR 5000 POLY trailing canisters

Total of (4) AIR 5000 POLY

Larger size recommended to reduce changeout c
(viz. frequency of changeout)

(1) AIR 5000 POLY	13,075
Setup	1,050
	14,125 x 4 = 56,500

O & M:

Usage Estimated by Carbon Serv Co @ 2500-4000/mon

1 x 10,000 lb changeout is 12,600

Leading 2 canisters will require a changeout ;

$$\frac{1 \text{ changeout}}{10{,}000 \text{ lbs}} \times \frac{4000 \text{ lbs}}{\text{month}} \times \frac{12 \text{ mo}}{\text{yr}} = 4.8 \ \frac{\text{changeouts}}{\text{year}}$$

@ 2500 lbs/mo = 3 changeouts/y

\$12,600 x 5/yr = \$63,000/yr.

FACSIMILE TRANSMITTAL

MALCOLM PIRNIE, INC.
S. 3515 Abbott Road
P.O. Box 1938
Orchard Park, New York 14127
Tele: 716/828-1300
FAX: 716/828-0431

TO: Bob Wright

OF: Carbon Service Company

FAX NO.: 412/379-7780

RE: Mr. C Cleaners Carbon Usage Estimate

FROM: Kathy McCue

DATE: 10/9/95 **TIME:** 10:15

JOB NUMBER: 0266-314-005

NUMBER OF PAGES (INCLUDING THIS SHEET): 2

RETURN ORIGINALS TO SENDER (CIRCLE ONE) YES NO

MESSAGE: Please determine the activated carbon usage rate (lb carbon/1000 gal water) for the groundwater stream described on the attached table. Acetone and 2-butanone can be ignored. Please let me know which compound controls breakthrough. Thanks for your help.

If you do not receive all pages or if portions are illegible please call 716-828-1300 for retransmission.

TABLE 1-3

MR. C CLEANERS SUPERFUND SITE
FEASIBILITY STUDY REPORT

GROUNDWATER CONTAMINANTS

Parameter	Concentration Range Detected (ug/l)
Tetrachloroethene	8200
Potential Degradation Products/Contaminants of Tetrachloroethene:	
• Trichloroethene	280
• 1,2 Dichloroethene	82
• 1,1 Dichloroethene	19J
• Vinyl Chloride	240
Petroleum Hydrocarbons:	
• Benzene	3200
• Toluene	740
• Ethylbenzene	430
• Xylene ✓	1900
• Chlorobenzene	3J
Other Parameters:	
• 1,1,1 Trichloroethane	14
• Acetone (1)	91
• Chloroform	3J
• Methylene Chloride	120J
• 2-Butanone	10UJ
• 1,2-Dichloropropane	3J

Notes:

(1) Detected primarily in lacustrine aquifer, thus, not anticipated to be present in treatment system influent.

Carbon Service Company

Carbon Service & Equipment Company

P.O. Box 838 • Donora, PA 15033 • Phone 412-379-8032 • Fax 412-379-7780

FAX COVER SHEET

TO: Kathy McQue

FROM: Bob Wright

DATE: October 11, 1995

PAGES: 1

SUBJECT: Mr. C project

Kathy

Because of the Vinyl Chloride, you may use 20,000 lbs. per month of liquid phase carbon, based on 85 gpm constant flow. I would air strip this stream, if I were designing a system, as you have over two orders of magnitude difference between the most adsorbed and least adsorbed organics. The only way I would go carbon only on this would be for a temporary project where equipment costs and permitting issues may make liquid phase carbon attractive.

Bob

$$\frac{20{,}000\ lb}{mo} * \frac{min}{85\ gal} * \frac{d}{1440\ min} * \frac{mo}{30\ d} * 1000 = 5.4\ \frac{lb}{1000\ gal}$$

APPENDIX B

CONCEPTUAL GROUNDWATER COLLECTION SYSTEM

MALCOLM PIRNIE, INC.

BY RHO DATE 10-5-95 SHEET NO. 1 OF 1

CHKD. BY RHF DATE 6/10/96 JOB NO. 0266-314

SUBJECT Pumping Radius Test Zone A

Estimate Radius of Influence of RW-1
Mr C Cleaners Parking Lot.

Response was observed at MP1-10B @ 100 ft
and at ES1-3 @ 55 ft
while pumping 27 gpm for 6~~x~~ hours.

IT is noted that the slug test results for
MW-1 - 1.8E-3
MP1-10B - 4.2E-3
are similar to OW-B and OW-C behind the Library.

∴ Assume hydrolgeologic boundary between $K = 10^{-2}$ and $K = 10^{-3}$ aquifers occurs on Agway.

Because RW-1 influenced MP1-10B ~~after 2 hours~~ at a low pumping rate it can be ~~anticip~~ anticipated that the radius of influence of RW-1 will reach the hydrogeologic boundary and influence water levels ~~sign~~

The extent of the influence cannot be estimated without ~~a~~ the results of a pumping test.

