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Stantec

April 13, 2006

Mr. Bart Putzig, P.E.
NYSDEC
Division of Hazardous Waste Remediation
6274 East Avon-Lima Road
Avon, New York 14414

RE: Multi Phase Vacuum Extraction (MPVE) System Pilot Test **190500014**
Ward Street Site
BCA Site No.: C828117
Rochester, New York

Dear Bart:

On behalf of Germanow-Simon Corporation, please find the enclosed MPVE System Pilot Test report for the Ward Street Site located in the City of Rochester, Monroe County, New York. This report is submitted pursuant to Germanow-Simon's Brownfield Cleanup Agreement (BCA) for the Ward Street Site (Site) that was executed by the New York State Department of Environmental Conservation (Department) on August 31, 2004.

We look forward to your review and approval of the MPVE System Pilot Test report. In the meantime, should you have any questions, please contact me.

Sincerely,

Michael P. Storonsky
Managing Senior Associate

Sincerely,

David P. Belaskas, P.E.
Associate

Enclosure:

c: Todd Caffoe, P.E. (NYSDEC – Avon)
James Charles Esq. (NYSDEC – Buffalo)
Gary Litwin (NYSDOH – Troy)
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File

WARD STREET SITE
MULTI PHASE VACUUM EXTRACTION SYSTEM PILOT TEST

SITE #C828117
INDEX #B8-0566-99-10
ROCHESTER, NEW YORK

April 2006

Prepared for:

NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
6274 EAST AVON-LIMA ROAD
AVON, NEW YORK 14414

Prepared on Behalf of:

GERMANOW-SIMON CORPORATION
408 ST. PAUL STREET
ROCHESTER, NEW YORK 14601-0144

Prepared by:

STANTEC CONSULTING SERVICES INC.
2250 BRIGHTON HENRIETTA TOWN LINE ROAD
ROCHESTER, NEW YORK 14623

190500014.208.100

Executive Summary

Stantec Consulting Services Inc. (Stantec) was retained by Germanow-Simon Corporation to perform a Multi Phase Vacuum Extraction (MPVE) pilot test at the Ward Street Site (Site) as part of their Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation. The pilot study was performed to evaluate MPVE as a remedial alternative for addressing the previously documented presence of volatile organic compound (VOC) in the soils and groundwater at the Site. The key focus of the study was to determine the hydrocarbon recovery rates and groundwater recovery rates, and to establish the relationship between vacuum pressure and formation airflow.

The pilot study involved the use of a MPVE system trailer, the conversion of monitoring wells within the Building B Annex to extraction wells, construction of a header pipe and discharge pipe linked to two 6,900 gallon recovery tanks and connecting the MPVE system trailer to the Building B electrical system. Pro-Act Services Corporation provided a 15 hp liquid ring pump capable of 200 ACFM at 28 inches Hg. Five existing monitoring wells within the Building B Annex impacted area, MW-16R, MW-22, MW-22R, MW-101, and MW-105, were converted to temporary extraction wells for the pilot study.

A total of six formation airflow tests were performed while operating on one, two, or four extraction wells in total fluids recovery mode. Total fluids recovery mode was determined to be the optimal mode of operation. Two pneumatic response tests were conducted while operating on one extraction well. Total operating time was 205 hours (8.5 days).

The MPVE system was very successful as it recovered an estimated 24.2 L of VOCs, including Tetrachloroethene, a/k/a perchloroethylene, (PCE) and its daughter products during the pilot study. The majority of the contaminant was removed in the vapor phase. A pneumatic radius of influence of 5 feet was measured during the pilot study. The pneumatic radius of influence for the full scale operation is estimated at 15 to 20 feet.

Given the success of the pilot study, a full scale MPVE system, utilizing an estimated 50± hp pump, is recommended. This system will operate at higher airflow rates and will need to operate on a greater number of extraction wells to be installed at impacted areas across the Site. A combination of both horizontal and vertical extraction wells are recommended beneath the Building B Annex to address subsurface impacts and eliminate the potential for vapor intrusion. The MPVE system selected for full scale operation will depend on a cost benefit analysis. In addition, a long-term operations and monitoring program for the MPVE system will need to be implemented to assess hydrocarbon recovery and treatment of contaminants.

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1.0 Introduction

Stantec Consulting Services Inc. (Stantec) was retained by Germanow-Simon Corporation to perform a Multi Phase Vacuum Extraction (MPVE) pilot test at the Ward Street Site, Rochester, NY, pursuant to Germanow-Simon's Brownfield Cleanup Agreement (BCA) that was executed by the New York State Department of Environmental Conservation (NYSDEC) on August 31, 2004. The Site is shown on Figure 1. A Site Plan is presented as Figure 2.

The pilot study was performed to evaluate MPVE as a remedial alternative for addressing the previously documented presence of VOCs in the soils and groundwater beneath the Building B Annex. Remediation by MPVE would also serve to prevent the VOCs that are documented to be present beneath the foundation of the Building B Annex from entering the building.

Stantec personnel conducted the MVPE system pilot study from December 16, 2005 to December 23, 2005 and January 5, 2006 to January 11, 2006. Pro-Act Environmental Services Corporation (Pro-Act) supplied the MPVE remediation equipment.

This report presents the results of the MVPE system pilot test.

1.1 MULTI PHASE VAPOR EXTRACTION

Multi Phase Vapor Extraction is an in-situ remediation technology used to simultaneously recover VOCs from subsurface soils and groundwater. Vacuum applied to the subsurface through extraction wells screened across the contaminated zone(s) induces a flow of air, soil vapor, groundwater and dissolved phase VOCs through the impacted area of the subsurface and out the extraction well. Subsurface airflow volatilizes and extracts VOCs from the soil and groundwater. Dissolved phase VOCs are removed in groundwater extracted by the system. Extracted air and groundwater typically requires treatment on the surface prior to discharge. Granular Activated Carbon (GAC) vessels were used to treat air and groundwater in the Ward Street Pilot Test.

1.2 OBJECTIVE

The objectives of the MPVE system pilot test were to:

- Assess the potential radius of influence of the existing vertical wells and determine the need for supplemental vertical and/or horizontal wells to be installed in and around the identified source area beneath the Building B Annex.
- Identify the optimal remedial modes for contaminant recovery; and
- Assess design parameters for a full-scale remediation system.

1.3 SCOPE OF WORK

To accomplish the study objectives of the MPVE pilot test, the following tasks were performed by Stantec at the Ward Street Site:

- Supervised the commissioning of the MPVE pilot study system.
- Conducted an 11 day MPVE pilot study.
- Conducted performance monitoring on the MPVE throughout the pilot study.
- Assessed the liquid, dissolved, and vapor phase VOC recovery rates, including daughter products of the primary contaminants of concern.
- Submitted exhaust air samples for laboratory analysis.
- Submitted influent, process, and effluent water samples from the MPVE system for laboratory analysis.
- Assessed design parameters for a full-scale MPVE.
- Prepared this MPVE pilot study report.

2.0 Background

2.1 REVIEW OF BACKGROUND INFORMATION

The Germanow-Simon Corporation operates a manufacturing facility at the Site that currently produces bimetal thermometers, plastic optics, and gauge and watch crystals. Germanow-Simon, first, entered into a Voluntary Cleanup Agreement (VCA) with the NYSDEC in 1999 as part of the Volunteer Cleanup Program. The Site was transferred from the Voluntary Cleanup Program into the NYSDEC Brownfield Cleanup Program (BCP) in 2004.

The following environmental investigations have assessed the nature and extent of contaminants at the Site:

- D.J. Parrone & Associates, P.C. Phase I Environmental Site Assessment for Germanow-Simon Corporation, City of Rochester, County of Monroe, State of New York. February 26, 1999.
- Sear-Brown (presently Stantec). Phase II Environmental Site Investigation, Ward Street Site, Rochester, New York. May 1999.
- Stantec. Remedial Investigation Report - Ward Street Site, Site #C828 117, Index #B8-0566-99-10. April 2006.

Besides PCE (Tetrachloroethene) and daughter products, contaminants identified at the Site include Trichloroethene (TCE), 1,2-Dichloroethene (DCE), and Vinyl Chloride (VC); Stoddard solvent; Benzene, Toluene, Ethylbenzene, Xylenes (BTEX); and lube oil. Impacts beneath the Building B Annex are attributed to surface spills of chlorinated solvent VOCs and petroleum products that occurred during previous ownership, and, prior to construction of the building in the 1960s. The principal contaminants of concern in this area consist of PCE, TCE, DCE, VC, BTEX, and lube oil.

2.2 BROWNFIELD CLEANUP AGREEMENT

New York's BCP encourages the voluntary cleanup of contaminated properties so that they can be reused and redeveloped. Under the current BCA that was executed by the NYSDEC on October 14, 2004, remedial measures are to be put in place in order to address the documented VOC contamination at the Site consistent with its current and intended future commercial/industrial use.

The data acquired during the pilot test will be used to complete an Alternatives Analysis Report and Remedial Work Plan under the current BCA with the objectives of eliminating or removing on-Site contaminant sources, abating off-Site migration of contaminants, and obtaining a Certificate of Completion (CoC) for the Site.

2.3 GEOLOGIC CONDITIONS

Soils on the subject property are mapped in the Monroe County Soil Survey as Urban Land. This classification applies to areas that have been so altered or obscured by human activity that identification of the soils is not feasible. These areas are commonly located in the older areas of the City of Rochester.

Upon examination, the overburden on the subject property actually consists of layers of fill, upper till and lower till soils. The fill and glacial till deposits comprise a 20± ft thick profile of silty sand sediments that overlie dolomitic bedrock tentatively assigned to the Silurian DeCew Formation.

Undefined fill thicknesses ranged from 0.0 to 11.2 ft and averaged 6.4 ft across the Site. The depth to bedrock across the Site ranges between 17.5 ft and 23.1 ft below ground surface (ft BGS) and averages 20.1 ft BGS. The glacial till profile beneath the fill is divisible into upper and lower portions based upon texture and density. The depth to dense, lower till ranges from 10.0 to 16.0 ft BGS and averages 12.8 ft BGS.

The DeCew Formation bedrock forms the cap rock of the nearby Upper Falls in the Genesee River Gorge west of the Site. The DeCew formation consists of lime sand and silt sediments that are similar to sediments that comprise the upper beds of the Rochester Shale (Gates Member)[1]. The DeCew Formation is generally on the order of 6 to 16 feet thick and is underlain by the Rochester Shale.

A Site subsurface cross section is presented as Figure 3.

Fill Material

The fill encountered across the Site consists primarily of re-worked till and some imported gravel materials. Based upon analysis of samples from borings B-7 and B-10, the fill materials consist of 20.0% - 35.8% gravel, 31.3% - 47.3% sand, 25.9% - 26.6% silt, and 6.1% - 7.0% clay. Miscellaneous fill includes trace amounts of brick, concrete, cinders and ash.

Estimates of porosity, using mass and volume measurements for fill samples, range from 23% to 31%. Wet densities range from 138.4 to 142.6 pounds per cubic foot (pcf). Dry densities range from 115.9 to 125.8 pcf.

Upper Till Deposits

The glacial till profile beneath the fill is divisible into upper and lower portions based upon texture and density. Average upper till descriptions include moist, brown fine sand, some silt, with trace clay and gravel. Based upon grain-size analyses of samples from B-7, B-10 and B-15, the upper till deposits consist of 0.0% - 7.3% gravel, 32.8% - 48.0% sand, 47.1 – 52.6% silt, and 4.9% - 11.0% clay.

[1] Goodman, W.M. (2005), Bedrock Exposures Within the Lower Genesee River Gorge: Their Context within the Stratigraphic Framework for the Niagara Region, Rochester Committee for Scientific Information, Bulletin #329.

Estimates of porosity, using mass and volume measurements for upper till samples, range from 29% to 37%. Wet densities range from 127.8 to 138.4 pounds per cubic foot (pcf). Dry densities range from 106.9 to 121.8 pcf.

Lower Till Deposits

The lower till deposits are slightly coarser-grained and more dense than the upper till profile. The lower till deposits represent a dense lodgement till. The transition from upper to lower till is marked by a dramatic increase in density, represented by the increased number of blows (N-values) during standard penetration tests while advancing boreholes. Average lower till descriptions include moist, gray to gray-brown, fine sand and silt, some coarse to fine gravel, with trace clay. The lower till deposits encountered in soil borings appear to be poorly sorted with a higher gravel fraction than the upper till deposits. Based upon grain-size analyses of samples from borings B-7, B-10 and B-15, the lodgment tills consist of 11.8% to 25.2% gravel, 34.4% to 37.0% sand, 35.3% to 46.3% silt, and 4.9% to 5.5% clay.

Estimates of porosity, using mass and volume measurements for lower till samples, range from 22.6% to 23.4%. Wet densities range from 136.9 to 147.4 pounds per cubic foot (pcf). Dry densities range from 122.8 to 130.7 pcf.

2.4 HYDROGEOLOGIC CONDITIONS

Overburden

The depth to groundwater in overburden across the Site ranges from 7.1 to 11.4 ft BGS, averaging 9.1 ft BGS. An average depth to water of 9.1 ft BGS corresponds to the base of the upper till profile. Shallow groundwater generally flows in a radial direction from the center of the block at the end of Cork Street and flows in a west-southwesterly direction across the source area towards the corner of Ward Street and St. Paul Street.

Sewer Influence on Groundwater Flow

A prominent depression in the water table exists beneath the west end of Ward Street. Groundwater flow from both the north and south sides of Ward Street appears to be directed toward the center of the street before the flow proceeds south-westerly towards the intersection with St. Paul Street. The patterns in the equipotential lines suggest a prominent influence of Ward Street utilities on local groundwater flow directions.

Bedrock

Water level data in bedrock wells collected on September 12, 2005 indicate that depths to water across the Site in wells screened in bedrock ranged from 8.9 to 11.8 ft BGS and averaged 10.6 ft BGS. Groundwater in bedrock generally flows in a westerly direction towards St. Paul Street and the Genesee River Gorge.

Hydraulic Conductivity

The hydraulic conductivity of the glacial deposits were estimated during the 1999 Phase II Environmental Site Investigation using two separate methods based upon grain-size distributions described in Fetter (1994).

The Hazen method, which is based upon the effective grain size or d_{10} on particle distribution plots, produced hydraulic conductivity values of ranging between 2.9×10^{-6} cm/s and 2.9×10^{-4} cm/s. The geometric mean of these values derived from the Hazen Method is 3.0×10^{-5} cm/s, a value that is consistent with the permeability estimates for regional glacial tills.

The Shepherd method, which is based upon the median grain size or d_{50} on particle distribution plots, was also applied to the geotechnical samples. The Shepherd method produced values of hydraulic conductivity ranging between 3.7×10^{-4} cm/s and 6.1×10^{-3} cm/s with a geometric mean value of 1.1×10^{-3} cm/s.

The permeability values reported above fall within the normal range for glacial deposits [2]. The Shepherd method values appear to be skewed to the higher end of the spectrum based on the relatively high sand content of the on-Site deposits. The poor sorting and dense compaction of the lodgement tills, however, would suggest that the lower hydraulic conductivity values derived from the Hazen method are more representative.

Using the available water level, the average hydraulic conductivity and an average porosity of the on-Site soils, an estimated average linear velocity for groundwater flow was calculated. The equation for the linear velocity is:

$$v = \frac{k \times i}{n_e}$$

where k= hydraulic conductivity

i= hydraulic gradient

and n_e= effective porosity

Based upon the Hazen method calculations, the mean hydraulic conductivity value of the overburden profile is 3.0×10^{-5} cm/s. Based upon the water level data collected on July 21, 2005, the horizontal hydraulic gradient is 0.019 ft/ft as measured between wells MW-32 and MW-16. Using an average porosity value of 0.28, an estimated linear velocity of 2.0×10^{-6} cm/s is calculated. This value equates to a groundwater flow velocity of approximately 2.1 feet per year.

[2] Freeze, R.A. and J.A. Cherry. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, NJ, 1979. p 604.

Slug Test Calculations

Slug tests were performed on wells MW-17, MW-17R, MW-18, MW-23, MW-24 and MW-24R on October 12, 2001. Slug tests were also performed on wells MW-9R, MW-16, MW-16R, MW-19, MW-20, MW-21 and MW-22 on July 12, 2005. Results from both rising head and falling head tests yielded hydraulic conductivity values ranging between 2.9×10^{-5} cm/s and 8.5×10^{-4} cm/s for overburden and 1.8×10^{-5} cm/s and 6.1×10^{-4} cm/s for bedrock. These ranges of values are typical for the silty glacial till and fractured shale and dolomite bedrock (Rochester Shale and DeCew Dolostone) at the Site and are consistent with hydraulic conductivities estimated from grain size.

2.5 DISTRIBUTION OF IMPACTS

The impacted area was determined by comparing soil analytical results from boreholes advanced in and surrounding the Building B Annex to the NYSDEC Technical and Administrative Guidance Memorandum #4046 (TAGM) Recommended Soil Cleanup Objective (RSCO) for PCE of 1.4 ppm. The surface area of the 1.4 ppm PCE soil concentration isocontour is approximately 3,700 sq.ft. This is approximately equal to the shipping & packaging area in the Building B Annex. Impacts extend off-Site to the south as observed in B-16/MW-16. Impacts were observed in the soil in this boring at greater depths and at approximately 10 percent of the concentrations observed beneath the Building B Annex, while groundwater concentrations were comparable. No significant VOC impacts have been observed in Building B, north of the Building B Annex. A subsurface cross section of the impacted area is presented in Figure 3.

PCE impacts extend to bedrock at approximately 22.5 ft BGS and are migrating to the south southwest in the direction of groundwater flow towards Ward Street.

Stoddard solvent impacts are limited to the area around MW-9 extending from approximately 2 ft BGS to the groundwater table at approximately 12 ft BGS.

Chlorinated solvents observed at MW-23, exceed the TAGM-RSCOs, indicating the presence of a potential off-Site source area on the adjacent High Falls Brewery property east of the Site, north of Ward Street.

2.6 MPVE PRELIMINARY DESIGN CONSIDERATIONS

MPVE is an in-situ remediation technology used to help recover VOCs from soil and groundwater. The effectiveness of the MPVE system depends on the Site geology, hydrogeology and distribution of contaminants within the soil profile. MPVE can be impeded by stagnation zones. Stagnation zones may occur in the following conditions:

- Complex geological conditions, and
- Airflow along preferential pathways.

Remediation within stagnation zones, if they exist, will be limited and impacts may remain in these areas. Possible remedies include densification of the extraction well grid, or injection of oxygen-releasing or reducing compounds to promote aggressive biodegradation of VOCs in areas where contaminants persist due to stagnation zones.

The remediation system will be designed to remove subsurface contaminants. Vacuum applied to extraction wells is an effective way of managing potential vapor intrusion into the building during remediation and collecting contaminants from the source area.[3]

2.7 EXTRACTION WELL CONSIDERATIONS

Existing monitoring wells at the Site were converted to extraction wells for the pilot study.

2.7.1 Vertical Extraction Well Construction Details

The typical design of the vertical extraction wells used during the pilot tests is presented in Figure 4 and was comprised of the following:

- The PVC well was connected through a PVC coupler and a short section of solid PVC pipe, to a PVC tee.
- The horizontal end of the PVC tee was connected to the header system and the vertical end of the tee was fitted with a short section of PVC pipe and a flexible fernco (coupler) to connect the PVC pipe to a smaller diameter drop tube installed within the well.
- The drop tube consisted of flexible tubing or small diameter solid PVC which extended to the bottom of the well.