Conclusion: Assume RW-1 will impact MW-1 at a minimum (≈ 150 ft)+

MALCOLM PIRNIE, INC.
BY RHO DATE 10/5/95 SHEET NO. 1 OF 1
CHKD. BY LHF DATE 6/10/96 JOB NO. 02666-314
SUBJECT Pumping Radius Test zone B

Estimate radius of influence of a single well Located behind the Library

Assume : 4-inch diameter well installed in 8¼-inch augers with sand pack diameter ≈ 1.0 feet

Based on Pumping and recovery test analyses ~~the~~ aquifer parameters are as follows

T =	Transmissivity	GPD/FT	- 1000
K =	hyd. conductivity	GPD/FT²	55.6
H =	saturated thickness	FT	18
h =	pumping level (measured from base)	FT	13
Q =	pumping rate	GPM	5
r_w =	~~well~~ effective well radius	FT	0.5
R_o =	radius of Influence	FT	X

Use Theim Equation for unconfined Aquifers

$$Q = \frac{K\,(H^2-h^2)}{1055\ \cancel{Q}\log R_o/r_w}$$

$$\log R_o = \frac{K\,(H^2-h^2)}{1055\ Q} + \log r_w$$

$$= \frac{(55.6)\ (18^2-13^2)}{1{,}055\ (5)} + \log(0.5)$$

$$= \frac{8618}{5275} + 0.3010$$

$$= 1.3327$$

$$R_o = 21.5\ \text{ft}$$

✓

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RHD DATE 10-5-95 SHEET NO. 1 OF 6

CHKD. BY RMF DATE 6-10-96 JOB NO.

SUBJECT Mr C Cleanerr- Alternate Well Configurations

Total Pumping. Rate

Objective is to collect GW from the >1000 ppb plume extending from ESI-3 to MPI-6S.

Analysis.:

a) The portion of the plume extending 200 ft west northwest of ESI-3 will be collected by pumping RW-1 @ 55 to 100gpm

↖ non-appropriate

b) ~~Bego~~ Beyond MW-1 the ~~to~~ ~~Trans~~ hyd. conductivity decreases and pumping is less effective.

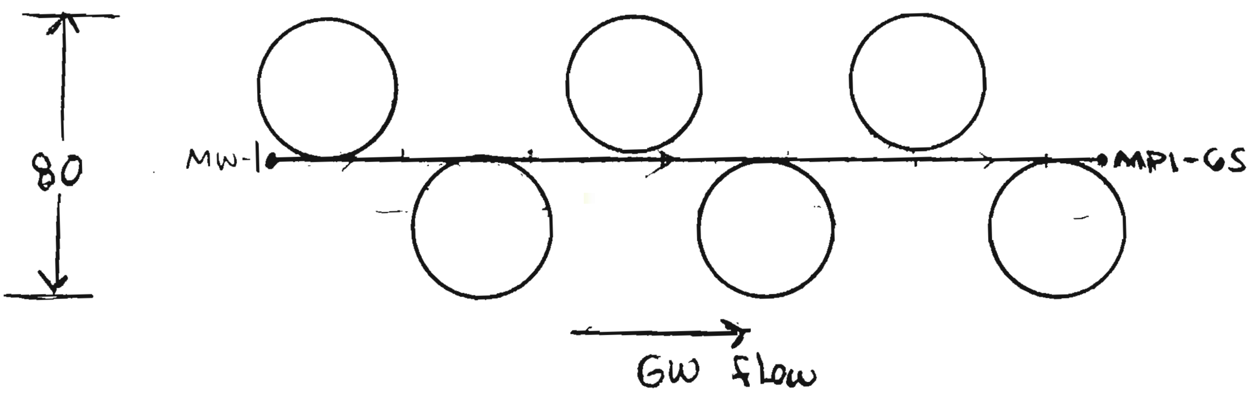
Assume ~~ea~~ each well has a radius of influence of 21 feet

Assume Plume is 80 feet wide - requiring two wells to intercept the >1000 ppb plume.

Alternative ~~Pump~~ Well configurations are;

① Linear ~~ne~~ well network parallel with plume axis betweem MW-1 and MPI-6S

~260 ft @ ~~21~~ 42/well = ~~13~~ 6 wells



MALCOLM PIRNIE

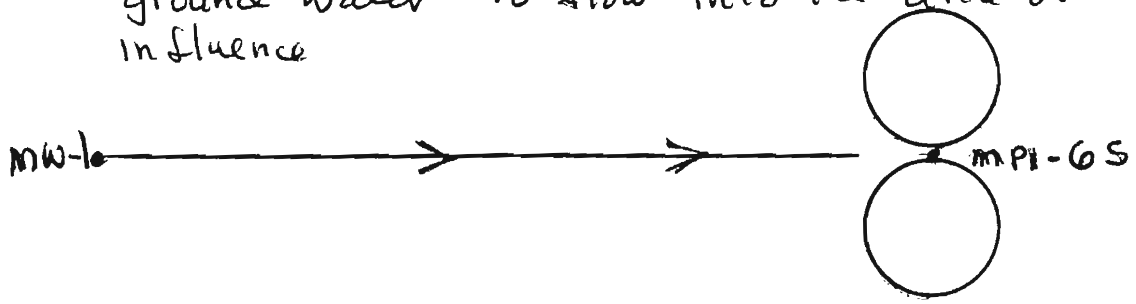
MALCOLM PIRNIE, INC.