The annular space in the extraction wells consisted of sand extending from the bottom of the screened interval to approximately 1-2 feet above the screen followed by a bentonite seal and grout backfill to the surface. Additional bentonite sealant was added to the to the top of each well and hydrated to ensure an effective surface seal for the pilot study. Two exceptions to this design were MW-22R and MW-101. MW-22R was already constructed using bentonite as backfill (instead of grout) to the surface, and the bentonite appeared well hydrated. MW-101 was also already constructed with a bentonite seal above the grout interval, and the bentonite appeared well hydrated. Well construction details are presented in Table 2-1.

[3] State Coalition for Remediation of Drycleaners - Project Management/Technical Issues Subgroup. Technology Assessment for Remediation at Solvent Contaminated Drycleaner Sites. June 2005. p19. source: www.drycleancoalition.org.

Table 2-1
Extraction Well Construction Details

Well Designation	Well Diameter (in)	Screened Interval (ft. BGS)	Sandpack Interval (ft. BGS)	Bentonite Seal		Grout Interval (ft. BGS)	Total Well Depth (ft. BGS)
				Interval (ft. BGS)	Thickness (ft)		
MW-16R	2.0	26.5-31.5	23.0-32.0	20.0-23.0	3.0	1.0-20.0	32.0
MW-22	4.0	5.3 - 20.3	4.0 - 20.3	2.0 - 4.0	2.0	1.0 - 2.0	20.3
MW-22 R	2.0	27.2 - 32.2	25.5 - 32.2	6.5 - 25.5	19.0	-	32.2
MW-101	1.0	5.2-10.0	1.0-12.0	0.1-0.5	0.4	0.5-1.0	12.0
MW-105	1.0	9.9-19.9	1.4-19.9	1.0-1.4	0.4	0.5-1.0	19.9

Notes: ft BGS – feet below ground surface

3.0 Pilot Study Field Program

Stantec personnel conducted the MPVE pilot study from December 16, 2005 to January 11, 2006. ProAct supplied the MPVE remediation equipment.

The pilot study was conducted with a small-scale mobile MPVE system. The key focus of the study was to determine the hydrocarbon recovery rates, groundwater recovery rates, and to establish the relationship between vacuum and formation airflow.

3.1 REMEDIATION EQUIPMENT

The MPVE system was contained within a 8 ft wide x 16 ft long x 7 ft high 7000 pound double axle trailer. The trailer consisted of two separate rooms. The control room contained the electrical control panel for the system. This room was not rated for explosion proof environments. The system room contained the MPVE system equipment and was rated for Hazard 1, Division 2 electrical conditions, explosion proof environments. The MPVE system consisted of a Liquid Ring Pump (LRP) blower (vacuum pump), 15 hp electric motor powering the vacuum pump, 110 gallon water knock out tank, 5 GPM XP ¾ hp Moyno pump, 10 GPM oil water separator, product collection drum, 110 gallon holding tank, 10 GPM XP ½ Hp transfer pump used to transmit fluids from the holding tank, two LCO8 Rosedale bag filters, two 200 pound GAC adsorbers, and two 6,900 gallon (26,000 L) recovery tanks within the Building B Annex. The MPVE system was equipped with two additional 200 lb GAC absorbers located outside of the trailer to treat exhaust air. A schematic of the MPVE system trailer is presented in Appendix B.

Pro-Act provided one employee to assist with setup of the MPVE system on December 15, 2005. The discharge system did not operate as expected during initial system testing. The carbon drums began to swell indicating that they could not operate under the pressure. To correct this issue so that the recovered groundwater could be pumped from the holding tank in the trailer to the recovery tanks within the Building B Annex, the system was modified to bypass the oil / water separator and draw the groundwater directly through the carbon vessels and bag filters. Liquid hydrocarbons, if present, could no longer be recovered in a separate vessel as a result of this modification.

3.2 EXTRACTION WELL NETWORK

Four existing monitoring wells within the Building B Annex impacted area MW-22, MW-22R, MW-101, and MW-105, and one well outside the Building B Annex, MW-16R, were converted to temporary extraction wells for the pilot study. The header network is shown on the Site Plan, Figure 2. Construction details are presented graphically on Figure 4.

3.3 SITE PREPARATION AND SYSTEM SETUP

Site preparations for the pilot study test included the following.

- Delivery of the MVPE trailer;
- Delivery of the GAC vessels;
- Delivery of the recovery tanks;
- Connecting the MVPE trailer to the Building B 240V, three phase power supply; and
- Installation of header pipe to connect the MVPE trailer to the extraction wells and to the recovery tanks.

The MVPE trailer was delivered to the Site by ProAct Environmental Services Corporation and located near the north wall of Building B within the chain link fence surrounding the parking lot north of Building B.

Blackmon-Farrell Electric connected the MVPE trailer to a 240V, three phase power supply.

The header and discharge pipes, constructed of two inch PVC, were run adjacent to each other from the MVPE trailer through a window on the north side of Building B, suspended from the basement floor rafters of Building B, and into the Building B Annex. The piping was sloped downwards from the rafters until it met the floor elevation in the Building B Annex. Sloping the pipe encouraged even fluid flow through the header pipe and uniform vacuum at extraction wells.

The extraction wells were connected to the header pipe in one of two configurations, as shown in Figure 4. The ball valve between the extraction well and the header pipe allowed each well to be used for extraction or monitoring. A second ball valve was connected to the drop tube to meter the flow of air or water depending on the mode of operation. Each well was also equipped with a small section of clear PVC pipe to allow visual observation of groundwater flow at the well and a vacuum gauge quick connect to allow measurement of vacuum at the well.

Two 6,900 gallon groundwater recovery tanks, Tank One and Tank Two, were delivered to the Site by Rain For Rent. Each tank was positioned in the Building B Annex as shown on Figure 2 with the assistance of Germanow-Simon staff.

The discharge pipe was connected to the top of the north recovery tank, Tank One, using a section of flexible 2” hose. Tank One and Tank Two were linked using a flexible two inch hose connected to the valves at the bottom of each tank.

Site photographs are presented in Appendix A.

MPVE systems are versatile in nature and have the ability to simulate several vacuum enhanced remediation technologies. The MPVE system used for the pilot study was capable of operating in the following extraction modes:

- Priming mode - consists of applying vacuum to the well casing with the drop tube open to the atmosphere. The drop tube is set below the Light Non-aqueous Phase Liquids (LNAPL) and groundwater interface, if present, or to the bottom of the extraction well.
- Non-priming mode - consists of applying vacuum to the well casing with the absence of a drop tube.
- Bioslurping mode - consists of applying vacuum to the drop tube with the well casing closed to the atmosphere. The drop tube is set below the LNAPL and groundwater interface, if present.
- Skimming mode - consists of applying vacuum to the drop tube with the well casing open to the atmosphere. The drop tube is set below the LNAPL and groundwater interface.
- Total fluids recovery mode - consists of applying vacuum to the drop tube with the well casing open to the atmosphere. The drop tube is set at the bottom of extraction well.

3.4 PERFORMANCE MONITORING PROGRAM

Performance monitoring was conducted by Stantec throughout the duration of the pilot study program. A summary of the performance monitoring tasks is provided below.

3.4.1 Hydraulic Conditions

The monitoring wells and MPVE extraction wells completed in the saturated zone were monitored before, during, and following the pilot study for depth to product, if present, and depth to groundwater to assess the hydraulic response induced by operation of the MPVE system.

3.4.2 Pneumatic Conditions

The vacuum at the extraction wells and surrounding monitoring wells were measured to assess the pneumatic response induced by the MPVE system.

Total VOCs as PCE, gaseous oxygen (O_2) and gaseous carbon dioxide (CO_2) were also measured at surrounding monitoring wells to assess the pneumatic communication with the MPVE extraction wells. The gaseous concentrations and combustible vapor concentration readings were measured using a Gastech Model GTCO2. Two Photoionization Detector (PID) meters, a MiniRae 2000 and a MultiRae Plus, both calibrated to isobutylene, were set to measure PCE.

The pneumatic data was used to calculate the radius of influence and communication between MPVE extraction wells. The data was also used to determine the subsurface vacuum profile characteristics.

3.4.3 Formation Airflow Versus Vacuum

Six formation airflow tests were performed on the MPVE extraction wells. Tests were performed by varying the vacuum applied to the formation while operating on one, two, or four extraction wells. Closing an air bleed at the MPVE trailer increased the vacuum. Airflow and air temperature were measured at the exhaust, air bleed, and at the main header pipe during each test. Airflow was measured using a Pitot tube and Magnehelic gauge.

3.4.4 Hydrocarbon Recovery

Liquid Phase

As previously discussed, the oil water separator and product collection drum on the MPVE trailer had to be bypassed during commissioning. Therefore, no liquid phase contaminants, in the form of light non-aqueous phase liquids (LNAPL) or dense non-aqueous phase liquids (DNAPL), were recovered in the product collection drum and none were observed within the two recovery tanks.

Dissolved Phase

Concentrations of dissolved phase contaminants were estimated by collecting water samples at points within the groundwater treatment system (GTS) both before and after the carbon vessels. Water meter readings were recorded during the pilot study to determine the amount of water collected and to assist in estimating the amount of contaminant recovered in the dissolved phase. The contaminant removal amount for the dissolved phase was calculated by multiplying the average contaminant concentration in the groundwater by the amount of water collected.

Vapor Phase

The exhaust vapors from the MPVE system were vented through 200 lb GAC vessels. The exhaust vapor was monitored before and after the carbon vessels for Total VOCs as PCE, O_2, and CO_2 to determine the concentrations recovered in the vapor phase. Gaseous concentrations were measured using the Gastech Model GTCO2, MiniRae 2000 and MultiRae Plus air monitors. A sample of exhaust air prior to the carbon vessels was submitted for laboratory analysis to further calibrate the results from the air monitoring equipment.

Airflow was calculated from measurements of the air pressure differential across a Pitot tube in the exhaust pipe and the exhaust air temperature. The standard airflow rate was calculated from the exhaust air pressure differential across the Pitot tube, the exhaust air temperature, and the system vacuum. The contaminant removal rate in the vapor phase was calculated by multiplying the average exhaust air contaminant concentration by the standard exhaust airflow rate. The amount of contaminant removed for the vapor phase was calculated by multiplying contaminant removal rate by the length of time that the system operated.

Biodegradation Phase

It has been demonstrated at MPVE remediation sites that reduced O_2 levels and elevated CO_2 levels in the exhaust stream can indicate in situ biodegradation of contaminants. [4] Microbes in the subsurface consume oxygen in cellular respiration and use hydrocarbons as their source of carbon for growth. The degradation rate was calculated through the stoichiometric relationship of PCE biodegradation. The hydrocarbon removal rate in the biodegradation phase was calculated by multiplying the degradation rate by the airflow rate. By drawing new O_2 to the existing microrobes, the MPVE system enhances in situ biodegradation of contaminants.

3.5 LABORATORY PROGRAM

An exhaust air sample was obtained from the MPVE exhaust port, prior to the carbon treatment vessels, during the pilot study. The air sample was submitted under chain of custody to Paradigm Environmental Services Inc. in Rochester, New York (Paradigm) for analysis of VOCs, using EPA Method TO-15.

Groundwater samples were collected from five points within the groundwater treatment system (GTS), as listed below.

- GTS-1, GTS-1A – Bottom of the liquid knockout vessel in the trailer.
- GTS-2, GTS-2A – Following the bag filters but before the GAC, in the trailer.
- GTS-3, GTS-3A: Bottom of the holding tank following the GAC, inside the trailer.
- GTS-4, GTS-4A: Top of Tank One. This tank was linked through a bottom valve with Tank Two, both inside the Building B Annex.
- GTS-5: Bottom of recovery Tank One. This tank was linked through a bottom valve with recovery Tank Two, both inside the Building B Annex.

Groundwater samples were submitted under chain of custody to Paradigm for analysis of purgeable VOCs using EPA Method 624.

The analytical reports are presented as Appendix C.

[4] United States Environmental Protection Agency, 1995. Bioventing Principles and Practice. Office of Research and Development. EPA/540/R-95/534a.

4.0 Results and Analysis

The MPVE system was operated intermittently during subsurface vacuum profile testing from December 16, 2005 to the evening of December 19, 2005. The MPVE system was operated continuously from the evening of December 19, 2005 to December 22, 2005, when it was shut down due to elevated PCE readings in the vapor GAC exhaust. The system was restarted on January 5, 2006 following the installation of two new vapor GAC treatment drums and ran almost continuously until shutdown on January 11, 2006. The extraction wells were operated in priming, non-priming, and total fluids recovery modes.

4.1 PERFORMANCE MONITORING PROGRAM

The MPVE system was also operated on single well, two well, and four well combinations during the pilot study. Analysis was conducted on an individual well during the single well test. System performance monitoring was conducted, in terms of the overall system, on multi-well tests due to the overlapping effects of the concurrently operating extraction wells, which are more representative of a full scale operation.

4.1.1 Remedial Modes

Each well was operated in priming, non-priming, and total fluids recovery modes prior to the start of the formation airflow test. Total Fluids recovery mode was the optimum mode of operation, resulting in the highest hydrocarbon recoveries.

4.1.2 Hydraulic Conditions

Groundwater levels were monitored before, during, and following the pilot study test.

A plot of groundwater elevations versus time is presented in Figure 5. The water elevation rose in extraction wells MW-105, MW-22, and MW-22R an average of 11 ft, and fell in surrounding wells used for monitoring an average of 0.5 feet during the pilot test.

4.1.3 Pneumatic Conditions

Pneumatic conditions in the formation were evaluated by measuring the vacuum at monitoring wells surrounding extraction wells. The MPVE system was operating at an average inlet vacuum of approximately 50 kPa (15 inches Hg) to 71 kPa (21 inches Hg) during the pneumatic response testing. The pneumatic radius of influence is the maximum distance from a recovery well where vacuum can be measured. The pneumatic radius of influence may be estimated by plotting the distance from the MPVE extraction wells versus the log of the formation vacuum. Pneumatic radius of influence is an empirical value and may be measured at a vacuum as low 0.1 inches H_2O.[5]

[5] Hinchee, R. and Leeson, A. Soil Bioventing Principles and Practice. CRC Press, Inc., Boca Raton, Florida. 1997.

The vacuum distribution profile for MW-22 is shown in Figure 6. The test was conducted at the maximum MPVE inlet vacuum of 90 kPa (26.5 inches Hg). The data indicates a pneumatic radius of influence of approximately 5 ft based on measured vacuums of:

- 0.28 inches Hg at MW-101 (screened in overburden), 2 feet from MW-22,
- 0.21 inches Hg at MW-22R (screened in bedrock), 4 feet from MW-22, and
- 0 inches Hg, 0 inches H_20 at MW-105 (screened in overburden), 24 feet from MW-22.

The low pneumatic radius of influence is due to the low permeability of the formation, effective air porosity, and volumetric water content.

Low pneumatic response was also detected in MW-22 when performing the vacuum distribution profile for MW-22R as shown on Figure 7.

No pneumatic response was detected during tests on MW-16R or MW-105. However, MW-16R was screened in the bedrock 10 ft below the surface of the water table and the nearest monitoring well to MW-105 was MW-22, approximately 25 feet away.

Due to the low pneumatic response measured during the one well tests, pneumatic response testing was not performed during two or four well tests.

4.1.4 Formation Airflow versus Vacuum

Operational analysis was conducted on the MPVE pilot study system in order to develop system flow curves for a full scale system operating in multi phase extraction mode.

Figure 8 presents the formation airflow curve for the system while it is recovering from one shallow MPVE extraction well, MW-105. The well was constructed from one inch PVC and operated in the total fluids recovery (TFR) mode. The plot indicates that the maximum wellhead vacuum would be at approximately 7.5 inches Hg that would produce a formation airflow rate of 4 SCFM.

The plot demonstrates a linear relationship between formation airflow and inlet vacuum from 0 inches Hg to 7.5 inches Hg simulating vapor phase extraction. Formation airflow decreases above 7.5 inches Hg as airflow through the well screen is replaced by water flow.

Figure 9 presents the formation airflow curve for the system while it is recovering from one MPVE extraction well, MW-16R. The well was constructed from two inch PVC and operated in the total fluids recovery mode. The plot indicates that the maximum wellhead vacuum would be at approximately 9 inches Hg that would produce a formation airflow rate of 7 SCFM.

Formation airflow was not detected during the one well test on MW-22R operated in Total Fluids Recovery Mode or the one well test on MW-22 operated in Total Fluids Recovery Mode. This is a result of the pneumatic conditions described in Section 4.1.2.

The range of vacuum during the two well test on MW-16R and MW-22R was limited to between 12 inches Hg and 15.1 inches Hg. Formation airflow was not measurable below 12 inches Hg or above 15.1 inches Hg as the vacuum at the system vessel increased rapidly, causing an automatic shutdown of the system. Therefore, the two well system curve has been excluded from this analysis.

The formation airflow curve for the system while recovering from four MPVE extraction wells, MW-22, MW-22R, MW-101, and MW-105 is presented in Figure 10. The plot indicates that the maximum wellhead vacuum would be approached at approximately 9 inches Hg that would produce a formation airflow rate of 3 SCFM. The plot shows a repeated pattern of gradually increasing airflow followed by rapid decrease in airflow as vacuum increases. Each decrease in airflow represents a well converting from vapor phase extraction to groundwater extraction.

The formation airflow curves for the one and four well tests are shown in Figure 11 for comparative purposes. Approximately 9 inches Hg appears to produce the best overall formation airflow rate with this system.

4.1.5 Effluent Evaluation

Liquid Effluent

Water samples were collected from five points within the groundwater treatment system on December 20, 2005, December 23, 2005, January 5, 2006 and January 6, 2006. Samples were collected to evaluate the incoming contaminant concentrations and treatment effectiveness. The results of these sampling events are presented in Tables 4-1 and 4-2.

A total of 33,831 L of water was treated through the duration of the pilot study. Contaminant concentrations were successfully reduced through the groundwater treatment system as demonstrated in Tables 4-1 and 4-2. Results of samples GTS-3, GTS-4, GTS-5A and GTS-5B indicate discharge water met the Monroe County short term discharge permit requirements.

Table 4-1
Summary of Groundwater Treatment System Analytical Results – December 20, 2005

Parameters Sampling date	Units (dd-mmm-yy)	Monroe County DES discharge permit[2]	GTS-1 20-Dec-05	GTS-2 20-Dec-05	GTS-3 20-Dec-05	GTS-4 20-Dec-05
Halocarbons						
1,1-Dichloroethane	µg/L	–	ND<20	ND<40	ND<2	ND<2
1,2-Dichloroethane	µg/L	–	ND<20	ND<40	ND<2	ND<2
1,1-Dichloroethene	µg/L	–	ND<20	ND<40	ND<2	ND<2
Trans-1,2-Dichloroethene	µg/L	–	ND<20	ND<40	ND<2	ND<2
1,1,2,2-Tetrachloroethane	µg/L	–	ND<20	ND<40	ND<2	ND<2
Tetrachloroethene	µg/L	–	1200	1080	ND<2	ND<2
1,1,1-Trichloroethane	µg/L	–	ND<20	ND<40	ND<2	ND<2
1,1,2-Trichloroethane	µg/L	–	ND<20	ND<40	ND<2	ND<2
Trichloroethene	µg/L	–	201	389	ND<2	ND<2
Vinyl chloride	µg/L	–	ND<20	ND<40	ND<2	ND<2
Aromatics						
Benzene	µg/L	–	ND<7	ND<14	0.805	ND<0.7
Ethylbenzene	µg/L	–	ND<20	ND<40	ND<2	ND<2
Toluene	µg/L	–	ND<20	ND<40	2.81	3.45
Totals						
Total non-detected Halocarbons and Aromatics[1]	µg/L	–	298.5	597	30.5	30.85
Total detected halocarbons and aromatics	µg/L	–	1401	1469	3.615	3.45
Total estimated halocarbons and aromatics	µg/L	–	1700	2066	35	35
Total estimated halocarbons and aromatics	mg/L	2.13	1.7	2.07	0.04	0.04

Notes:

1 – Concentration of non-detected compounds estimated as 50% x detection limit (ug/L). Additional compounds, not presented in summary table, are included in this value.

2 – Monroe County short term permit allowable concentration of VOC's in discharge water.

ND – indicates compound not detected at indicated detection limit.

GTS-1: Collected from bottom of system vessel, prior to treatment.

GTS-2: Collected following bag filters, prior to GAC treatment.

GTS-3: Collected immediately following GAC treatment, from bottom of holding tank within system trailer.

GTS-4: Collected from top of Tank One.

Table 4-2
Summary of Groundwater Treatment System Analytical Results
December 23, 2005, January 5, 2006 and January 6, 2006

Parameters Sampling date	Units (dd-mmm-yy)	Monroe County DES discharge permit[2]	GTS-1A 23-Dec-05	GTS-2A 23-Dec-05	GTS-5A 05-Jan-06	GTS-5B 06-Jan-06
Halocarbons						
1,1-Dichloroethane	µg/L	–	ND<20	ND<20	ND<2	ND<2
1,2-Dichloroethane	µg/L	–	ND<20	ND<20	ND<2	ND<2
1,1-Dichloroethene	µg/L	–	ND<20	ND<20	ND<2	ND<2
trans-1,2-Dichloroethene	µg/L	–	ND<20	ND<20	ND<2	ND<2
1,1,2,2-Tetrachloroethane	µg/L	–	ND<20	ND<20	ND<2	ND<2
Tetrachloroethene	µg/L	–	1430	1300	ND<2	5.35
1,1,1-Trichloroethane	µg/L	–	ND<20	ND<20	ND<2	ND<2
1,1,2-Trichloroethane	µg/L	–	ND<20	ND<20	ND<2	ND<2
Trichloroethene	µg/L	–	228	198	ND<2	ND<2
Vinyl chloride	µg/L	–	ND<20	ND<20	ND<2	ND<2
Aromatics						
Benzene	µg/L	–	ND<7	ND<7	ND<0.7	ND<0.7
Ethylbenzene	µg/L	–	ND<20	ND<20	ND<2	ND<2
Toluene	µg/L	–	ND<20	ND<20	ND<2	ND<2
Total Petroleum Hydrocarbons	µg/L	–	NA	NA	ND<500	ND<500
Total non-detected Halocarbons and Aromatics[1]	µg/L	–	298.5	298.5	31.85	30.85
Total detected halocarbons and aromatics	µg/L	–	1658	1498	0	5.35
Total estimated halocarbons and aromatics	µg/L	–	1957	1797	32	37
Total estimated halocarbons and aromatics	mg/L	2.13	1.96	1.8	0.03	0.04

Notes:

1 – Concentration of non-detected compounds estimated as 50% x detection limit (ug/L). Additional compounds, not presented in summary table, are included in this value.

2 – Monroe County short term permit allowable concentration of VOC's in discharge water.

ND – indicates compound not detected at indicated detection limit.

GTS-1A: Collected from bottom of system vessel, prior to treatment.

GTS-2A: Collected following bag filters, prior to GAC treatment.

GTS-5A & GTS-5B: Collected from bottom of Tank One.

Exhaust Air

An exhaust air sample was collected from the vapor exhaust stack prior to GAC treatment on December 12, 2005. The air sampling location is presented shown on Photo 2 in Appendix A. Air sample Vap-1 was obtained during the one well test on MW-22 and corresponds with a field measurement of 707 ppm collected using a MiniRae PID meter, calbrated with isobutylene, set

to PCE. The field measurement is an average of the concentrations measured immediately before and after collection of air sample Vap-1. A summary of the detected compounds in the analytical results is presented in Table 4-3.

Table 4-3
Summary of Detected Compounds in MVPE System Exhaust- December 19, 2005

Parameters	Field Measurement[1] (ppmV)	Vap-1		Qualifier
Sampling date		**19-Dec-05**		
Units		$\mu g/m^3$	ppmV	
Halocarbons				
Chloroform	-	5,020	1.04	E
1,1-Dichloroethene	-	32,700	8.32	*
cis-1,2-Dichloroethene	-	2,510,000	638	*
trans-1,2-Dichloroethene	-	261,000	66.4	*
Tetrachloroethene	-	2,760,000	412	*
Trichloroethene	-	2,360,000	443	*
Vinyl Chloride	-	1,010,000	399	*
Aromatics				
Benzene	-	4,850	1.52	*
Ethylbenzene	-	68.9	0.0159	
Toluene	-	242	0.0644	
m,p-Xylene	-	318	0.0734	
o-Xylene	-	114	0.0264	
Miscellaneous				
Carbon Disulfide	-	290	0.0932	
Total VOC's		8,944,312.9	-	*
Total VOC's expressed as Tetrachloroethene	707	-	1819.6	

Notes: 1 – Field measurement of Tetrachloroethene performed using MiniRae PID meter set to express total volatile organic compounds (VOC's) as Tetrachloroethene

ppmV - parts per million by volume.

$\mu g/m^3$ – micrograms per cubic meter of air.

E - denotes estimated. Concentration exceeds calibration range.

* - Tedlar bag dilution.

The laboratory results are presented both in micrograms of compound per cubic meter of air and converted to parts per million by volume using the molar mass of each compound. The analytical results from the Vap-1 air sample indicated a PCE concentration of 412 ppmV and a total VOC concentration of 8,944 mg/m^3. The laboratory result for total VOCs expressed as PCE was 1819.6 ppmV versus the field measurement of 707 ppmV. The ratio between the lab result and the field measurement of 1:1.9 was used as a calibration factor for PID readings to estimate vapor phase hydrocarbon recovery.

Exhaust air was treated on Site using GAC. Field measurements of Total VOCs as PCE before and after GAC treatment are presented in Table 4-4.

Table 4-4
Exhaust Air Monitoring Field Measurements

Parameters		Total VOCs as Tetrachloroethene[1] (ppmV)				Operating Extraction Wells
Date	LRP hours	Before GAC		After GAC		
		MiniRae		MiniRae		
		Field Reading[1]	Calibrated[2]	Field Reading[1]	Calibrated[2]	
12/19/2005 12:00 PM	18639.6	65	122	-	4	MW-105
12/19/2005 12:30 PM	18643.0	707	1322	-	-	MW-22
12/19/2005 3:30 PM	18645.8	575	1075	0.25	0.5	MW-22R
12/19/2005 10:45 PM	18652.1	1846	3452	5.3	10	MW-101, MW-105, MW-22, MW-22R
12/20/2005 9:15 AM	18662.6	1550	2899	2.2	4.1	
12/21/2005 10:45 AM	18687.9	900	1683	11	21	
12/21/2005 3:20 PM	18692.6	80	150	7.5	14	MW-16R
12/21/2005 3:42 PM	18692.8	18.2	34	15.2	28	MW-16R, MW-22R
12/22/2005 8:00 AM	18710.0	-	352	84	157	MW-101, MW-105, MW-22, MW-22R
12/22/2005 6:00 PM	18718.6	-	-	95	178	
Installation of two additional GAC vapor treatment drums.						
01/05/2006	18718.6	1070	2001	0	0	MW-101, MW-105, MW-22, MW-22R
01/06/2006	18738.9	447	836	0.1	0.19	
01/09/2006	18810.6	340	636	0.5	0.9	
01/10/2006	18822.2	394	737	3	5.6	
01/10/2006	18827.8	390	729	0.3	.6	
01/11/2006	18843.3	300	561	30	56	

Notes: ' –' indicates measurement not performed.

1 – Value recorded on field measurement.

2 – Field measurement calibrated to the exhaust air sample, Vap-1, collected December 19, 2005.

The MPVE system was temporarily shut down on December 22, 2005 due to elevated exhaust post GAC concentrations. The system was restarted on January 5, 2006 after the installation of an additional two GAC vapor treatment drums. Figure 12 is a plot of Total VOCs as PCE versus time during extraction from four wells (MW-101, MW-105, MW-22, and MW-22R). Concentrations of Total VOCs as PCE decreased over the duration of the pilot study until a sustainable rate near 560 ppmV was reached after 95 hours of operation.

4.1.6 Hydrocarbon Recovery

An estimated 24.2L of PCE and daughter products were recovered from the subsurface in the dissolved, vapor, and biodegradation phases during the pilot study. The total recovery volume is partitioned into the three phases as follows: 0.15% in the dissolved phase, 21% in the biodegradation phase and 79% in the vapor phase. The hydrocarbon recovery data is presented in Appendix D.

Dissolved Phase

An estimated 0.15% of the contaminant was recovered in the dissolved phase. The volume and rate of removal was calculated using the water meter readings on the discharge line in the trailer, the duration of operation and the contaminant concentration in the dissolved phase. The average contaminant concentration entering the system was measured as 1.7 mg/L, and the average groundwater flow rate was approximately 165 L/hr.

It is estimated that less than 0.1 L of the total 24.2 L was recovered in the dissolved phase over the duration of the pilot study. The rate of removal in the dissolved phase was less than 0.001 L/hr. Dissolved phase hydrocarbon recovery versus elapsed time is shown in Figure 13.

Contaminants recovered in the dissolved phase were treated on Site using activated carbon vessels, connected in series. Contaminant concentrations following the activated carbon vessels were either non detect or at trace concentrations, indicating effective removal, as presented in Table 4-1.

Vapor Phase

An estimated 79% of the contaminant was recovered in the vapor phase. The volume and rate of hydrocarbon removal was calculated using the exhaust temperature, flow rate and field measurements of Total VOCs as PCE in the exhaust stream before GAC treatment. The average exhaust air temperature was 60ºC and the average exhaust airflow rate was 11 SCFM. The Total VOCs as PCE concentrations, calibrated to the laboratory sample, ranged from 34 ppm to 3,452 ppm with an average of approximately 1,132 ppm.

Over the duration of the pilot study an estimated 19.1 L of the total 24.2 L of contaminant was recovered in the vapor phase. The rate of removal in the vapor phase was approximately 0.072 L/hr. Vapor phase hydrocarbon recovery versus elapsed time is shown in Figure 14.

In situ Biodegradation

An estimated 21% of the contaminant was removed through biodegradation. In situ biodegradation was calculated from the stochiometric relationship of PCE biodegradation.

Biodegradation of hydrocarbons in the formation depletes oxygen from atmospheric conditions of 20.9% and elevates carbon dioxide from atmospheric conditions of approximately 0.04%. Plots of the exhaust air O_2 and CO_2 concentrations during the pilot study are shown in Figure 15. The concentration of O_2 was depleted to 18% and the concentration of carbon dioxide was elevated to greater than 2.6% at the start of the pilot study. The O_2 concentration further decreased to 13% and the CO_2 concentration further increased to 5% as formation air flow increased. After a couple of days, oxygen and carbon dioxide concentrations approached 20.9% and 0.05% respectively, as other limiting factors besides availability of O_2 impeded biological activity. At that point, and through the time during which the MPVE system reached equilibrium, the average oxygen and carbon dioxide concentrations in the MPVE exhaust were 19.4% and 1.7%, respectively.

Over the duration of the pilot study an estimated 5.1 L of the total 24.2 L of contaminant was recovered in the biodegradation phase. The rate of removal in the biodegradation phase was

approximately 0.1 L/hr at the start of the pilot study and approached 0 L/hr near the end of the pilot study, as the MPVE system recovery conditions began to approach an apparent state of equilibrium. Contaminant removal through biodegradation versus elapsed time is shown in Figure16.

Total Hydrocarbon Recovery

The estimated total hydrocarbon recovery for the pilot study was 24.2 L with the majority recovered in the vapor phase. The total hydrocarbon removal rate was approximately 0.12 L/hr. Total hydrocarbon recovery versus elapsed time is shown in Figure 17.

4.2 FULL SCALE SYSTEM DESIGN PARAMETERS

Full scale design parameters are estimated below based on the data obtained during the pilot study and the configuration of the proposed MPVE extraction wells.

4.2.1 Pneumatic Conditions

A pneumatic radius of influence of 5 ft was measured in the pilot study. The pneumatic radius of influence was detected in the area of nested wells MW-22, MW-22, and MW-101.

The pneumatic radius of influence for the full scale operation is estimated at 15 to 20 feet, based on a 50 HP MPVE system. The estimated radius of influence is based on past experience with MPVE operation in total fluids recovery mode, whereby the groundwater table is depressed by the vacuum applied to the drop tube opening placed at the bottom of the well. Increasing vacuum pump capacity in this regime has consistently demonstrated a corresponding increase in formation airflow and radius of influence. As such, additional wells would need to be installed in order to remediate the identified source areas.

4.2.2 Formation Airflow versus Vacuum

Formation airflow is dependant upon both the capacity of the vacuum pump and the number of extraction wells at constant vacuum.

Formation airflow and the capacity of the vacuum pump are directly related. As the capacity of the vacuum pump increases, formation airflow increases.

Conversely, formation airflow and the number of extraction wells are inversely related. As the number of extraction wells increases, the formation airflow decreases. This was demonstrated in the pilot study by the reduction in formation airflow from 7 SCFM in the one well tests to 3 SCFM in the four well test.

4.2.3 Hydrocarbon Recovery

The hydrocarbon recovery rate is expected to decrease with time during full scale operation. Long term monitoring will provide a more accurate assessment of hydrocarbon recovery rates and treatment of contaminants.

4.2.4 Full Scale System

MPVE Sizing

The pilot study was performed using a 15 hp liquid ring pump capable of 200 ACFM at 28 inches Hg (12.8 SCFM). A larger MPVE system will generate higher airflow rates and be able to operate on a greater number of extraction wells, reducing remediation timelines. The MPVE system selected for full scale operation will depend on a cost benefit analysis but is expected to be in the range of a 50 hp unit.

Vertical Extraction Wells

Additional vertical extraction wells will need to be installed in the (source) areas of known impact to encourage a higher rate of volatilization, taking into account the anticipated 15-20 ft. radius of influence. The wells will need to be screened across the contaminated zones and across the water table including shallow fractured bedrock.

Horizontal Extraction Wells

Horizontal extraction wells are recommended to be installed beneath the building slab of the Building B Annex to encourage a higher rate of volatilization and reduce the number of stagnant zones. They will also address the most significantly impacted soils within the shallow soils at the suspected near-surface source area in the vicinity of MW-105. The horizontal wells will also serve as a long term sub-slab depressurization system to minimize potential infiltrations of vapors through the building floor slab.

Well Fouling

Scaling and biofouling of the well screen can diminish the performance of full scale MPVE systems. Scaling and biofouling were not encountered during the pilot study. If scaling or biofouling is encountered during full scale operation, muriatic acid tablets will be added to the extraction wells to remove scale and organics. The groundwater extracted following the application of muriatic acid will require neutralization in an elementary neutralization tank/drum prior to discharge.

5 Summary

Stantec Consulting Services Inc. was retained by Germanow-Simon Corporation to perform a MPVE pilot test at the Ward Street Site as part of their Brownfield Cleanup Agreement with the New York State Department of Environmental Conservation. The pilot study was performed to evaluate MPVE as a remedial alternative for addressing previously documented VOC impacts at the Site. The key focus of the study was to determine the hydrocarbon recovery rates, groundwater recovery rates, and to establish the relationship between vacuum and formation airflow. All three of these objectives were accomplished.

The pilot study involved the use of a MPVE system trailer, the conversion of monitoring wells within the Building B Annex to extraction wells, construction of a header pipe and discharge pipe linked to two 6,900 gallon recovery tanks and connecting the MPVE system trailer to the Building B electrical system. Pro-Act Services Corporation provided a 15 hp liquid ring pump capable of 200 ACFM at 28 inches Hg. Five existing monitoring wells within the Building B Annex impacted area, MW-16R, MW-22, MW-22R, MW-101, and MW-105, were converted to temporary extraction wells for the pilot study.

A total of six formation airflow tests were performed while operating on one, two, or four extraction wells in total fluids recovery mode. Total fluids recovery mode was determined to be the optimal mode of operation. Two pneumatic response tests were conducted while operating on one extraction well. Total operating time was 205 hours (8.5 days).

The MPVE system was very successful as it recovered an estimated 24.2 L of PCE equivalents (PCE and its daughter products) during the pilot study. The majority of the contaminant was removed in the vapor phase. A pneumatic radius of influence of 5 feet was measured during the pilot study. The pneumatic radius of influence for the full scale operation is estimated at 15 to 20 feet.

Given the success of the pilot study, a full scale MPVE system, estimated at 50± hp, is recommended. This system will operate at higher airflow rates and will need to operate on a greater number of extraction wells to be installed at impacted areas across the Site. A combination of both horizontal and vertical extraction wells are recommended beneath the Building B Annex to address subsurface impacts and prevent potential vapor intrusion. The MPVE system selected for full scale operation will depend on a cost benefit analysis.

In addition, if an MPVE system is the remedial alternative selected for implementation at the Site, a site management plan, including a long-term operations and monitoring program, will need to be implemented. Among other things, the site management plan will assess hydrocarbon recovery and treatment of contaminants, and describe the institutional and engineering measures to be implemented with respect to any residual VOCs remaining in the subsurface of this light industrial site.

6 References

D.J. Parrone & Associates, P.C. Phase I Environmental Site Assessment for Germanow-Simon Corporation, City of Rochester, County of Monroe, State of New York. February 26, 1999.

Fetter, C.W. Applied Hydrogeology – Third Edition. Upper Saddle River, New Jersey. 1994

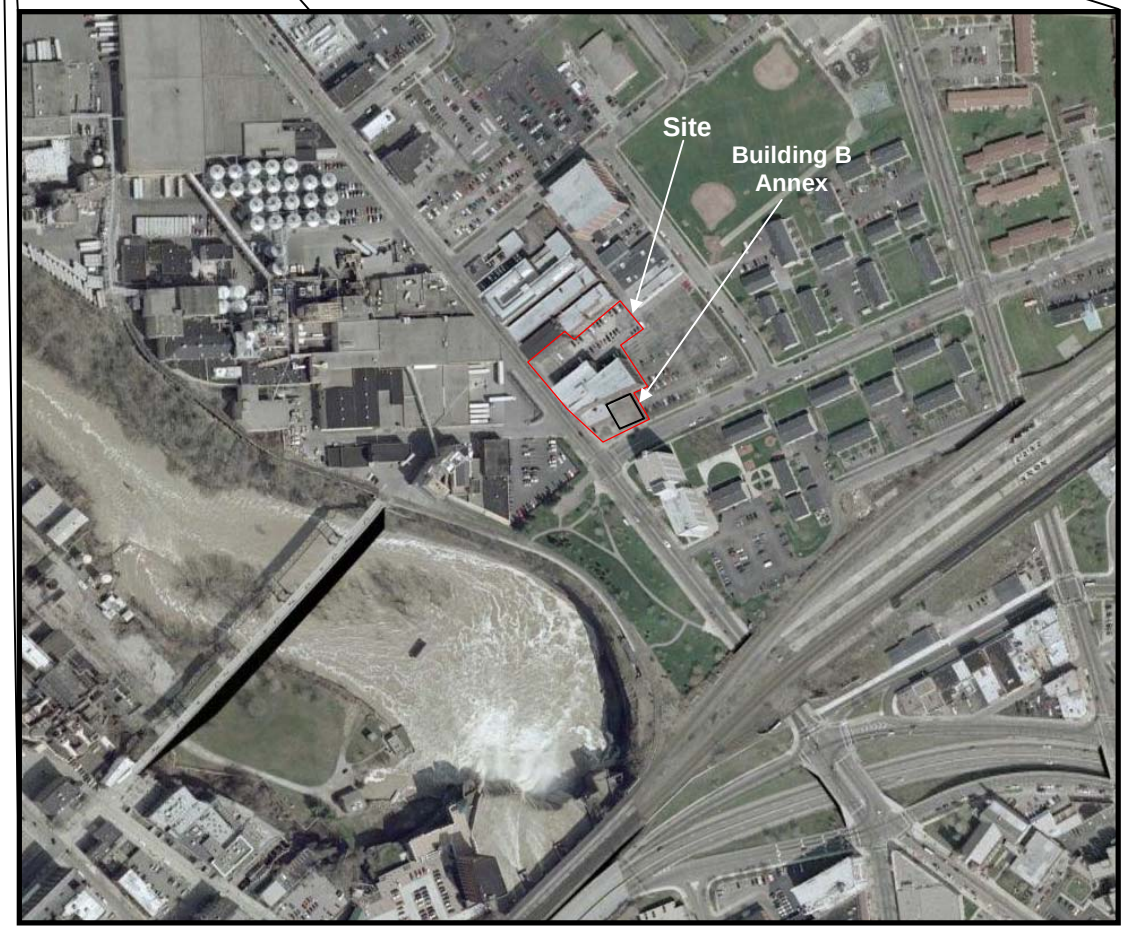
Freeze, R.A. and J.A. Cherry. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, NJ. 1979.