BY RHS DATE 10-5-95 SHEET NO. 2 OF 6

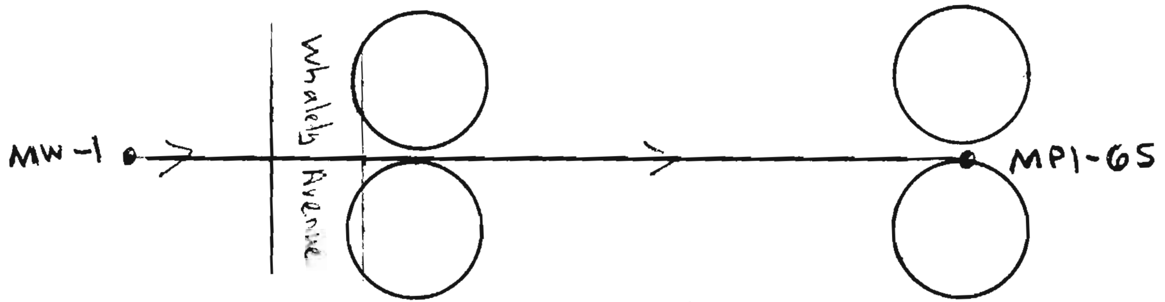
CHKD. BY AMF DATE 6-14-96 JOB NO.

SUBJECT

② Place ⁽²⁾ Guard wells at MPI-6S area pump the wells and allow contaminated ground water to flow into the area of influence



③ Place Guard wells at MPI-6S area and near Whalely and allow contaminated GW to flow into the area of influence



The two wells near Whalely will ~~clean up the plu~~ segment the plume and more rapidly collect any contaminated water outside of the influence of RW-1

Recommended well configuration is ③

① is too many wells

② relies on ground water flow too strongly

③ ~~is a~~ provides a more rapid clean-up than ② for a nominal increase in wells

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RHO DATE 10-5-95 SHEET NO. 3 OF 6

CHKD. BY RMF DATE 6-14-96 JOB NO. 0266-314

SUBJECT

Alternate Well configuration #3 (modified)

a) The portion of the Plume extending from ESI-3 to MPI-10B will be collected by pumping RW-1 @ 55 gpm

estimate drawdown @ MPI-10B where r = 100 ft while pumping RW-1 @ 55 gpm
for 3 days
30 days
300 days

$$s = \frac{114.6\ Q}{T}\ W(u)$$

- assume simple confined conditions and non-steady state flow

=

- assume T of 25,000 GPD/FT

$$s = \frac{114.6\,(55)}{25{,}000}\ (W(u))$$

- $u = \dfrac{1.87\ r^2\ S}{T\ t}$

$$s_{t=3} = 0.252(2.468) = 0.6\ \text{ft}$$

$$s_{t=30} = 0.252(4.726) = 1.2\ \text{ft}$$

$$s_{t=300} = 0.252(7.024) = 1.8\ \text{ft}$$

$$u_{t=3} = \frac{1.87\,(100)^2\,(0.2)}{25000\,(3)} = 4.986$$

$$u_{t=30} = \frac{1.87\,(100)^2\,(0.2)}{25{,}000\,(30)} = 4.9867$$

$$u_{t=300} = \frac{1.87\,(100^2)(0.2)}{25{,}000\,(300)} = 4.9867$$

t = 3 days and t = 30 days values may not be meaningful estimates due to the potential for delayed yield in the unconfined aquifer

However the effects of delayed yield should be gone by t = 300 days ~~to~~ ✓

therefore, 55 gpm should be sufficient to influence MPI-10B

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RHO DATE 10-5-95 SHEET NO. 4 OF 6

CHKD. BY AMF DATE 6-10-96 JOB NO.

SUBJECT

Calculate Drawdown at MPI-10B
with pumping RW-1 for 300 days at 55gpm

Assume

T= 18,000 GPD/FT

$$u = \frac{1.87\ (100)^2\ (0.2)}{(18{,}000)\ (300)} = 6.926\ E-4$$

$$W(u) = 6.7023$$

$$s = \frac{(114.6)\ (55)}{18{,}000}\ (6.7023) = 2.3\ ft$$

~~Dra~~ Influence on Agway will increase at lower Transmissivity values.

In fact T at MPI-10B is estimated to be ≈ 1500 GPD/FT so influence should be substantial.

Conclusions

Even at 27 gpm, we would expect 1.15 ft of drawdown at MPI-10B.

~~Conclusion~~ However,

~~Rum~~ Assume RW-1 is pumped at 55 gpm since actual impact needs to be demonstrated with a pumping test.

Actual hydrogeologic boundary may be closer to RW-
than ~~we~~ assumed.

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

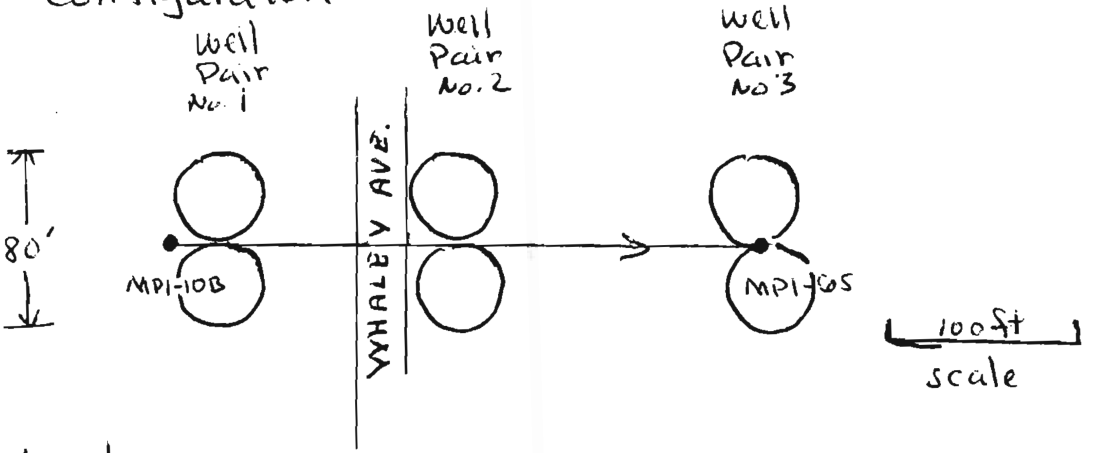
BY RHO DATE 10-5-95 SHEET NO. 5 OF 6

CHKD. BY GHP DATE 6-16-96 JOB NO.

SUBJECT

Alternate Well Configuration (Cont'd)

b) The portion of the plume extending from MPI-10B to MPI-6S will be collected by pumping from the following well configuration



~~locate~~

- Assume the plume is 80 ft wide
- Locate three well pairs along the axis of the plume so that the combined radius of influence, equals the width of the plume.
  2 for each pair
- Space the well pairs based on access considerations

viz:

Well Pair # 1	on Agway
Well Pair # 2	West side of Whaley Avenue RO
Well Pair # 3	Town Property behind Library

- Allow ~~natural gw flow to~~ wells to intercept the natura flow of contaminated GW.

- Steady state flow rates are ≈ 100 ft/year in the vicinity of Agway. Substantially less than 100 ft year west of MPI-6S due to lower hydraulic gradient.

- The need for Well Pair No 1 should be based on a pumping test @ RW-1

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RHO DATE 10-5-95 SHEET NO. 6 OF 6

CHKD. BY AMF DATE 4-16-96 JOB NO.

SUBJECT

- Allowing natural flow to flush 10 ~~vo~~ plume volumes through the Aquifer would require

$$125 \frac{ft}{volume^{(1)}} \times \frac{1\,yr}{100\,ft} \times 10\,volumes = 12{,}5 \text{ years}$$

(1) linear extent of plume between downgradient area of influence of well Pair No 2 and upgradient area of influence of well pair No 3.

Total flow for alternate well configuration

6 Low flow wells	@ 5 gpm	=	30 gpm
RW-1	@ 55 gpm	=	55 gpm
			85 gpm

11-15-95

Add one additional Well Pair west of MPI-6S To collect contaminated GW at the leading edge of the plume (source plume)

This assumes that further field investigation during remedial design will ~~identify~~ delineate the source plume more accurately.

Total Flow :	8 low flow wells @ 5gm	40 gpm
	RW-1 @	55gpm
		95 gpm

APPENDIX C

CAPITAL, O&M, AND PRESENT WORTH COSTS FOR REMEDIAL ALTERNATIVES

BY MC
CHKD BY
DATE 6/10/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR ON-SITE TREATMENT OF GROUNDWATER
ALTERNATIVE GW-1
NO ACTION

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
GROUNDWATER MONITORING				
Analytical costs	samples	22 [1]	$150 [3]	$3,300
Sampling Labor	hours	40	$40	$1,600
Report Labor	hours	40	$50	$2,000
Equipment	hours	1	$400	$400
INDOOR AIR SAMPLING				
Analytical costs	samples	38 [2]	$100 [4]	$3,800
Sampling Labor	hours	40	$105	$4,200
Equipment	hours	2	$400	$800
FIVE YEAR EFFECTIVENESS REVIEW	hours	40	$90	$3,600
ANNUAL COST				$19,700
30 Year Present Worth for above				$221,800
Capital Cost				0
TOTAL				$241,500

Notes:
(1) Includes 17 Phase I & II RI monitoring wells; 3 private irrigation wells; & 2 QC samples. Sampled annually
(2) Includes 8 locations analyzed in duplicate; 3 QC samples; sampled semi-annually
(3) Analyzed for volatile organics by Method 8260
(4) Analyzed for volatile organics by NYSDOH Method 311-7.