Hinchee, R. and Leeson, A. Soil Bioventing Principles and Practice. CRC Press, Inc., Boca Raton, Florida. 1997.

Sear-Brown (presently Stantec). Phase I Environmental Site Investigation, Ward Street Site, Rochester, New York. May 1999.

Stantec. Draft Remedial Investigation Report - Ward Street Site, Site #C828 117, Index #B8-0566-99-10. February 2006.

United States Environmental Protection Agency, 1995. Bioventing Principles and Practice. Office of Research and Development. EPA/540/R-95/534a.



Legend

Stantec

Client/Project
GERMANOW SIMON CORPORATION
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
1

Title
Site Location Plan

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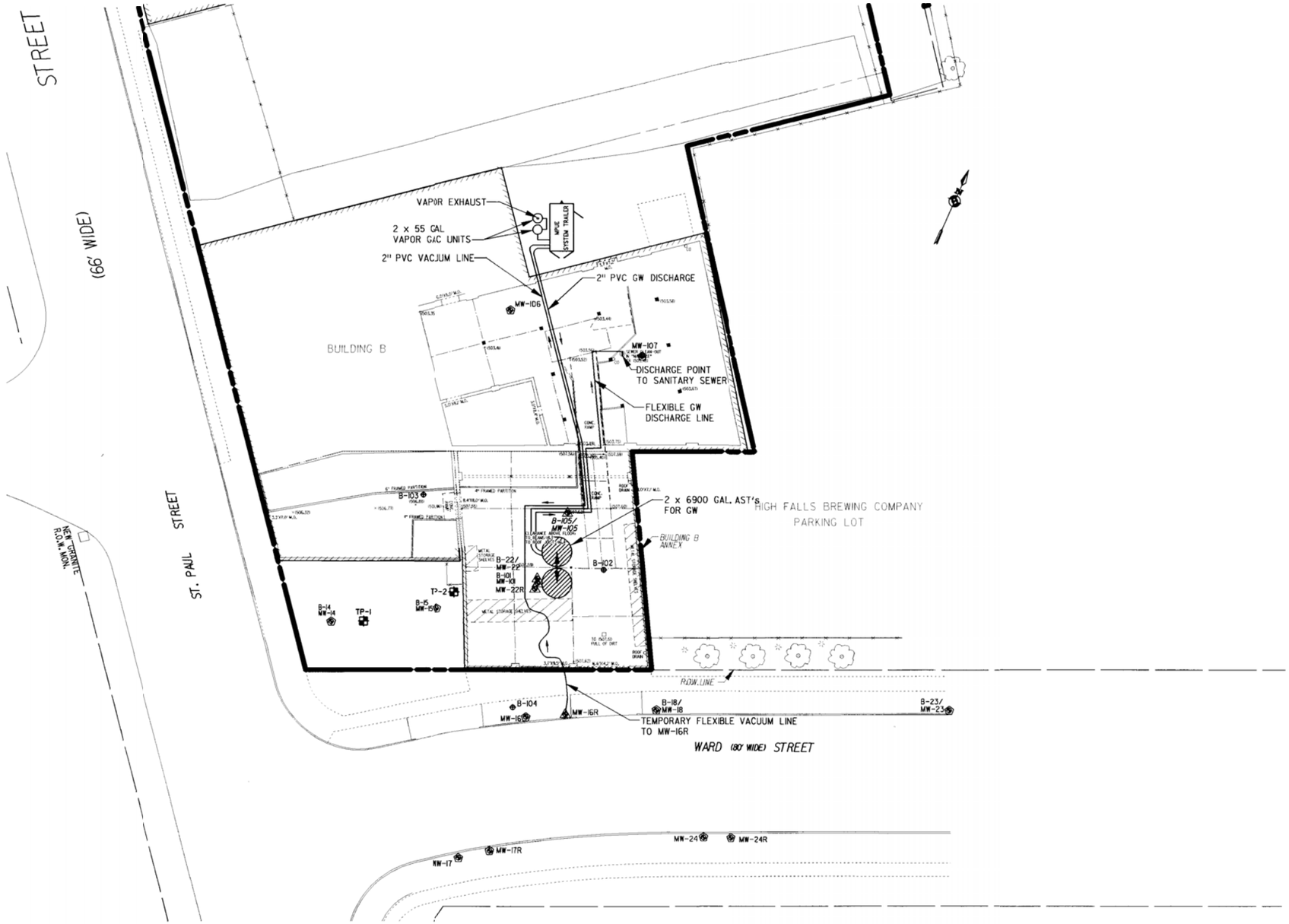

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4.26.06

Legend

- B-13 = SOIL BORING LOCATION
- B-101/MW-101 = MONITORING WELL LOCATION
- TP-1 = TEST PIT LOCATION
- MASONRY WALL
- MASONRY WALL ABOVE
- CONTROL JOINT
- STEEL HAND RAILING
- CHANGE IN GRADE LINE
- 6" SQUARE STEEL COLUMN
- 8" SQUARE STEEL COLUMN
- 1.0'X1.2' WOOD COLUMN
- PILOT STUDY EXTRACTION WELL
- PILOT STUDY MONITORING WELL

0 30 60 90
SCALE IN FEET

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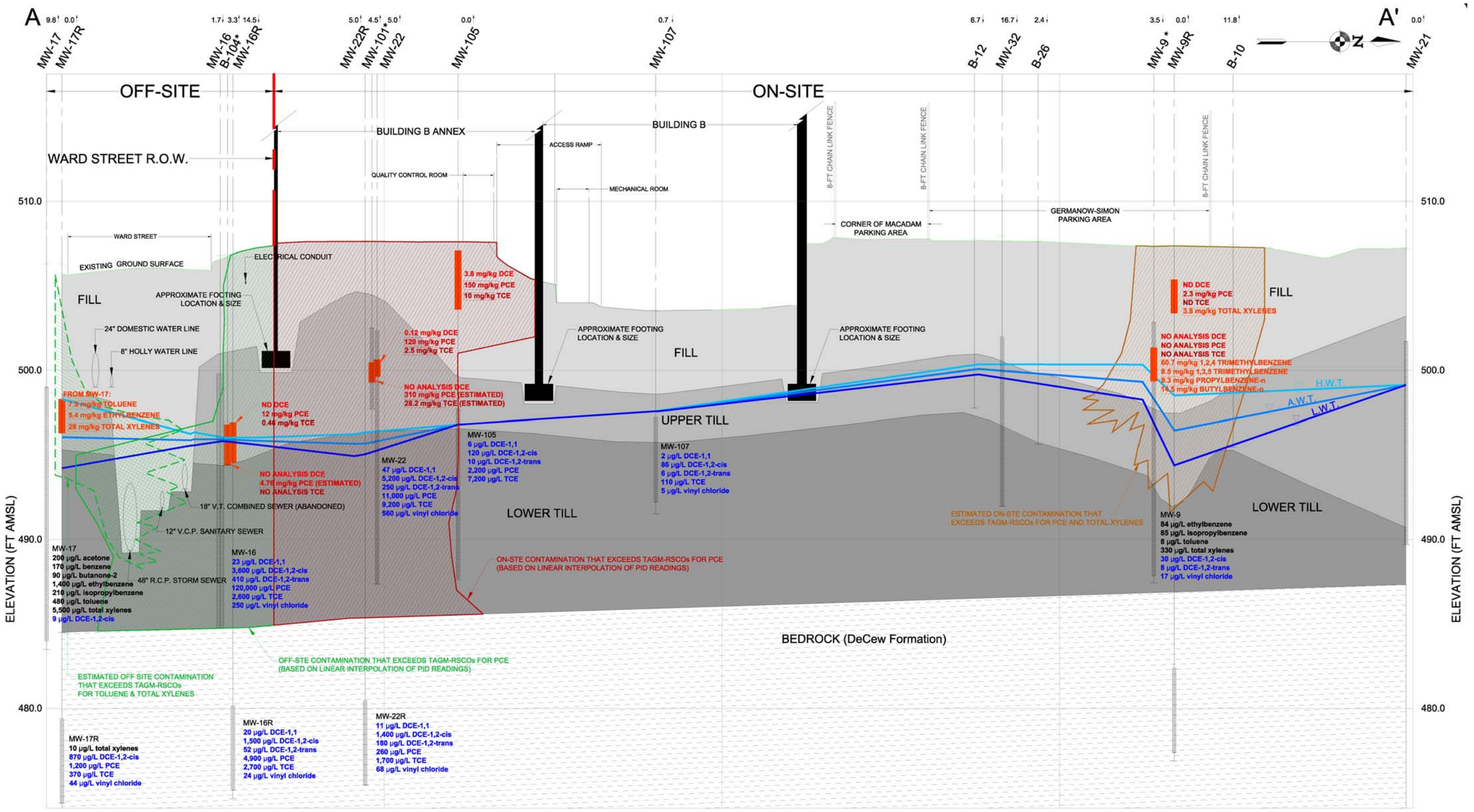
MPVE PILOT STUDY, WARD STREET SITE, ROCHESTER, NEW YORK

Figure No.
2

Title
Site Plan



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4.13.06

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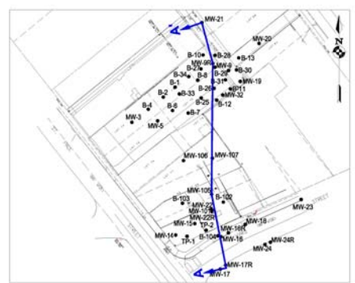
LEGEND:

- = ON-SITE PCE CONTAMINATION > TAGM-RSCOs (BASED ON LINEAR INTERPOLATION OF PID READINGS)
- = ESTIMATED ON-SITE STODDARD SOLVENT CONTAMINATION > TAGM-RSCOs
- = OFF-SITE PCE CONTAMINATION > TAGM-RSCOs (BASED ON LINEAR INTERPOLATION OF PID READINGS)
- = ESTIMATED OFF-SITE PETROLEUM HYDROCARBON CONTAMINATION > TAGM-RSCOs
- = SAMPLE LOCATION
- DCE = DICHLOROETHENE -1,2 (CIS)
- PCE = TETRACHLOROETHENE
- TCE = TRICHLORETHENE
- ND = ANALYZED BUT NOT DETECTED
- 28.2 mg/kg BOXED SOIL CONCENTRATIONS EXCEED TAGM-RSCOs.

- = APPROXIMATE WELL SCREEN LOCATION
- H.W.T. = APPROXIMATE HIGH GROUNDWATER WATER TABLE ELEVATION
- A.W.T. = APPROXIMATE AVERAGE GROUNDWATER TABLE ELEVATION
- L.W.T. = APPROXIMATE LOW GROUNDWATER TABLE ELEVATION
- 10 µg/L total xylenes = NON-CHLORINATED VOCs IN GROUNDWATER >CLASS GA STANDARDS
- 870 µg/L DCE-1,2-cis = CHLORINATED VOCs IN GROUNDWATER >CLASS GA STANDARDS
- 3.5' = OFFSET FROM A-A' AXIS. (- INDICATES DISTANCE IS EAST OF AXIS) (+ INDICATES DIRECTION IS WEST OF AXIS)
- * = NON-ASP SOIL ANALYSES. CONCENTRATIONS FOR PCE AND TCE IN SOIL SAMPLES COLLECTED FROM MW-101 AND B-104 ARE ESTIMATES.

NOTES:

1. GROUNDWATER SURFACES, STRATA INTERFACES AND GROUND SURFACE ARE BASED ON LINEARLY INTERPOLATED SURFACES THAT INCLUDE ALL AVAILABLE BORINGS AND SURVEY DATA.
2. UNDERGROUND ELECTRICAL SERVICE IS PRESENT WITHIN WARD STREET R.O.W. TYPICAL DEPTH FOR THIS SERVICE IS 18-24" BELOW GROUND SURFACE.



KEY MAP
SCALE 1"=200'

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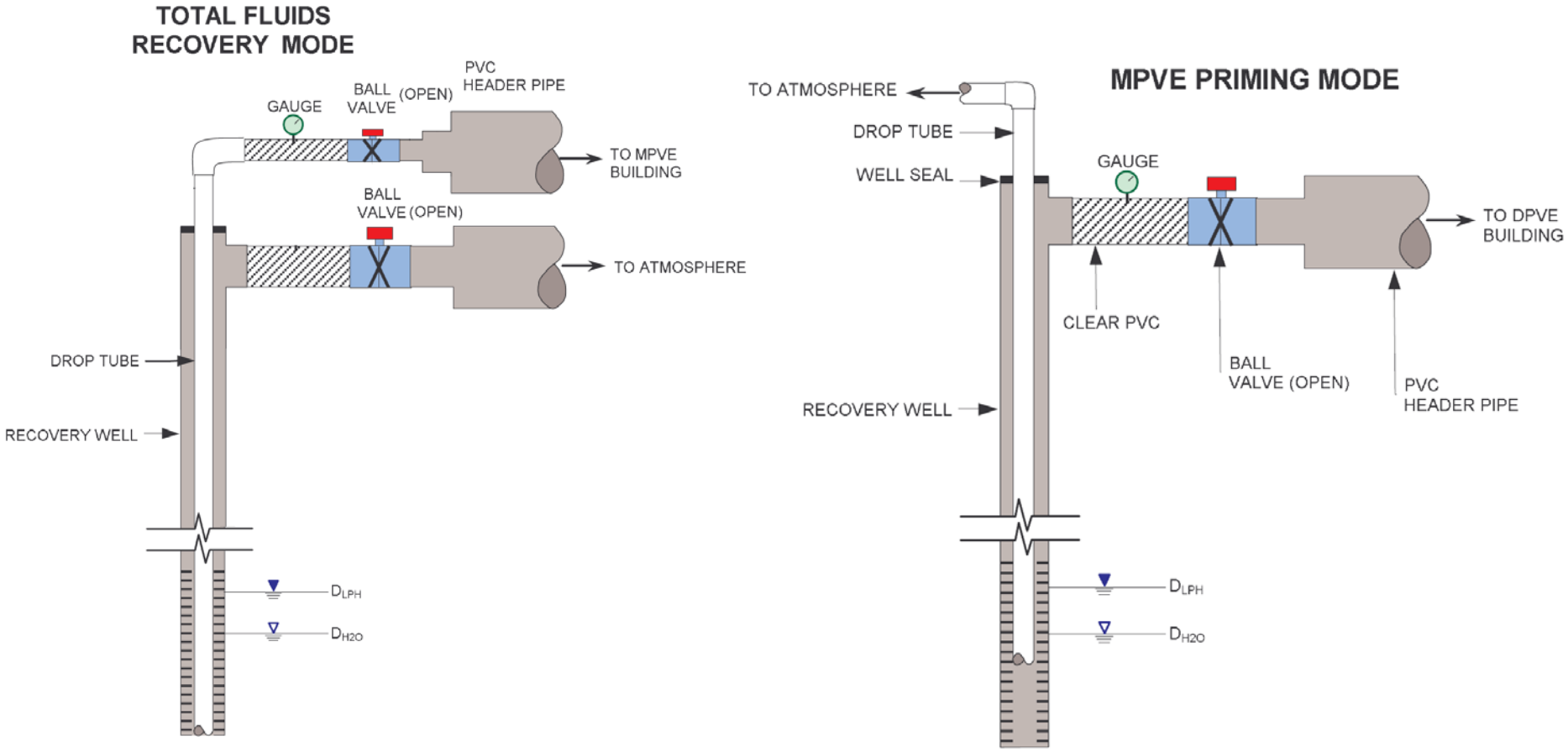
MPVE PILOT STUDY, WARD STREET SITE, ROCHESTER, NEW YORK

Figure No.
3

Title
Site Cross Section



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4.26.06

Legend

D_{LPH} – Depth to liquid petroleum hydrocarbons

D_{H2O} – Depth to groundwater

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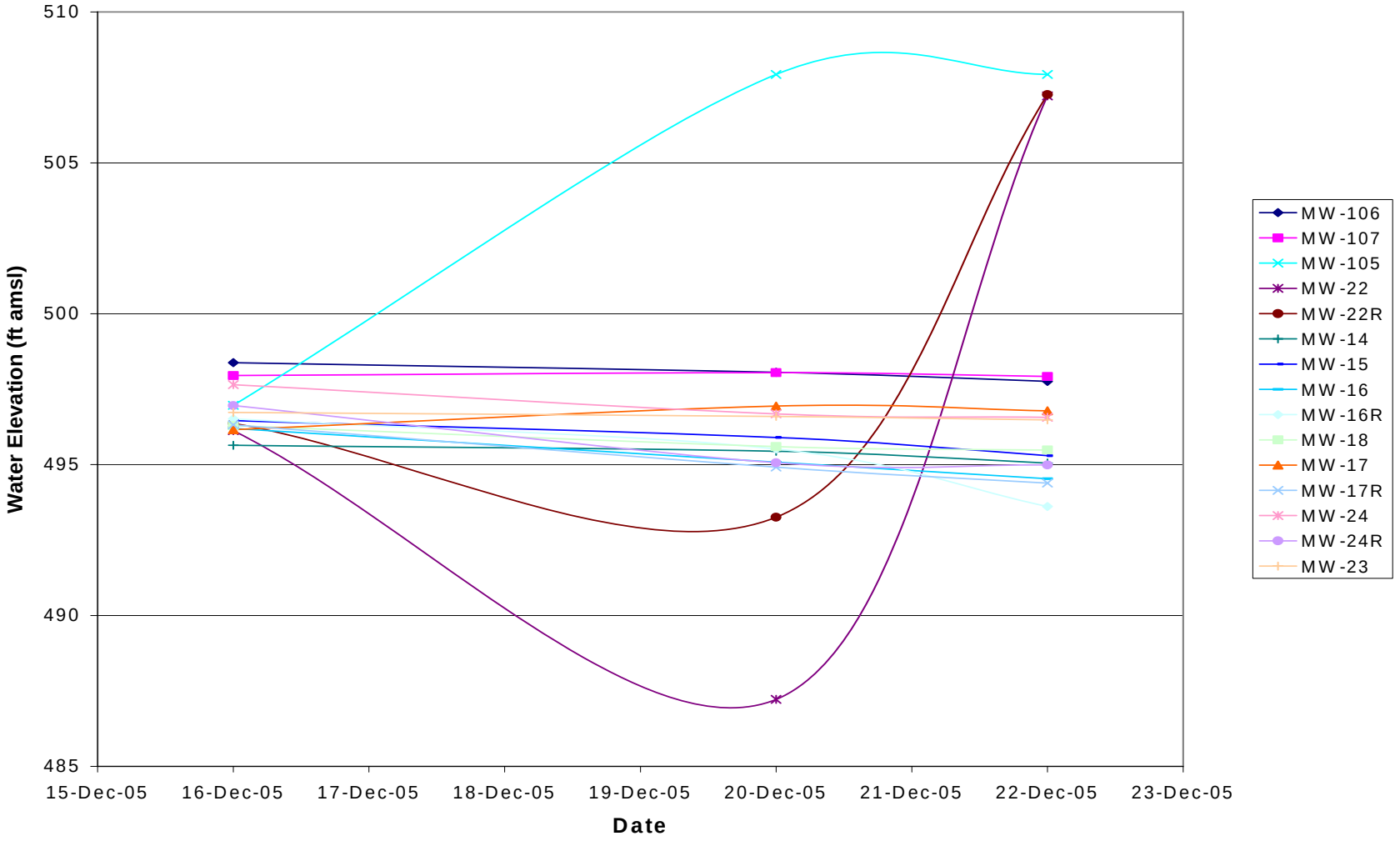
Figure No.
4