BY MC
CHKD BY
DATE 6/12/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR ON-SITE TREATMENT OF GROUNDWATER
ALTERNATIVE GW-2
UTILIZING IN SITU AIR STRIPPING WELLS

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
PROCESS EQUIPMENT[1]				$150,540 to $373,300
ADDITIONAL ITEMS				
Process building with foundation & HVAC	SF	700	$75	$52,500
Water Supply	LF	100	$55	$5,500
Gas Supply	LF	100	$50	$5,000
Air Line Piping	LF	1,900	$7	$13,300
Develoment Water Treatment (GAC)	LS	1	$6,000	$6,000
Soil Disposal				
Analysis	composite	3	$500	$1,500
Transport	drums	30	$50	$1,500
Disposal (landfill)	drums	30	$135	$4,050
Vapor Phase GAC[2]	LS	2	$28,250	$56,500
			Low Cost	High Cost
Subtotal			$296,400	$519,200
Engineering @ 15%				$78,000
Engineering @ 25%			$74,100	
Contingency @ 25%			$74,100	$129,800
TOTAL			**$444,600**	**$727,000**

(1) Range of proposals received from EG&G Environmental, Inc. and SBP Technologies, Inc. includes:
Drilling, Installation & Development of 3 to 6 Remediation Wells
Regenerative Blowers for injection & vacuum
Moisture Separator, Electrical Controls

(2) Assumes two parallel systems. Each system includes two 5,000 lb vapor phase GAC canisters operating in series.

BY MLC
CHKD BY JCM
DATE 6/11/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR GROUNDWATER O&M AND PRESENT WORTH
ALTERNATIVE GW-2
UTILIZING IN SITU AIR STRIPPING

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST		1996$ ESTIMATED TOTAL
Electricity	kWh	126,000	$0.08		$10,080
Operator	hours	104	$60		$6,240
Natural Gas	total	1	$700		$700
Maintenance	hours	96	$80		$7,680
Well Maintenance:					
Well Screens	per well	6	$85		$510
Vapor Phase GAC[1]	10,000 lbs	5	$12,600		$63,000
Groundwater Monitoring:					
Analytical Cost	sample	22	$150		$3,300
Sampling Labor	hours	40	$40		$1,600
Report Labor	hours	40	$50		$2,000
Equipment	total	1	$400		$400
Indoor Air Sampling					
Analytical Costs	sample	38	$100		$3,800
Labor	hours	40	$105		$4,200
Equipment	total	2	$400		$800
Five Year Effectiveness Review	hours	24	$90		$2,160
ANNUAL COST					$106,500
10 Year Present Worth for above					$714,700
Capital Cost			$444,600	to	$727,000
TOTAL			$1,265,800	to	$1,548,200

(1) Assumes GAC usage rate of 4,000 lbs per month. Includes change-out, freight, and reactivation of spent carbon.

BY MLC
CHKD BY
DATE 6/10/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR ON-SITE TREATMENT OF GROUNDWATER
ALTERNATIVE GW-3
UTILIZING AIR STRIPPING WITH VAPOR PHASE GAC
FLOW = 95 GPM

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
PROCESS EQUIPMENT (Note 1)				
Sequestering Agent Dilution Tank	LS	1	$300	$300
Sequestering Agent Bulk Storage Tank	LS	1	$300	$300
Sequestering Agent Metering Pump	LS	2	$600	$1,200
Dual Bag Filters (Note 2)	LS	1	$33,600	$33,600
Air Stripper Feed Tank	LS	1	$3,000	$3,000
Air Stipper Feed Pumps	LS	2	$2,250	$4,500
Air Stripper	LS	1	$73,000	$73,000
Vapor-Phase GAC (Note 3)	LS	2	$29,700	$59,400
Air Stripper Stack	LS	1	$2,500	$2,500
Control Panel	LS	1	$20,000	$20,000
Sub-Total				$197,800
Piping and Valves (5 percent)	LS	1		$10,000
Electrical (20 percent)	LS	1		$40,000
Instrumentation (10 percent)	LS	1		$20,000
Start-Up Personnel/Testing	LS	1	$8,700	$8,700
Water Supply	LF	100	$55	$5,500
Gas Supply	LF	100	$50	$5,000
Groundwater Collection Piping	LF	950	$35	$33,700
Discharge Piping	LF	250	$35	$8,800
Process Building/Foundation/HVAC	SF	700	$75	$52,500
SUBTOTAL				$382,000
ENGINEERING @ 25%				$95,500
CONTINGENCY @ 25%				$95,500
GROUNDWATER COLLECTION				$109,400
TOTAL				$682,400

(1) Equipment costs include installation at 50% of capital cost (except where installation costs are specifically quoted).
(2) Duplex automatic sequencing bag filters.
(3) Each system includes two (2) Vapor-Phase GAC canisters operating in series.

BY MLC
CHKD BY
DATE 6/11/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR GROUNDWATER O&M AND PRESENT WORTH
ALTERNATIVE GW-3
UTILIZING AIR STRIPPING WITH VAPOR PHASE GAC
FLOW = 95 GPM

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
AIR STRIPPER/GAC O&M				
Operator	hours	104	$60	$6,200
Electricity	kWh	170,455	$0.08	$13,600
Natural Gas	total	1	$700	$700
Sequestering Agent	total	1	$17,480	$17,500
Activated Carbon	10,000 lbs.	8	$13,000	$101,400
Maintenance				
Labor	hours	96	$80	$7,700
Equipment	total	1	$2,000	$2,000
Sub-Total				$149,100
Pumping Well O&M				
Electricity	kWh	39,314	$0.08	$3,100
Pump Maintenance	per well	9	$125	$1,100
Screen Maintenance	per well	9	$85	$800
Effluent Monitoring				
Analytical Cost	sample	24	$150	$3,600
Labor	hours	96	$60	$5,800
Equipment	total	1	$400	$400
Influent Monitoring				
Analytical Cost	sample	8	$150	$1,200
Labor	hours	32	$60	$1,900
Site Monitoring from GW-1				$19,700
ANNUAL COST				$186,700
30 Year Present Worth for above				$2,101,900
Capital Cost				$682,400
TOTAL				$2,971,000

BY MLC
CHKD BY
DATE 6/6/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR ON-SITE TREATMENT OF GROUNDWATER
ALTERNATIVE GW-4
UTILIZING AIR ADVANCED OXIDATION PROCESS
FLOW = 95 GPM

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
PROCESS EQUIPMENT (Note 1)				
Sequestering Agent Dilution Tank	LS	1	$300	$300
Sequestering Agent Bulk Storage Tank	LS	1	$300	$300
Sequestering Agent Metering Pump	LS	2	$600	$1,200
Dual Bag Filters (Note 2)	LS	1	$33,600	$33,600
AOP Feed Tank	LS	1	$3,000	$3,000
AOP Feed Pumps	LS	2	$2,250	$4,500
Advanced Oxidation System	LS	1	$572,500	$572,500
Control Panel	LS	1	$20,000	$20,000
Sub-Total				$635,400
Piping and Valves (5 percent)	LS	1		$32,000
Electrical (20 percent)	LS	1		$127,000
Instrumentation (10 percent)	LS	1		$64,000
Start-Up Personnel/Testing	LS	1	$8,700	$8,700
Water Supply	LF	100	$55	$5,500
Gas Supply	LF	100	$50	$5,000
Groundwater Collection Piping	LF	950	$35	$33,700
Discharge Piping	LF	250	$35	$8,800
Process Building/Foundation/HVAC	SF	700	$75	$52,500
SUBTOTAL				$972,600
ENGINEERING @ 15%				$145,900
CONTINGENCY @ 25%				$243,200
GROUNDWATER COLLECTION				$109,400
TOTAL				$1,471,100

(1) Equipment costs include installation at 50% of capital cost (except where installation costs are specifically quoted).

(2) Duplex automatic sequencing bag filters.

BY MLC
CHKD BY AMM
DATE 6/11/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR GROUNDWATER O&M AND PRESENT WORTH
ALTERNATIVE GW-4
UTILIZING ADVANCED OXIDATION PROCESS
FLOW = 95 GPM

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
AOP O&M				
Operator	hours	104	$60	$6,200
Electricity	kWh	3,981,420	$0.08	$318,500
Natural Gas	total	1	$700	$700
Sequestering Agent	total	1	$17,480	$17,500
Hydrogen Peroxide	pound	41,504	$0.65	$27,000
Maintenance				
Labor	hours	96	$60	$5,800
Equipment	total	1	$57,250	$57,300
Sub-Total				$433,000
Pumping Well O&M				
Electricity	kWh	39,314	$0.08	$3,100
Pump Maintenance	per well	9	$125	$1,100
Screen Maintenance	per well	9	$85	$800
Effluent Monitoring				
Analytical Cost	sample	24	$150	$3,600
Labor	hours	96	$60	$5,800
Equipment	total	1	$400	$400
Influent Monitoring				
Analytical Cost	sample	8	$150	$1,200
Labor	hours	32	$60	$1,900
Site Monitoring from GW-1				$19,700
ANNUAL COST				$470,600
30 Year Present Worth for above				$5,298,000
Capital Cost				$1,471,100
TOTAL				$7,239,700

BY MLC
CHKD BY AMM
DATE 6/10/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR ON-SITE TREATMENT OF GROUNDWATER
ALTERNATIVE GW-5
UTILIZING ADVANCED OXIDATION PROCESS WITH AIR STRIPPING
FLOW = 95 GPM

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
PROCESS EQUIPMENT (Note 1)				
Sequestering Agent Dilution Tank	LS	1	$300	$300
Sequestering Agent Bulk Storage Tank	LS	1	$300	$300
Sequestering Agent Metering Pump	LS	2	$600	$1,200
Dual Bag Filters (Note 2)	LS	1	$33,600	$33,600
AOP Feed Tank	LS	1	$3,000	$3,000
AOP Feed Pumps	LS	2	$2,250	$4,500
Advanced Oxidation Process	LS	1	$115,500	$115,500
Air Stripper	LS	1	$73,000	$73,000
Air Stripper Stack	LS	1	$4,000	$4,000
Control Panel	LS	1	$20,000	$20,000
Sub-Total				$255,400
Piping and Valves (5 percent)	LS	1		$13,000
Electrical (20 percent)	LS	1		$51,000
Instrumentation (10 percent)	LS	1		$26,000
Start-Up Personnel/Testing	LS	1	$8,700	$8,700
Water Supply	LF	100	$55	$5,500
Gas Supply	LF	100	$50	$5,000
Groundwater Collection Piping	LF	950	$35	$33,700
Discharge Piping	LF	250	$35	$8,800
Process Building/Foundation/HVAC	SF	700	$75	$52,500
SUBTOTAL				$459,600
ENGINEERING @ 25%				$114,900
CONTINGENCY @ 25%				$114,900
GROUNDWATER COLLECTION				$109,400
TOTAL				$798,800

(1) Equipment costs include installation at 50% of capital cost (except where installation costs are specifically quoted).