Title
Extraction Wellhead Design



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4.26.06

Legend

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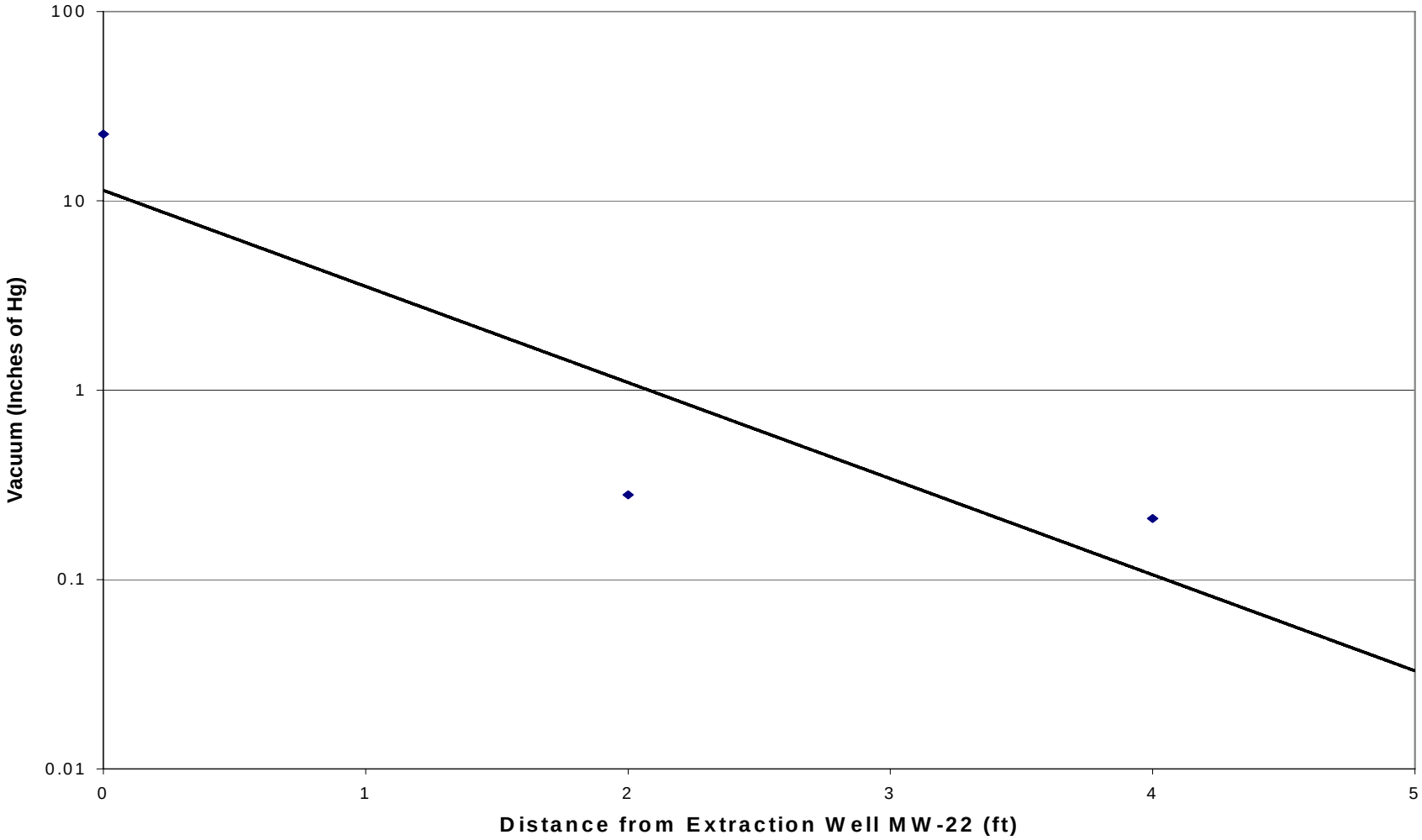
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
5

Title
Groundwater Elevations



U:\1405205\data\Remediation\MB\Pilot Study - November2005\Pilot Study Results\Final report\Final Report_13april06\figures\Figure 6.doc
4.26.06

Legend

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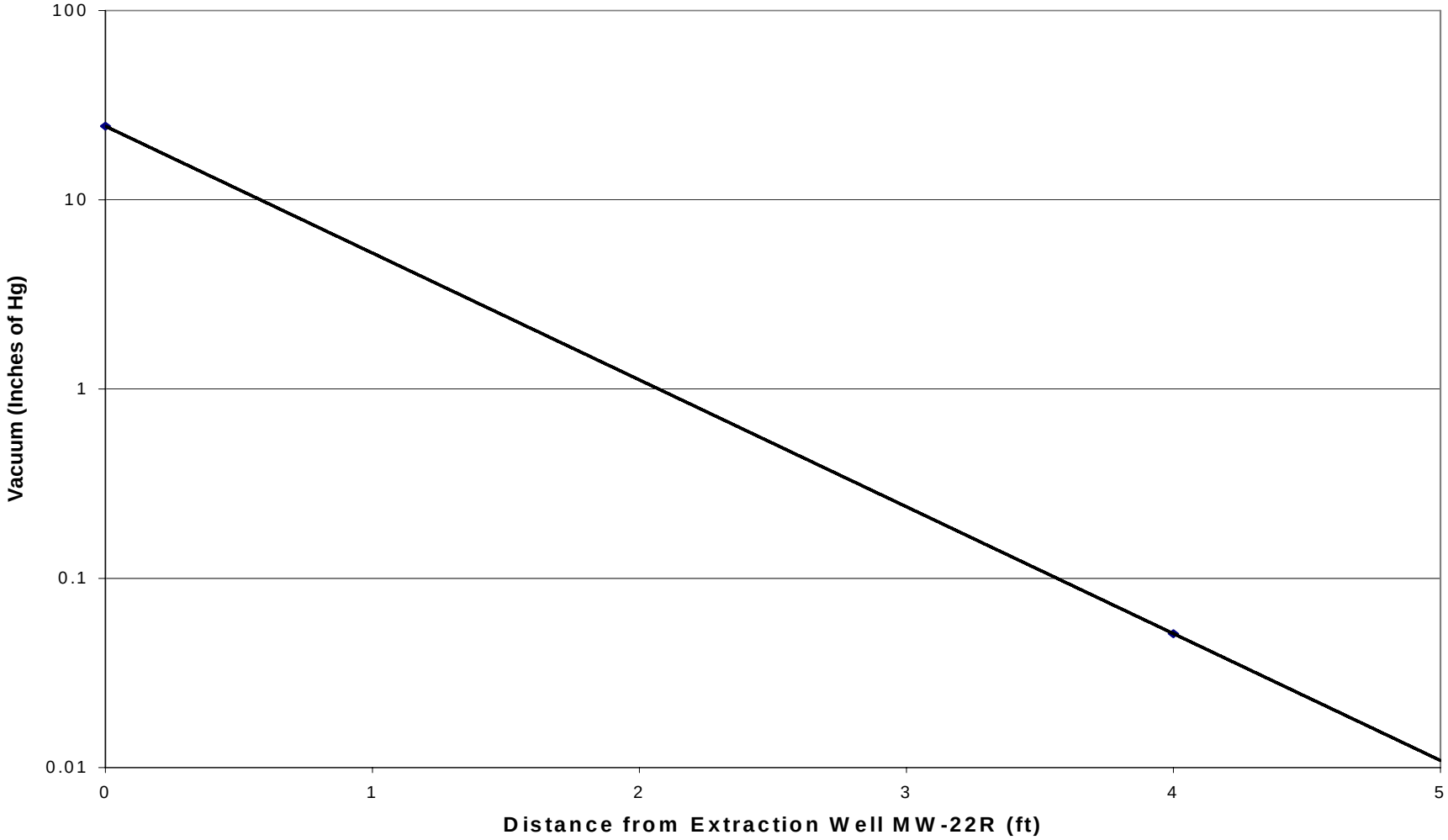
MPVE PILOT STUDY, WARD STREET SITE, ROCHESTER, NEW YORK

Figure No.
6

Title
Pneumatic Radius of Influence One Well (MW-22)



U:\1405205\data\Remediation\MB\Pilot Study - November2005\Pilot Study Results\Final report\Final Report_13april06\figures\Figure 7.doc
4.26.06

Legend

Stantec

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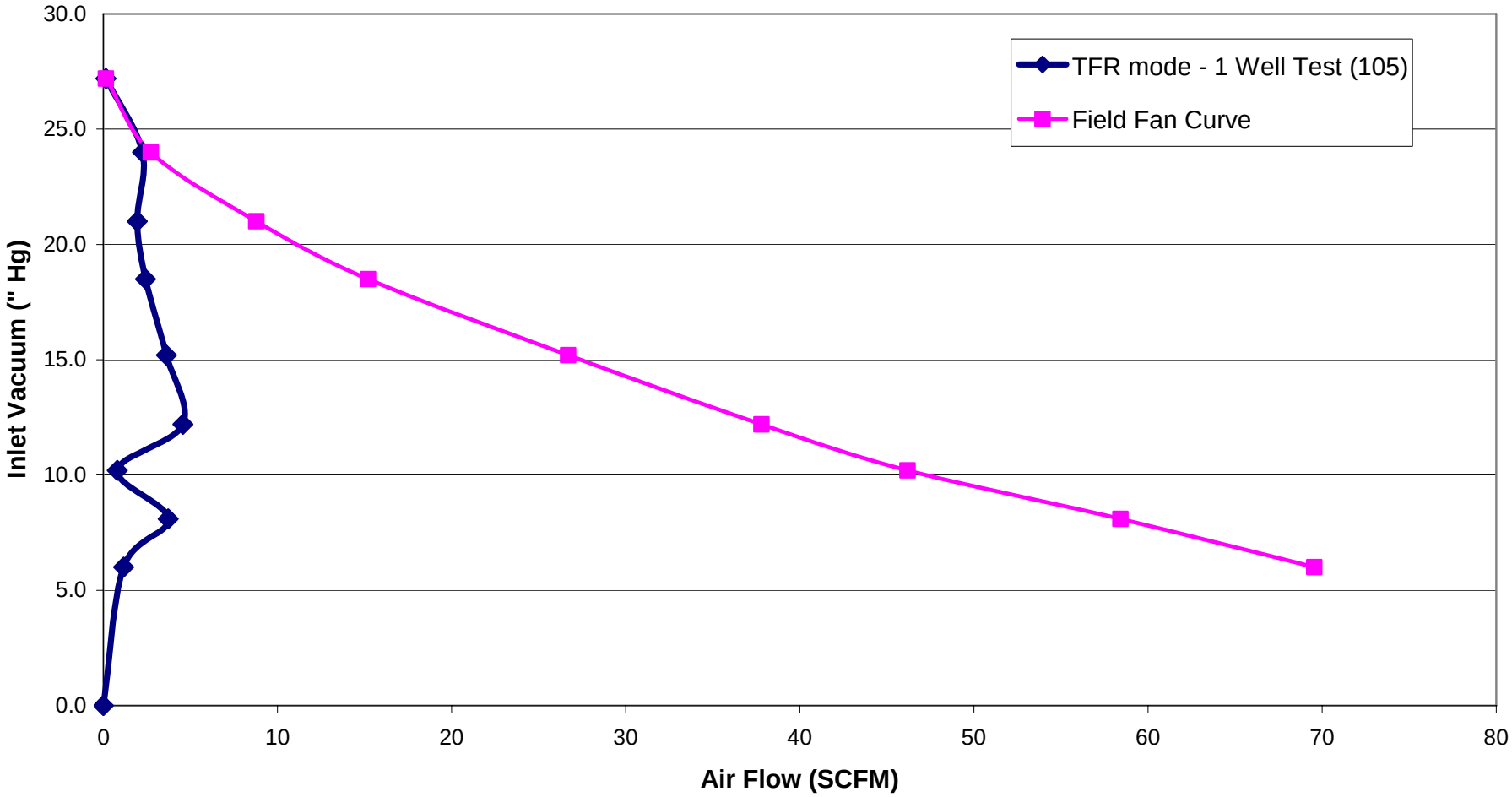
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
7

Title
Pneumatic Radius of Influence
One Well (MW-22R)



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4.26.06

Legend

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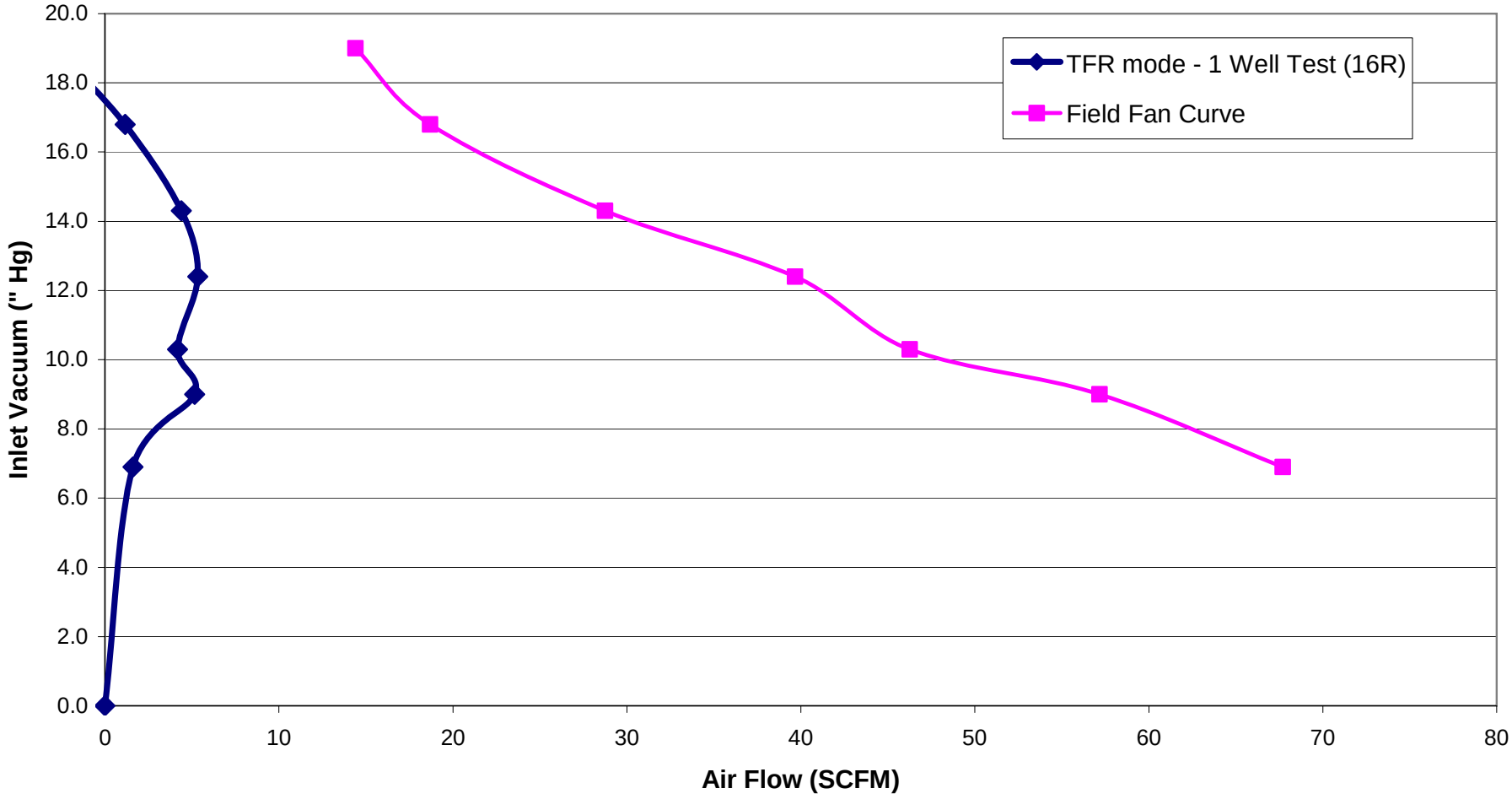
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
8

Title
Formation Airflow Summary
One Well (MW-105)



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Legend

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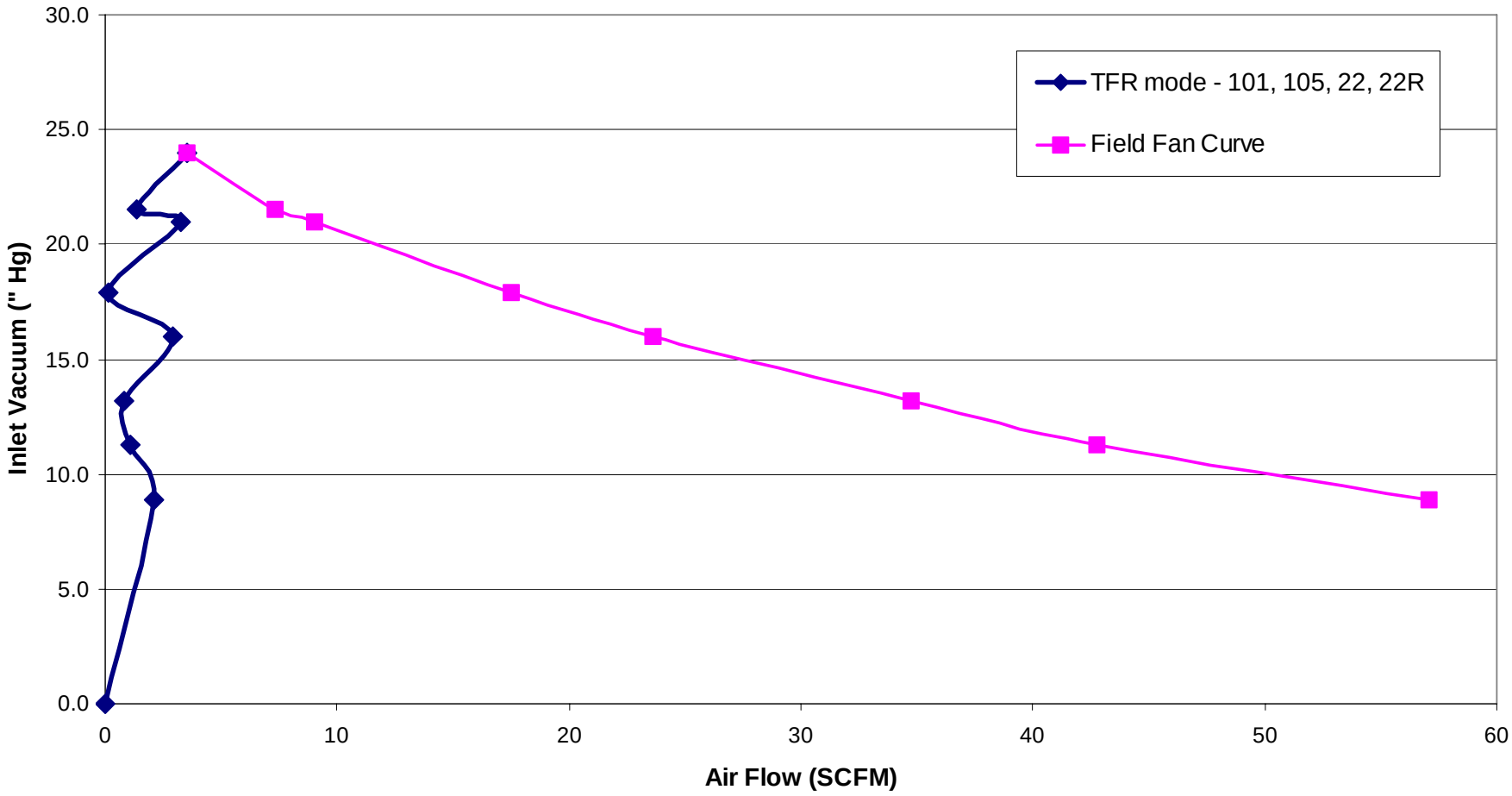
ROCHESTER, NEW YORK

Figure No.
9

Title
Formation Airflow Summary
One Well (MW-16R)



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Legend

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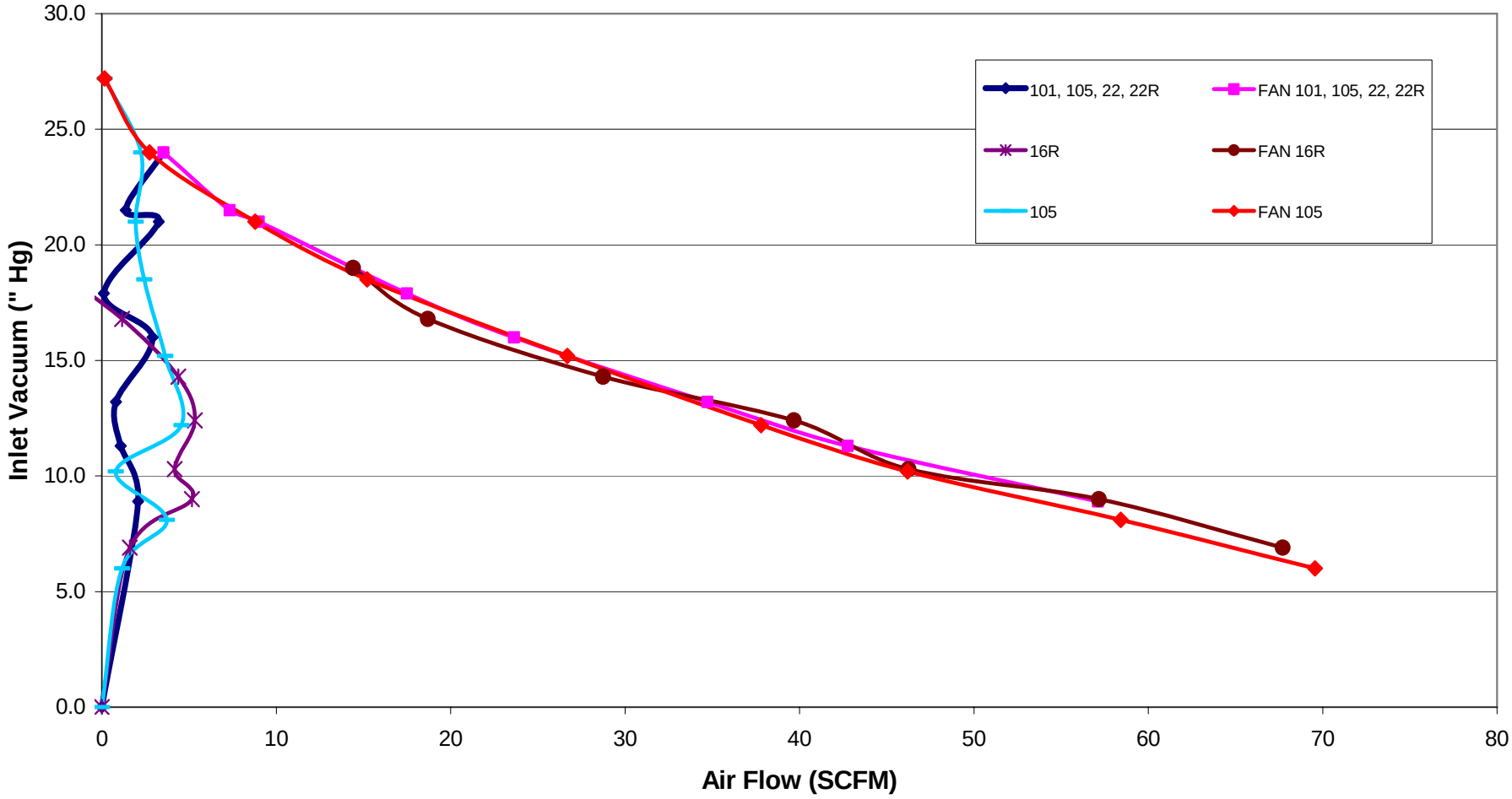
Figure No.
10

Title
Formation Airflow Summary
Four Well (MW-101, MW-105, MW-22, MW-22R)



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4.26.06

Legend

FAN: Total formation and bleed air flow curve

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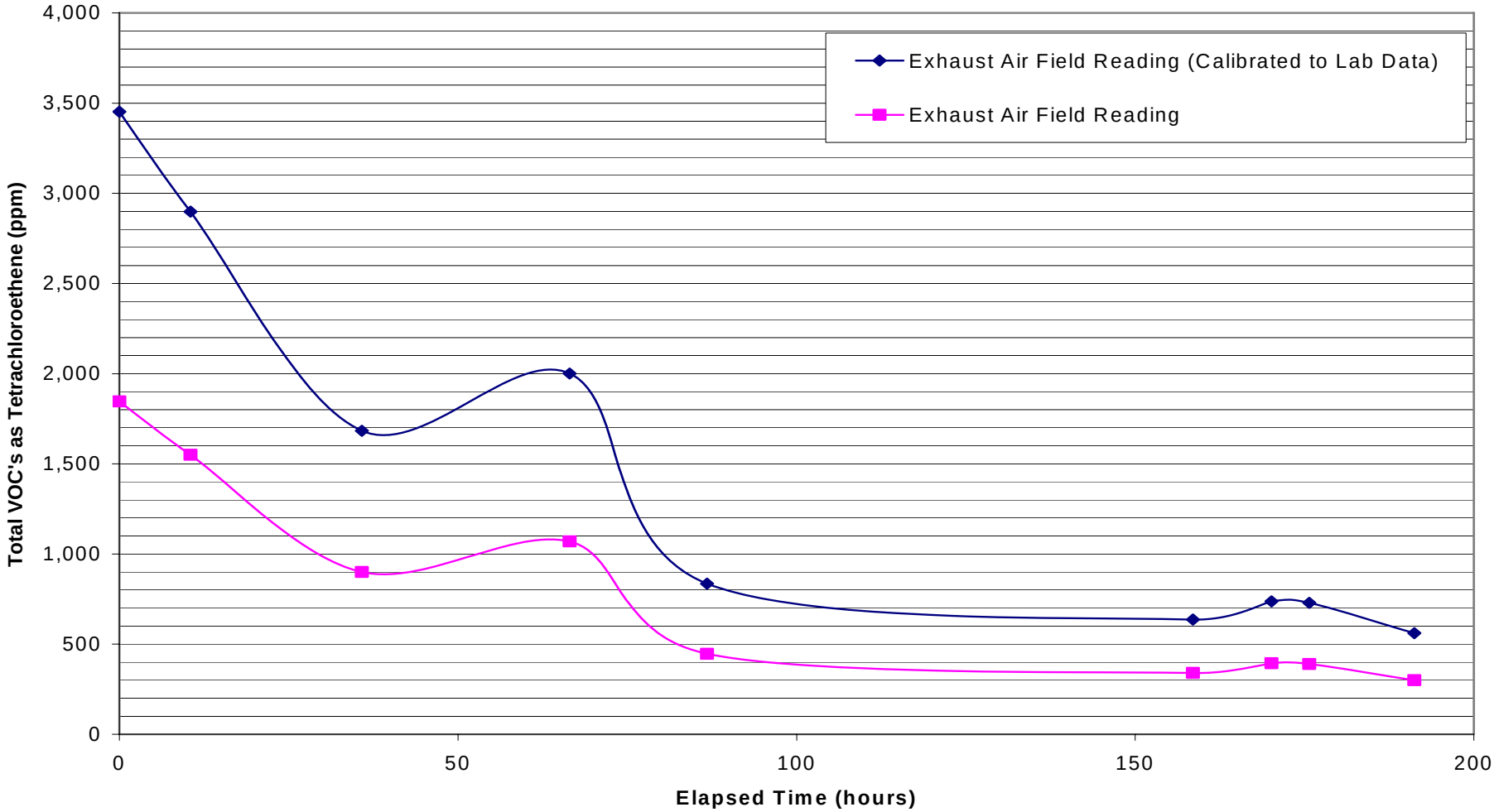
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
11

Title
Formation Airflow Curve Summary



U:\1405205\data\Remediation\MB\Pilot Study - November2005\Pilot Study Results\Final report\Final Report_13april06\figures\Figure 12.doc
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Legend

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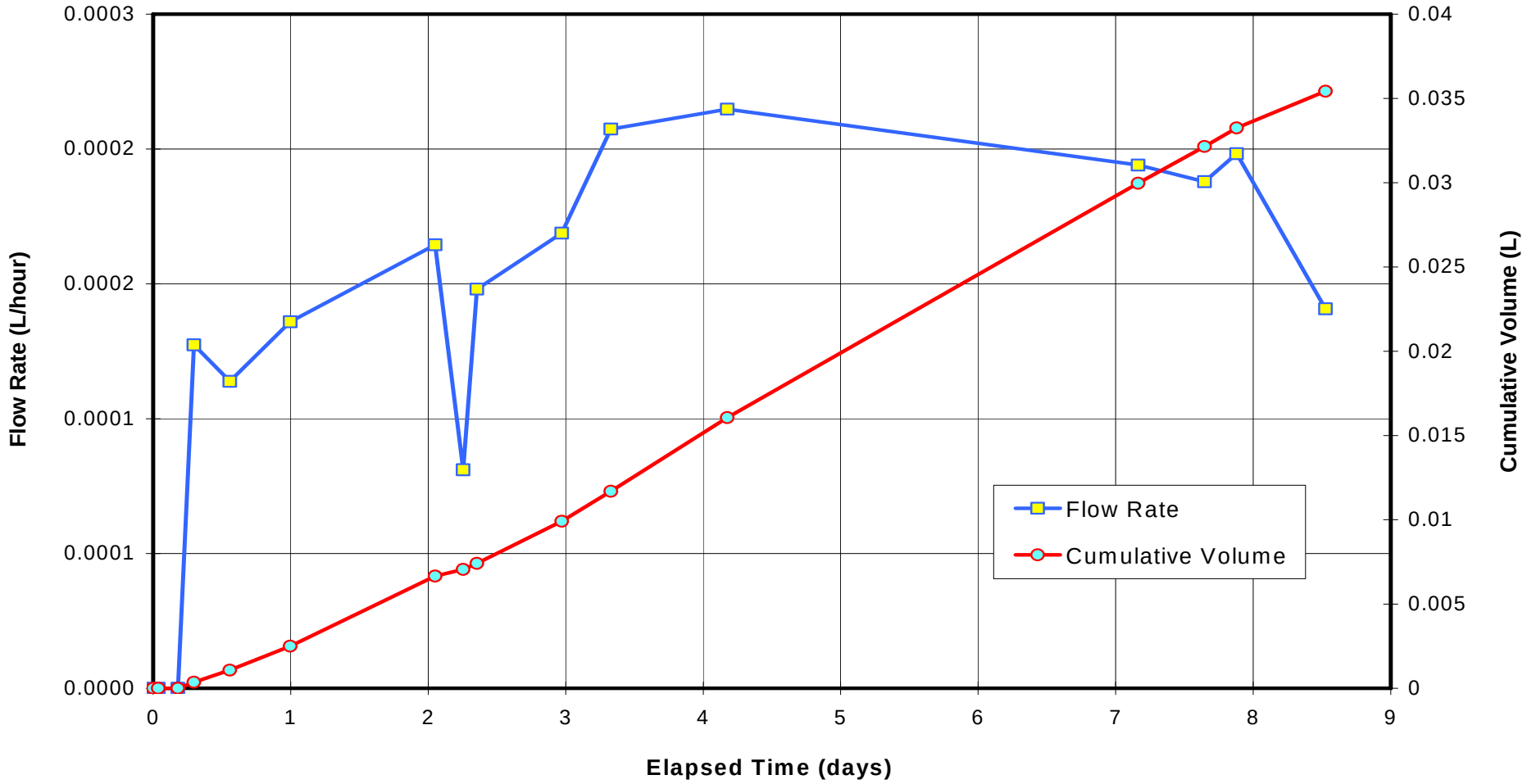
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
12

Title
Total VOC's as PCE
In Exhaust Air



U:\1405205\data\Remediation\MB\Pilot Study - November2005\Pilot Study Results\Final report\Final Report_13april06\figures\Figure 13.doc
4.26.06

Legend

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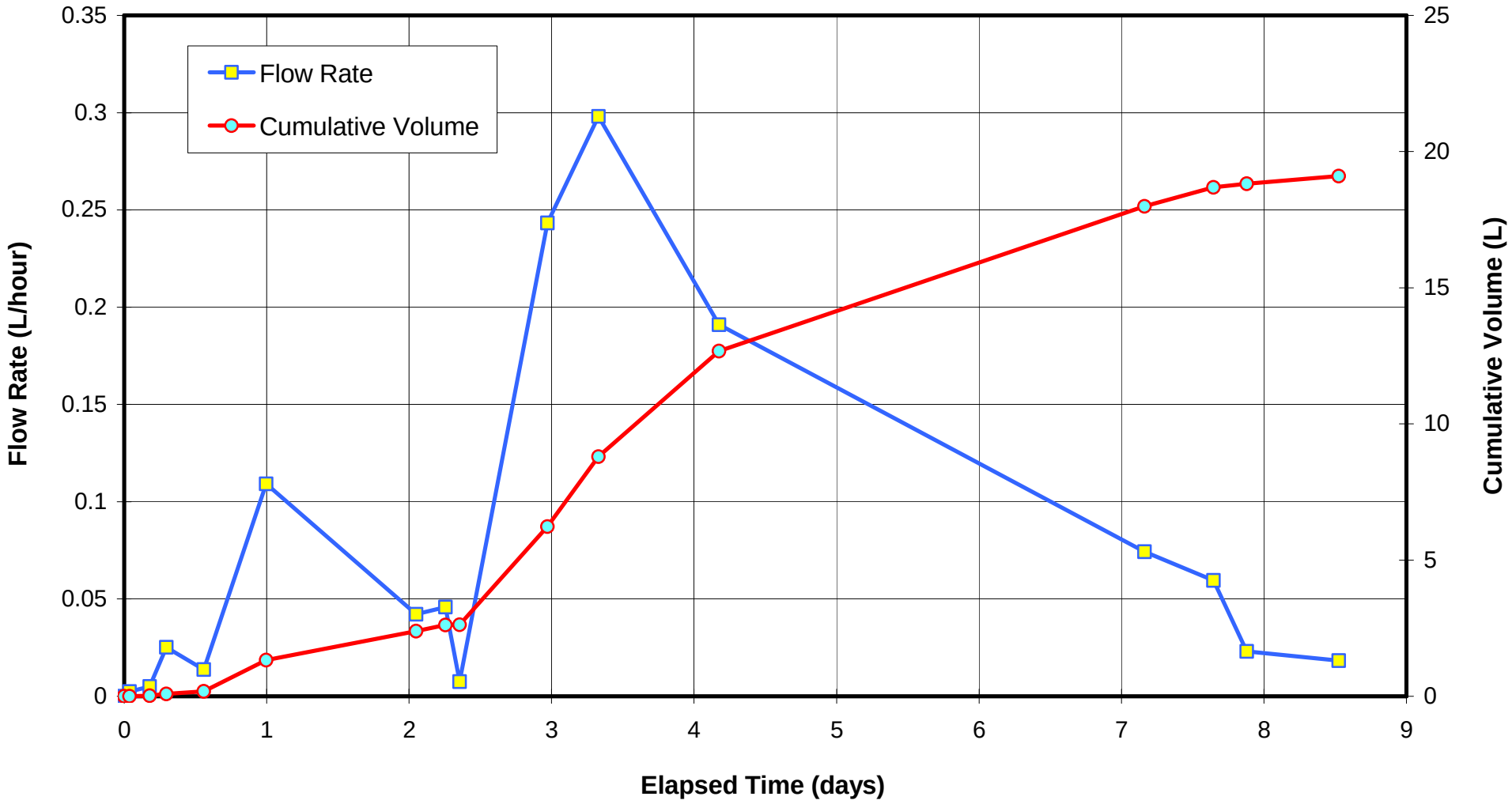
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
13

Title
Hydrocarbon Dissolved Phase Removal Versus Elapsed Time



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Legend

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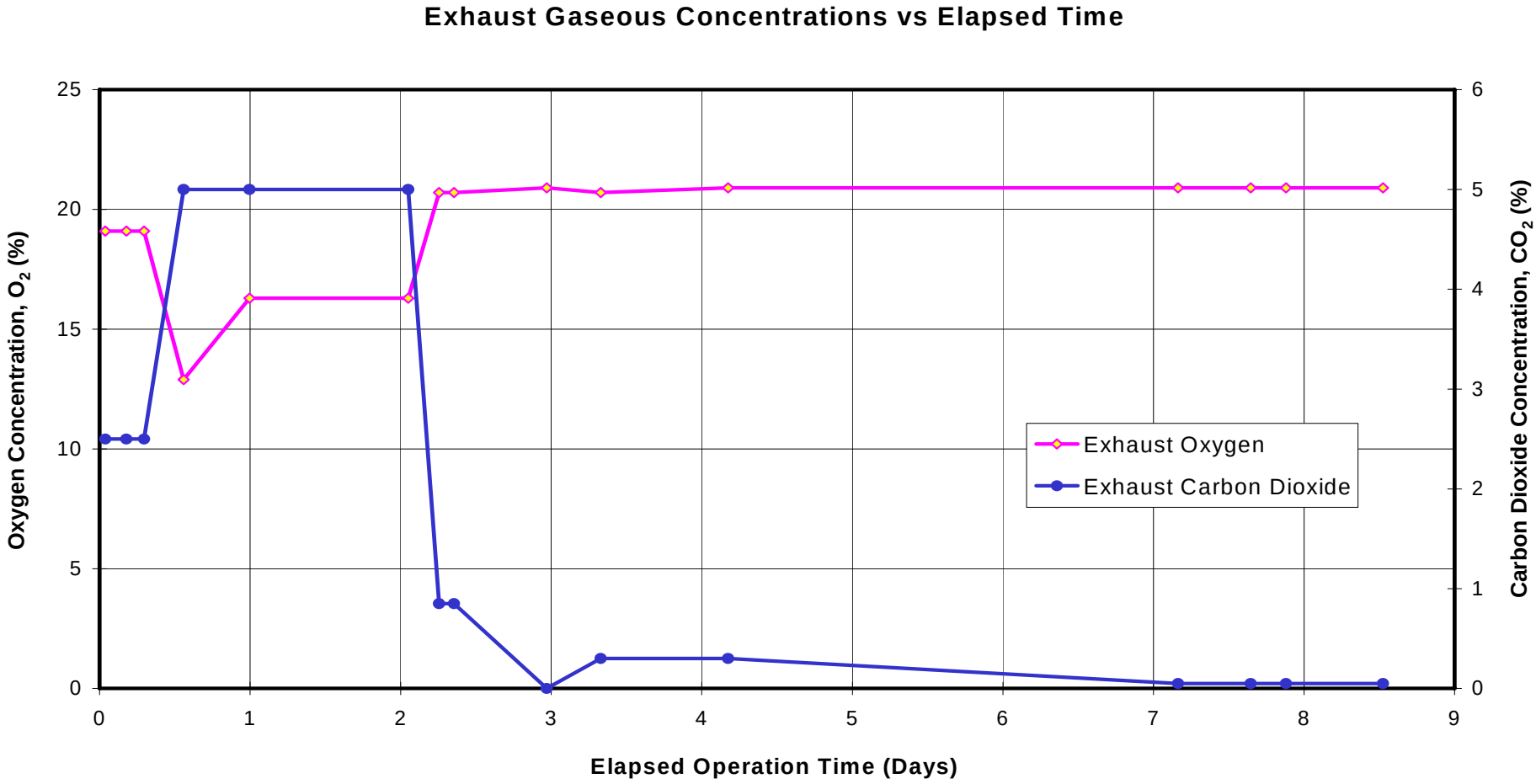
Figure No.
14