(2) Duplex automatic sequencing bag filters.

BY MLC
CHKD BY
DATE 10/2/96
10/11

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR GROUNDWATER O&M AND PRESENT WORTH
ALTERNATIVE GW-5
UTILIZING ADVANCED OXIDATION PROCESS WITH AIR STRIPPING
FLOW = 95 GPM

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
AOP/AIR STRIPPING O&M				
Operator	hours	104	$60	$6,200
Electricity	kWh	433,255	$0.08	$34,700
Natural Gas	total	1	$700	$700
Sequestering Agent	total	1	$17,480	$17,500
Hydrogen Peroxide	pound	41,504	$0.65	$27,000
Maintenance				
Labor	hours	96	$60	$5,800
Equipment	total	1	$9,700	$9,700
Sub-Total				$101,600
Pumping Well O&M				
Electricity	kWh	39,314	$0.08	$3,100
Pump Maintenance	per well	9	$125	$1,100
Screen Maintenance	per well	9	$85	$800
Effluent Monitoring				
Analytical Cost	sample	24	$150	$3,600
Labor	hours	96	$60	$5,800
Equipment	total	1	$400	$400
Influent Monitoring				
Analytical Cost	sample	8	$150	$1,200
Labor	hours	32	$60	$1,900
Site Monitoring from GW-1				$19,700
ANNUAL COST				$139,200
30 Year Present Worth for above				$1,567,100
Capital Cost				$798,800
TOTAL				$2,505,100

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVE ANALYSIS
COST ESTIMATE FOR GROUNDWATER EXTRACTION FOR EX-SITU TREATMENT
ALTERNATIVE GW-3, GW-4, and GW-5

BY MLC
CHKD BY AMM
DATE 6/1/96

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
LOW YIELD WELL INSTALLATION				
Pilot Boring (2 1/4" augers)	LF	224	$10	$2,240
Split Spoons	each	112	$10	$1,120
Well Boring (6 1/4" augers)	LF	224	$25	$5,600
4" Stainless Steel Screen	LF	80	$60	$4,800
4" Carbon Steel Riser	LF	144	$30	$4,320
Vault Installation & Materials	each	8	$500	$4,000
Drilling Equip. Decontamination	hour	16	$125	$2,000
Drums (Drill Cuttings)	drum	40	$40	$1,600
Well Development	hour	64	$150	$9,600
Subtotal				$35,280
LOW YIELD WELL COMPLETION				
Pump Installation/Materials	per well	8	$750	$6,000
Flow Meter & Level Controller	per well	8	$450	$3,600
Wiring Level Controller & Electrical Power Connection	per well	8	$750	$6,000
Plumb discharge line to header	per well	8	$250	$2,000
Landscaping	per well	8	$300	$2,400
Subtotal				$20,000
WASTE DISPOSAL				
Analysis	composite	4	$500	$2,000
Transport	drum	40	$50	$2,000
Disposal	drum	40	$136	$5,440
Subtotal				$9,440
HIGH YIELD WELL INSTALLATION				
Well Construction	-	-	-	(1)
Vault Installation & Materials	each	1	$500	$500
Subtotal				
HIGH YIELD WELL COMPLETION				
Pump Installation/Materials	per well	1	$1,250	$1,250
Flow Meter & Level Controller	per well	1	$450	$450
Wiring Level Controller &		1		
Electrical Power Connection	per well	1	$750	$750
Plumb Discharge Line to Header	per well	1	$250	$250
Landscaping	per well	1	$300	$300
Subtotal				$3,500
TOTAL CAPITAL COSTS: LOW YIELD WELLS				$64,720
TOTAL CAPITAL COSTS: HIGH YIELD WELL				$3,500
HEALTH & SAFETY COSTS @ 10%				$7,000
ENGINEERING COSTS @ 25%				$17,100
CONTINGENCY @ 25%				$17,100
TOTAL FOR EXTRACTION WELLS				$109,400

Notes:

(1) Well Installed for Pumpng Test

BY MLC
CHKD BY
DATE 6/10/96

MR. C CLEANERS SUPERFUND SITE
REMEDIAL ALTERNATIVE ANALYSIS
COST ESTIMATE FOR OPERATION & MAINTENANCE OF GROUNDWATER EXTRACTION SYSTEM
ALTERNATIVE GW-3, GW-4, and GW-5

Assumptions:
(1) Pump horsepower is 1.5 hp in high yield well and 0.5 hp in low yield well

MAINTENANCE

Item	Description	Frequency	Cost/well	No. Wells	Cost/ Event
Well Pump	Repair/Parts & Labor	2 yrs.	$250	9	$2,250
Well Screen	Biofouling/Encrustation: Labor & Materials to treat well with peroxide, chlorine, or acid	3 yrs	$250	9	$2,250
Water Level Probes	Cleaning	2 yrs	Perform with pump repair	9	N/C

ANNUAL OPERATION COSTS

High Yield Well	1 well * 1.5 hp * 0.748 kw/hp * $0.08/kw * 8,760 hr/yr =	$786	/yr
Low Yield Wells	8 wells * 0.5 hp * 0.748 kw/hp * $0.08/kw * 8,760 hr/yr =	$2,097	/yr
Total operation cost for nine wells		$2,885	/yr