Title
Hydrocarbon Vapour Phase Removal Versus Elapsed Time



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Legend

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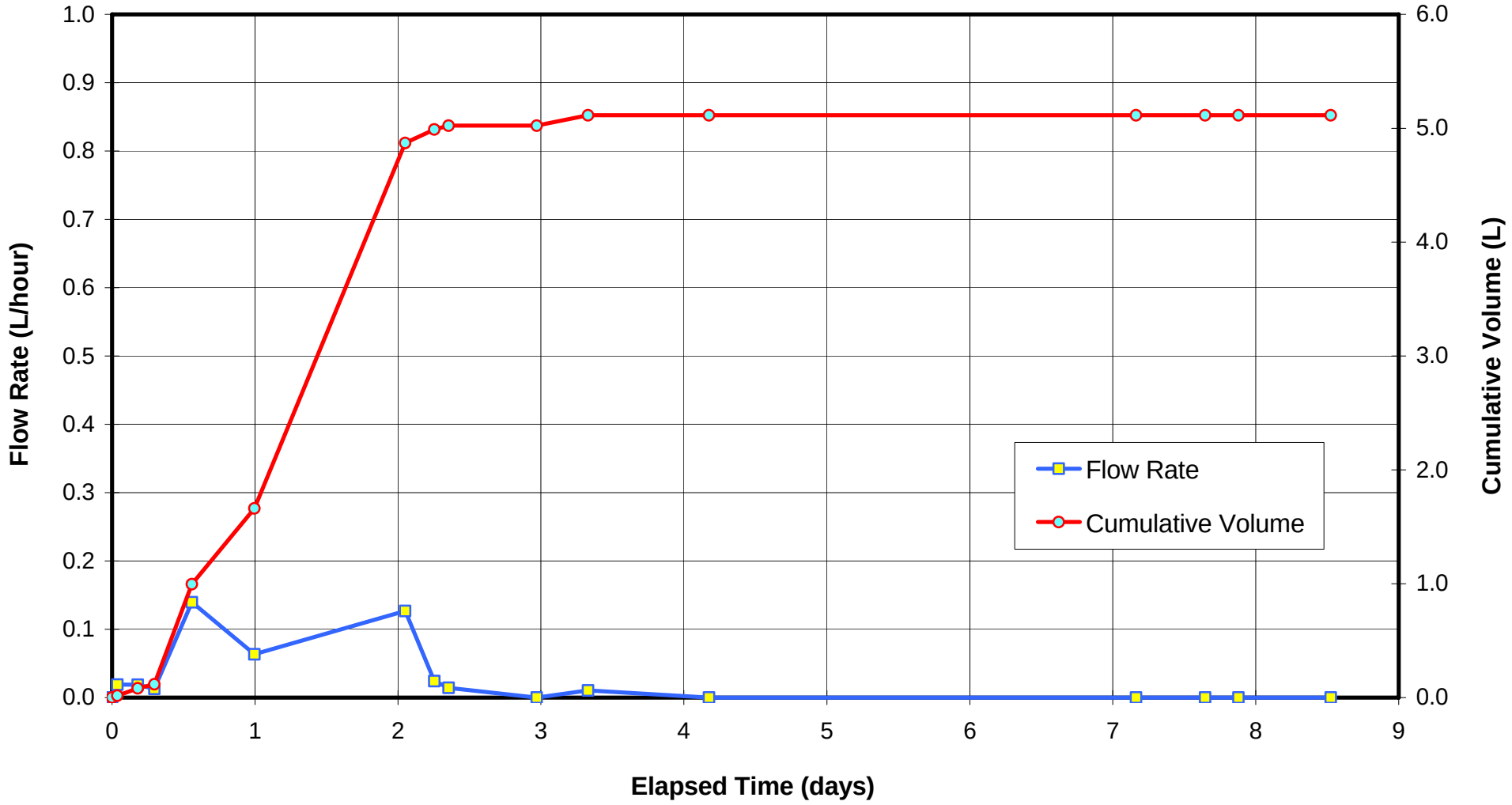
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
15

Title
Gaseous O_2 and CO_2 Concentrations Over Time



U:\1405205\data\Remediation\MB\Pilot Study - November2005\Pilot Study Results\Final report\Final Report_13april06\figures\Figure 16.doc
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Legend

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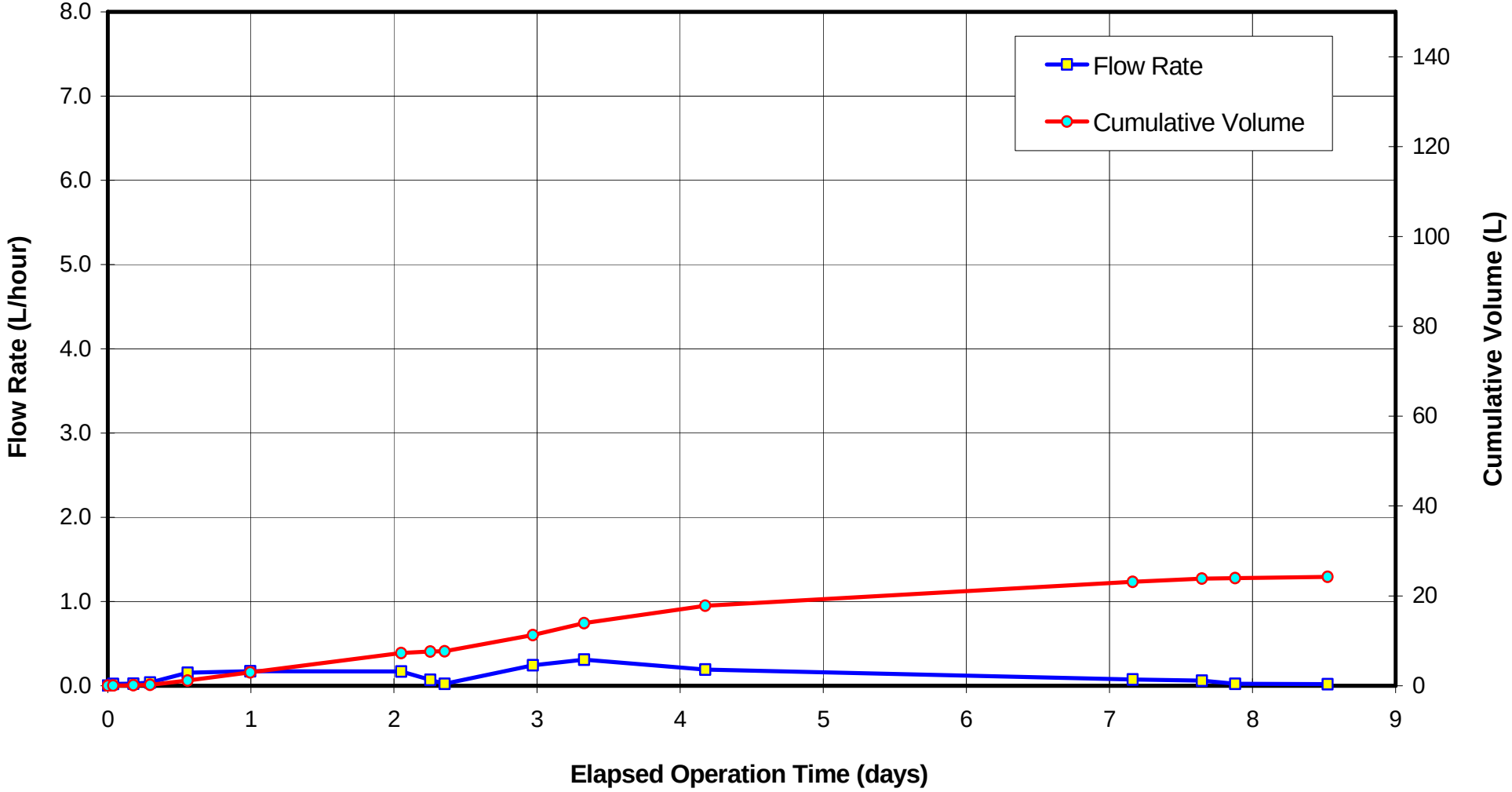
GERMANOW SIMON CORPORATION
MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
16

Title
Biodegradation Versus Elapsed Time



U:\1405205\data\Remediation\MB\Pilot Study - November2005\Pilot Study Results\Final report\Final Report_13april06\figures\Figure 17.doc
4.26.06

Legend

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MPVE PILOT STUDY, WARD STREET SITE,
ROCHESTER, NEW YORK

Figure No.
17

Title
Total Hydrocarbon Recovery
Versus Elapsed Time

APPENDIX A

Site Photographs

PHOTO 1 View of MPVE trailer in parking lot north of Building B.

PHOTO 2 View of MPVE trailer in parking lot north of Building B.

PHOTO 3 View of MPVE trailer exhaust point. Exhaust air was piped from this point to GAC treatment drums.

PHOTO 4 Pan of Building B Annex area to Building B ramp prior to delivery of recovery vessels and installation of system piping.

PHOTO 5 View of recovery Tank 1 being unloaded at the shipping/receiving entrance to the Building B Annex.

PHOTO 6 View of recovery Tanks 1 and 2 in the Building B Annex. The flexible discharge line is visible running up the side of Tank 1.

PHOTO 7 View of recovery tanks in Building B Annex. White 2" PVC header pipe is being set up along the edge of the tank.

PHOTO 8 View of header pipe and discharge pipe from Building B Annex down ramp to Building B.

PHOTO 9 View of header pipe and discharge pipe towards north wall of Building B.

PHOTO 10 Header pipe and discharge pipe passing through a window along the north wall of Building B.

PHOTO 11 View of connection at MW105 operating in total fluids recovery mode. The length of PVC pipe visible to the right of the lower valve and the Magnahelic gauges behind the well are used for air flow measurement.

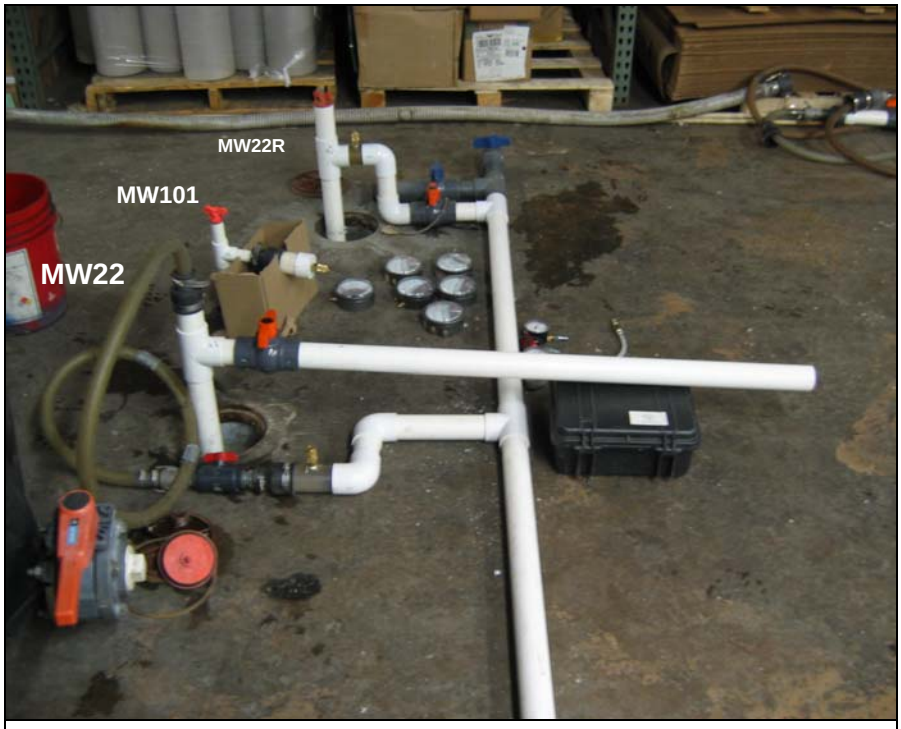

PHOTO 12 View of MW22, MW101, and MW22R. MW 22 is connected in total fluids recovery mode, MW22R is connected in non-priming mode.

PHOTO 13 Interior of MPVE trailer. Photo provided by Pro-Act.

PHOTO 14 Detail of liquid ring pump, air filter and system vessel.

APPENDIX B

ProAct Specifications

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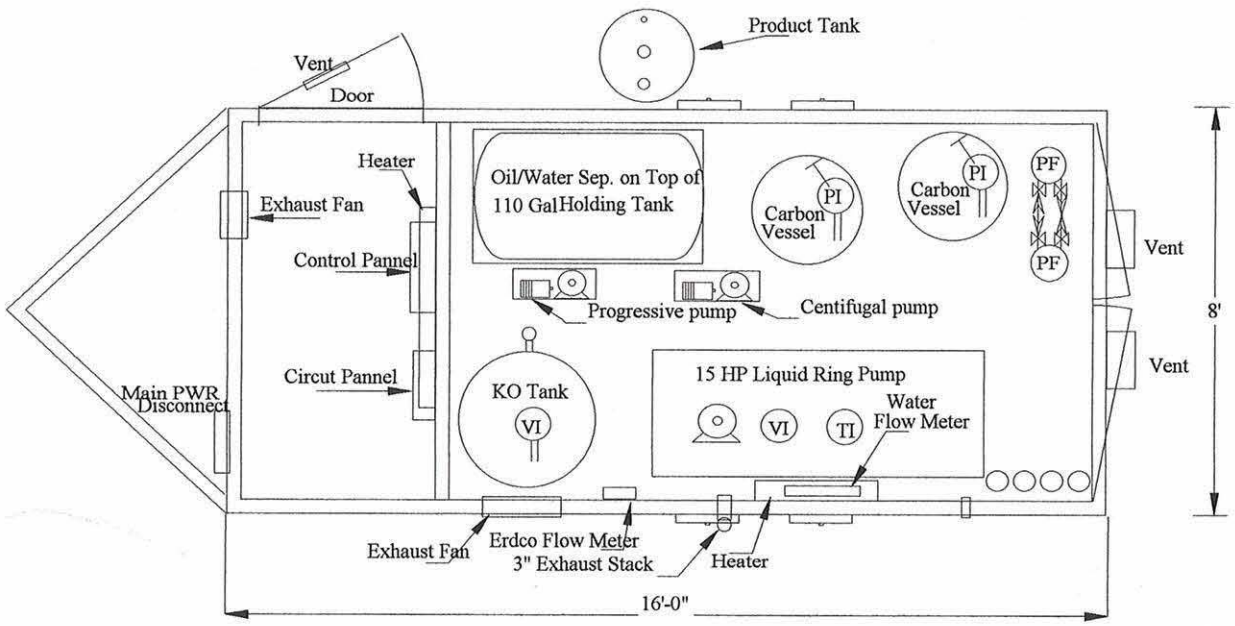
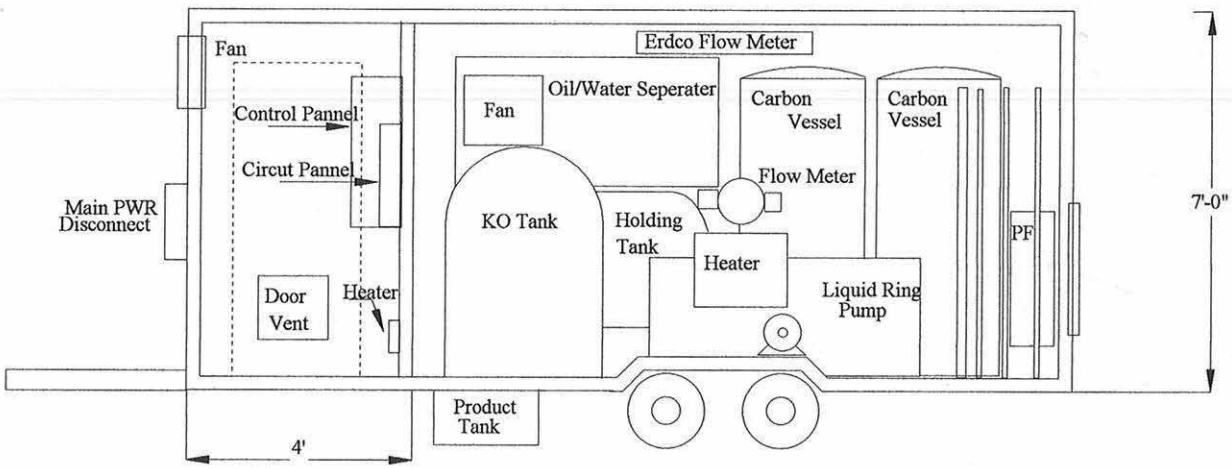
1140 Conrad Industrial Drive • Ludington, MI 49431 • (231) 843-2711 • Fax: (231) 843-4081

Specification Sheet

System:	**Multi Phase Extraction System** **Liquid Ring Pump w/ oil-water separator** **Bag filters, carbon adsorbers**
General Specifications:	**200 ACFM @ 28" Hg** **5 GPM water pump**
Trailer/System Size:	**8 ft wide x 16 ft long x 7 ft height** **7000 pounds double axle trailer**
Main Equipment:	**15 Hp Oil sealed Liquid Ring Pump** **120 gallon knock out tank w/clean out port** **5 GPM XP ¾ Hp Moyno pump** **10 GPM Oil/water separator** **55 gallon product collection drum** **10 GPM XP ½ Hp transfer pump** **2-LCO8 Rosedale bag filters** **2-200 pound granular activated carbon adsorbers** **Erco flow meter (air)** **Totalizing water flow meter** **Vacuum and pressure gauges, sample ports**
Trailer Specifications:	**XP Lights, Heater, fan in equipment room** **Components in equipment room wired for XP conditions** **Outside light and control panel**
Control Panel Specifications:	**PLC (Program Logic controller)** **HAO Switch all components** **Emergency stop button** **Fault lights and reset** **GFI**
Inlet hose connection:	**4 male camlock 2" inlet fittings (4 well manifold including site glass, flow meter, vacuum gauge, flow control valve.**
Outlet hose connection:	**2" air stack for LRP exhaust (18 ft ht.)** **Vapors can be plumbed for off-gas treatment** **1" male camlock water discharge**
Power requirement:	**230 volt, 3 phase, 50 Amp service (Main fused disconnect located outside trailer)**
Cost:	**$2,250/week or $4,475/month**