TOTAL COSTS

Well Pumps:	9 Pumps * $125/pump/yr =	$1,125	/yr
Well Screen:	9 Wells * $85/well /yr =	$750	/yr
Electrical Costs:		$2,885	/yr
AVERAGE ANNUAL O & M COSTS		$4,760	/yr

BY MLC
CHKD BY Adm
DATE 6/10/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR CLOSING AND REPLACING SEWER LATERAL
ALTERNATIVE SL-~~3~~2
PLACEMENT OF SEWER LATERAL TO WHALEY AVE. DISCHARGE

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
CLOSING EXISTING SEWER LATERAL				
Plug and Abandon Sewer Lateral at Floor Drain	LS	1	$5,000	$5,000
NEW SEWER LATERAL				
Removing Building Foundation	LF	25	$55	$1,400
Trenching (Note 1)				
Building Drain to Sewer	LF	100	$20	$2,000
Common Trench (Note 2)	LF	250	$10	$2,500
Removing Pavement	LF	50	$10	$500
Saw Cutting Road and Sidewalk	LF	50	$20	$1,000
Piping	LF	350	$31	$10,800
Connection to Main Sewer	LS	1	$2,000	$2,000
Replace Building Foundation	CY	10	$310	$3,100
Repaving	SF	100	$20	$2,000
Sub-Total				$25,300
SUBTOTAL				$30,300
ENGINEERING @ 25%				$7,600
CONTINGENCY @ 25%				$7,600
TOTAL				$45,500

(1) Trenching includes excavation, backfill, compaction and removal of excavated soil.
(2) Assumes use of common trench from process building discharge to storm sewer.

BY
CHKD BY
DATE 11/21/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR CLOSING AND REPLACING SEWER LATERAL
ALTERNATIVE SL-2
PLACEMENT OF SEWER LATERAL TO ROUTE 20A DISCHARGE

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
CLOSING EXISTING SEWER LATERAL				
TV Inspection pre and post cleaning	LS	1	$2,000	$2,000
Flushing Sewer Lateral	LS	1	$2,000	$2,000
Cutting Lateral Protrusion	LS	1	$5,000	$5,000
Spot Repair of lateral	LS	1	$5,000	$5,000
Debris Disposal	LS	1	$1,000	$1,000
By-Passing Main Sewer	LS	1	$1,500	$1,500
Traffic Control	LS	1	$1,000	$1,000
Sub-Total				$17,500
NEW SEWER LATERAL				
Removing Building Foundation	LF	25	$55	$1,400
Trenching (Note 1)				
Building Drain to Sewer	LF	150	$20	$3,000
Under Route 20A	LF	50	$40	$2,000
Removing Pavement	LF	125	$10	$1,300
Saw Cutting Road and Sidewalk	LF	50	$20	$1,000
Piping	LF	200	$39	$7,800
Connection to Main Sewer	LS	1	$2,000	$2,000
Replace Building Foundation	CY	10	$310	$3,100
Repaving	SF	175	$20	$3,500
Sub-Total				$25,100
SUBTOTAL				$42,600
ENGINEERING @ 25%				$10,700
CONTINGENCY @ 25%				$10,700
TOTAL				**$64,000**

(1) Trenching includes excavation, backfill, compaction and removal of excavated soil.

BY
CHKD BY
DATE 11/20/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR SOURCE AREA SOILS REMEDIATION
ALTERNATIVE SL-3

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
NOVOCS Well[1]				$25,100 to $62,200
ADDITIONAL ITEMS:				
Air Line Piping	LF	100	$7	$700
SOIL DISPOSAL:				
Analysis	composite	1	$500	$500
Transport	drums	5	$50	$250
Disposal (landfill)	drums	5	$135	$675
Sub-Total				$27,225
				$64,325
Piping	LF	200	$39	$7,800
Connection to Main Sewer	LS	1	$2,000	$2,000
Replace Building Foundation	CY	10	$310	$3,100
Repaving	SF	175	$20	$3,500
Sub-Total				$16,400
SUBTOTAL				
ENGINEERING @ 15%				$9,650
ENGINEERING @ 25%			$6,800	
CONTINGENCY @ 25%			$6,800	$16,100
TOTAL			**$40,825**	**$90,100**

(1) Based on range of cost estimates provided by EG&G Environmental & SBP Technologies, Inc. including drilling, installation, and development, moisture separator and electrical controls

BY J.AV
CHKD BY AWM
DATE 11/20/96

MR. C CLEANERS SITE
REMEDIAL ALTERNATIVES ANALYSIS
COST ESTIMATES FOR GROUNDWATER O&M AND PRESENT WORTH
ALTERNATIVE SL-3

ITEM/MATERIAL	UNITS	QUANTITY	UNIT COST	1996$ ESTIMATED TOTAL
Electricity	kWh	21,000	$0.08	$1,680
Operator[1]				
Well Maintenance:				
Well Screens	per well	1	$85	$85
Vapor Phase GAC[1]				
In door Air Sampling[1]				
Groundwater Monitoring[1]				
ANNUAL COST				$1,765
10 Year Present Worth for above				$11,850

(1) These annual costs are not measurably increased from those which will already be measured under the in-situ groundwater remediation alternative