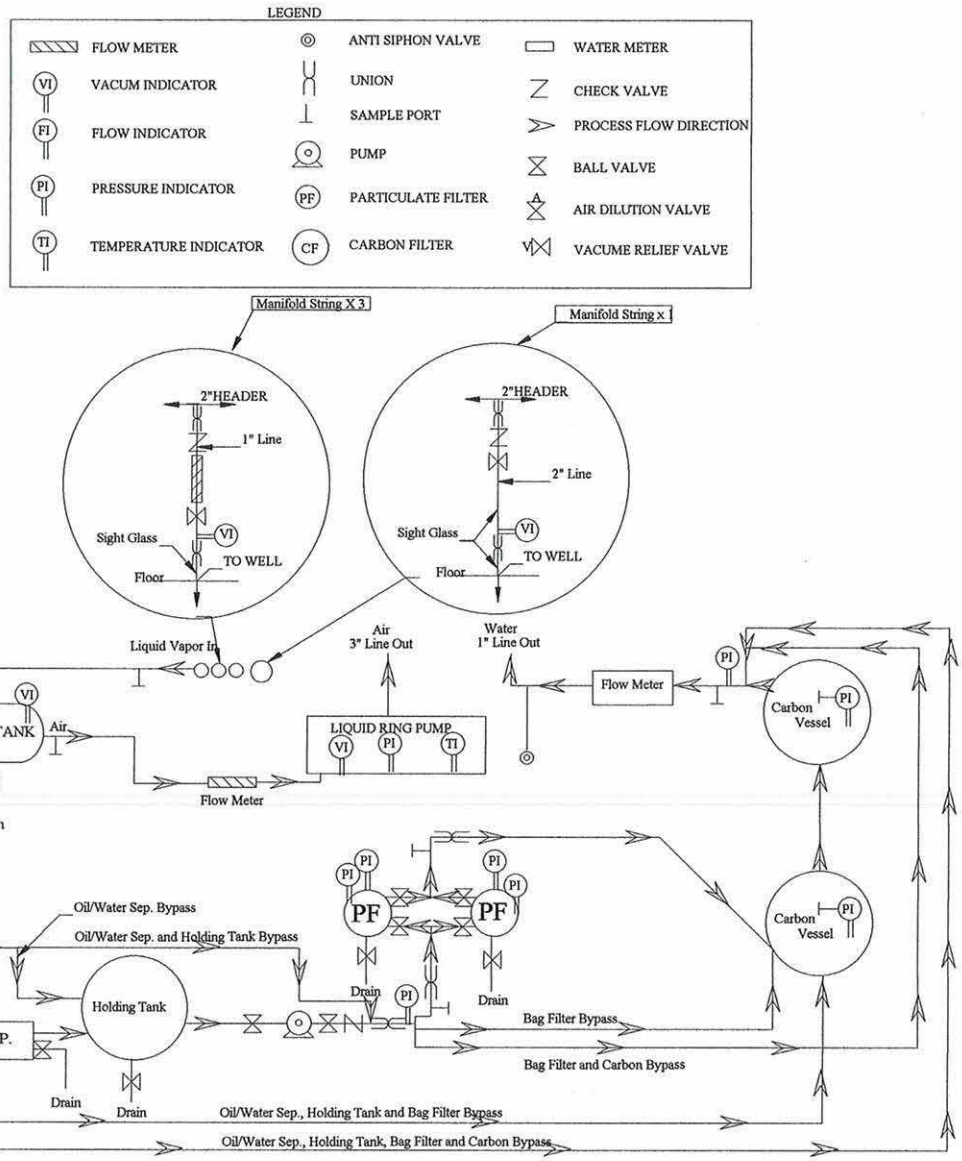


PLAN VIEW



SIDE VIEW

PROACT SERVICES CORPORATION	TITLE STATE OF MICHIGAN WATER TREATMENT TRAILER			
For use by ProAct only	SIZE B	CAGE CODE	PROJECT NO. 471	REV 1
Drawings By: Gerard Smiddy	SCALE NTS			SHEET 2 OF 2



PID

PROACT SERVICES CORPORATION	TITLE STATE OF MICHIGAN WATER TREATMENT TRAILER			
For use by ProAct only	SIZE B	CAGE CODE	PROJECT NO. 471	RE 1
Drawings By: Gerard Smiddy	SCALE NTS			SHEET 1 OF 2

APPENDIX C

Analytical Results

Stantec

Appendix C
Summary of Groundwater Analytical Results - December 2005 - January 2006
Germanow-Simon Corporation - Ward Street Site
Multi Phase Vacuum Extraction Pilot Study

	Analytical Results (ug/L)							
Sampling date	**20-Dec-05**	**20-Dec-05**	**20-Dec-05**	**20-Dec-05**	**23-Dec-05**	**23-Dec-05**	**5-Jan-06**	**6-Jan-06**
Sample Identification	**GTS-1**	**GTS-2**	**GTS-3**	**GTS-4**	**GTS-1A**	**GTS-2A**	**GTS-5A**	**GTS-5B**
Halocarbons								
Bromodichloromethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Bromomethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Bromoform	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Carbon Tetrachloride	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Chloroethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Chloromethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
2-Chloroethyl vinyl Ether	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Chloroform	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Dibromochloromethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,1-Dichloroethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,2-Dichloroethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,1-Dichloroethene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
trans-1,2-Dichloroethene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,2-Dichloropropane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
cis-1,3-Dichloropropene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
trans-1,3-Dichloropropene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Methylene chloride	ND< 50	ND< 100	ND< 5	ND< 5	ND< 50	ND< 50	ND< 5	ND< 5
1,1,2,2-Tetrachloroethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Tetrachloroethene	1200	1080	ND< 2	ND< 2	1430	1300	ND< 2	5.35
1,1,1-Trichloroethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,1,2-Trichloroethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Trichloroethene	201	389	ND< 2	ND< 2	228	198	ND< 2	ND< 2
Trichlorofluoromethane	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Vinyl chloride	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Aromatics								
Benzene	ND< 7	ND< 14	0.805	ND< 0.7	ND< 7	ND< 7	ND< 0.7	ND< 0.7
Chlorobenzene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Ethylbenzene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Toluene	ND< 20	ND< 40	2.81	3.45	ND< 20	ND< 20	ND< 2	ND< 2
1,2-Dichlorobenzene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,3-Dichlorobenzene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
1,4-Dichlorobenzene	ND< 20	ND< 40	ND< 2	ND< 2	ND< 20	ND< 20	ND< 2	ND< 2
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA	ND< 500	ND< 500

Total Halocarbons and Aromatics for non-detected compounds (50% x detection limit) (ug/L)	298.5	597	30.5	30.9	298.5	298.5	31.85	30.85
Total detected halocarbons and aromatics (ug/L)	1401	1469	3.615	3.45	1658	1498	0	5.35
Total estimated halocarbons and aromatics (ug/L)	1700	2066	35	35	1957	1797	32	37
Total estimated halocarbons and aromatics (mg/L)	**1.7**	**2.07**	**0.04**	**0.04**	**1.96**	**1.8**	**0.03**	**0.04**

Notes:
Monroe County DES maximum short term permit allowable concentration of VOCs in discharge = 2.13mg/l
Water samples collected while simultaneously extracting from wells MW-22, MW-22R, MW-101, and MW-105
Sampling Locations:
GTS-1 & GTS-1A: Collected from bottom of system vessel, prior to treatment
GTS-2 & GTS-2A: Collected prior to GAC treatment, following bag filtration
GTS-3: Immediately following GAC treatment, from bottom of holding tank within system trailer
GTS-4: From top of recovery tank 1.
GTS-5A & GTS-5B: From bottom of recovery tank 1.
ND denotes Non Detect
ug / L = microgram per Liter
mg / L = milligram per Liter
Samples analyzed using methods EPA 624 (VOCs) and NYSDOH 310.13 (TPH)

PARADIGM
ENVIRONMENTAL SERVICES, INC. 179 Lake Avenue Rochester, New York 14608 (585) 647 - 2530 FAX (585) 647 - 3311

Volatile Analysis Report for Non-potable Water

Client: Stantec Consulting

Client Job Site: Ward Street Site
Client Job Number: 190500014
Field Location: GTS-1
Field ID Number: N/A
Sample Type: Water

Lab Project Number: 05-4268
Lab Sample Number: 14468
Date Sampled: 12/20/2005
Date Received: 12/20/2005
Date Analyzed: 12/22/2005

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 20.0	trans-1,2-Dichloroethene	ND< 20.0
Bromomethane	ND< 20.0	1,2-Dichloropropane	ND< 20.0
Bromoform	ND< 20.0	cis-1,3-Dichloropropene	ND< 20.0
Carbon Tetrachloride	ND< 20.0	trans-1,3-Dichloropropene	ND< 20.0
Chloroethane	ND< 20.0	Methylene chloride	ND< 50.0
Chloromethane	ND< 20.0	1,1,2,2-Tetrachloroethane	ND< 20.0
2-Chloroethyl vinyl Ether	ND< 20.0	Tetrachloroethene	1,200
Chloroform	ND< 20.0	1,1,1-Trichloroethane	ND< 20.0
Dibromochloromethane	ND< 20.0	1,1,2-Trichloroethane	ND< 20.0
1,1-Dichloroethane	ND< 20.0	Trichloroethene	201
1,2-Dichloroethane	ND< 20.0	Trichlorofluoromethane	ND< 20.0
1,1-Dichloroethene	ND< 20.0	Vinyl chloride	ND< 20.0

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 7.00	1,2-Dichlorobenzene	ND< 20.0
Chlorobenzene	ND< 20.0	1,3-Dichlorobenzene	ND< 20.0
Ethylbenzene	ND< 20.0	1,4-Dichlorobenzene	ND< 20.0
Toluene	ND< 20.0		

ELAP Number 10958 Method: EPA 624 Data File: V33734.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Non-potable Water

Client: Stantec Consulting

Client Job Site: Ward Street Site
Client Job Number: 190500014
Field Location: GTS-2
Field ID Number: N/A
Sample Type: Water

Lab Project Number: 05-4268
Lab Sample Number: 14469
Date Sampled: 12/20/2005
Date Received: 12/20/2005
Date Analyzed: 12/22/2005

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 40.0	trans-1,2-Dichloroethene	ND< 40.0
Bromomethane	ND< 40.0	1,2-Dichloropropane	ND< 40.0
Bromoform	ND< 40.0	cis-1,3-Dichloropropene	ND< 40.0
Carbon Tetrachloride	ND< 40.0	trans-1,3-Dichloropropene	ND< 40.0
Chloroethane	ND< 40.0	Methylene chloride	ND< 100
Chloromethane	ND< 40.0	1,1,2,2-Tetrachloroethane	ND< 40.0
2-Chloroethyl vinyl Ether	ND< 40.0	Tetrachloroethene	1,080
Chloroform	ND< 40.0	1,1,1-Trichloroethane	ND< 40.0
Dibromochloromethane	ND< 40.0	1,1,2-Trichloroethane	ND< 40.0
1,1-Dichloroethane	ND< 40.0	Trichloroethene	389
1,2-Dichloroethane	ND< 40.0	Trichlorofluoromethane	ND< 40.0
1,1-Dichloroethene	ND< 40.0	Vinyl chloride	ND< 40.0

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 14.0	1,2-Dichlorobenzene	ND< 40.0
Chlorobenzene	ND< 40.0	1,3-Dichlorobenzene	ND< 40.0
Ethylbenzene	ND< 40.0	1,4-Dichlorobenzene	ND< 40.0
Toluene	ND< 40.0		

ELAP Number 10958 Method: EPA 624 Data File: V33741.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Non-potable Water

Client: Stantec Consulting

Client Job Site: Ward Street Site
Client Job Number: 190500014
Field Location: GTS-3
Field ID Number: N/A
Sample Type: Water

Lab Project Number: 05-4268
Lab Sample Number: 14470
Date Sampled: 12/20/2005
Date Received: 12/20/2005
Date Analyzed: 12/22/2005

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 2.00	trans-1,2-Dichloroethene	ND< 2.00
Bromomethane	ND< 2.00	1,2-Dichloropropane	ND< 2.00
Bromoform	ND< 2.00	cis-1,3-Dichloropropene	ND< 2.00
Carbon Tetrachloride	ND< 2.00	trans-1,3-Dichloropropene	ND< 2.00
Chloroethane	ND< 2.00	Methylene chloride	ND< 5.00
Chloromethane	ND< 2.00	1,1,2,2-Tetrachloroethane	ND< 2.00
2-Chloroethyl vinyl Ether	ND< 2.00	Tetrachloroethene	ND< 2.00
Chloroform	ND< 2.00	1,1,1-Trichloroethane	ND< 2.00
Dibromochloromethane	ND< 2.00	1,1,2-Trichloroethane	ND< 2.00
1,1-Dichloroethane	ND< 2.00	Trichloroethene	ND< 2.00
1,2-Dichloroethane	ND< 2.00	Trichlorofluoromethane	ND< 2.00
1,1-Dichloroethene	ND< 2.00	Vinyl chloride	ND< 2.00

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	0.805	1,2-Dichlorobenzene	ND< 2.00
Chlorobenzene	ND< 2.00	1,3-Dichlorobenzene	ND< 2.00
Ethylbenzene	ND< 2.00	1,4-Dichlorobenzene	ND< 2.00
Toluene	2.81		

ELAP Number 10958 Method: EPA 624 Data File: V33736.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Non-potable Water

Client: Stantec Consulting

Client Job Site:	Ward Street Site	**Lab Project Number:**	05-4268
		Lab Sample Number:	14471
Client Job Number:	190500014		
Field Location:	GTS-4	**Date Sampled:**	12/20/2005
Field ID Number:	N/A	**Date Received:**	12/20/2005
Sample Type:	Water	**Date Analyzed:**	12/21/2005

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 2.00	trans-1,2-Dichloroethene	ND< 2.00
Bromomethane	ND< 2.00	1,2-Dichloropropane	ND< 2.00
Bromoform	ND< 2.00	cis-1,3-Dichloropropene	ND< 2.00
Carbon Tetrachloride	ND< 2.00	trans-1,3-Dichloropropene	ND< 2.00
Chloroethane	ND< 2.00	Methylene chloride	ND< 5.00
Chloromethane	ND< 2.00	1,1,2,2-Tetrachloroethane	ND< 2.00
2-Chloroethyl vinyl Ether	ND< 2.00	Tetrachloroethene	ND< 2.00
Chloroform	ND< 2.00	1,1,1-Trichloroethane	ND< 2.00
Dibromochloromethane	ND< 2.00	1,1,2-Trichloroethane	ND< 2.00
1,1-Dichloroethane	ND< 2.00	Trichloroethene	ND< 2.00
1,2-Dichloroethane	ND< 2.00	Trichlorofluoromethane	ND< 2.00
1,1-Dichloroethene	ND< 2.00	Vinyl chloride	ND< 2.00

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 0.700	1,2-Dichlorobenzene	ND< 2.00
Chlorobenzene	ND< 2.00	1,3-Dichlorobenzene	ND< 2.00
Ethylbenzene	ND< 2.00	1,4-Dichlorobenzene	ND< 2.00
Toluene	3.45		

ELAP Number 10958 Method: EPA 624 Data File: V33712.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Non-potable Water

Client: Stantec

Client Job Site: N/A
Client Job Number: 190500014
Field Location: GTS-1A
Field ID Number: N/A
Sample Type: Water

Lab Project Number: 05-4359
Lab Sample Number: 14856
Date Sampled: 12/23/2005
Date Received: 12/30/2005
Date Analyzed: 01/04/2006

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 20.0	trans-1,2-Dichloroethene	ND< 20.0
Bromomethane	ND< 20.0	1,2-Dichloropropane	ND< 20.0
Bromoform	ND< 20.0	cis-1,3-Dichloropropene	ND< 20.0
Carbon Tetrachloride	ND< 20.0	trans-1,3-Dichloropropene	ND< 20.0
Chloroethane	ND< 20.0	Methylene chloride	ND< 50.0
Chloromethane	ND< 20.0	1,1,2,2-Tetrachloroethane	ND< 20.0
2-Chloroethyl vinyl Ether	ND< 20.0	Tetrachloroethene	1,430
Chloroform	ND< 20.0	1,1,1-Trichloroethane	ND< 20.0
Dibromochloromethane	ND< 20.0	1,1,2-Trichloroethane	ND< 20.0
1,1-Dichloroethane	ND< 20.0	Trichloroethene	228
1,2-Dichloroethane	ND< 20.0	Trichlorofluoromethane	ND< 20.0
1,1-Dichloroethene	ND< 20.0	Vinyl chloride	ND< 20.0

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 7.00	1,2-Dichlorobenzene	ND< 20.0
Chlorobenzene	ND< 20.0	1,3-Dichlorobenzene	ND< 20.0
Ethylbenzene	ND< 20.0	1,4-Dichlorobenzene	ND< 20.0
Toluene	ND< 20.0		

ELAP Number 10958 Method: EPA 624 Data File: V33944.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger, Technical Director

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Volatile Analysis Report for Non-potable Water

Client: Stantec

Client Job Site: N/A
Client Job Number: 190500014
Field Location: GTS-2A
Field ID Number: N/A
Sample Type: Water

Lab Project Number: 05-4359
Lab Sample Number: 14857
Date Sampled: 12/23/2005
Date Received: 12/30/2005
Date Analyzed: 01/04/2006

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 20.0	trans-1,2-Dichloroethene	ND< 20.0
Bromomethane	ND< 20.0	1,2-Dichloropropane	ND< 20.0
Bromoform	ND< 20.0	cis-1,3-Dichloropropene	ND< 20.0
Carbon Tetrachloride	ND< 20.0	trans-1,3-Dichloropropene	ND< 20.0
Chloroethane	ND< 20.0	Methylene chloride	ND< 50.0
Chloromethane	ND< 20.0	1,1,2,2-Tetrachloroethane	ND< 20.0
2-Chloroethyl vinyl Ether	ND< 20.0	Tetrachloroethene	1,300
Chloroform	ND< 20.0	1,1,1-Trichloroethane	ND< 20.0
Dibromochloromethane	ND< 20.0	1,1,2-Trichloroethane	ND< 20.0
1,1-Dichloroethane	ND< 20.0	Trichloroethene	198
1,2-Dichloroethane	ND< 20.0	Trichlorofluoromethane	ND< 20.0
1,1-Dichloroethene	ND< 20.0	Vinyl chloride	ND< 20.0

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 7.00	1,2-Dichlorobenzene	ND< 20.0
Chlorobenzene	ND< 20.0	1,3-Dichlorobenzene	ND< 20.0
Ethylbenzene	ND< 20.0	1,4-Dichlorobenzene	ND< 20.0
Toluene	ND< 20.0		

ELAP Number 10958 Method: EPA 624 Data File: V33945.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Air

Client: Stantec Consulting

Client Job Site: Ward Steet Site
Client Job Number: 190500014
Field Location: N/A
Field ID Number: N/A
Sample Type: Air

Lab Project Number: 05-4268
Lab Sample Number: Method Blank
Date Sampled: N/A
Date Received: N/A
Date Analyzed: 12/29/2005

Halocarbons	PPBv	ug / m3
Bromodichloromethane	ND< 0.500	ND< 3.31
Bromoform	ND< 0.500	ND< 5.11
Bromomethane	ND< 0.500	ND< 1.92
Carbon Tetrachloride	ND< 0.500	ND< 2.45
Chlorethane	ND< 0.500	ND< 1.31
Chloroform	ND< 0.500	ND< 2.41
Chloromethane	ND< 0.500	ND< 1.02
Dibromochloromethane	ND< 0.500	ND< 4.21
1,2 Dibromoethane	ND< 0.500	ND< 3.80
1,1-Dichloroethane	ND< 0.500	ND< 2.00
1,1-Dichloroethene	ND< 0.500	ND< 1.96
1,2-Dichloroethane	ND< 0.500	ND< 2.00
cis-1,2-Dichloroethene	ND< 0.500	ND< 1.96
trans-1,2-Dichloroethene	ND< 0.500	ND< 1.96
1,2-Dichloropropane	ND< 0.500	ND< 2.29
cis-1,3-Dichloropropene	ND< 0.500	ND< 2.25
trans-1,3-Dichloropropene	ND< 0.500	ND< 2.25
Methylene Chloride	ND< 0.500	ND< 1.72
1,1,2,2-Tetrachloroethane	ND< 0.500	ND< 3.39
Tetrachloroethene	ND< 0.500	ND< 3.35
1,1,1-Trichloroethane	ND< 0.500	ND< 2.70
1,1,2-Trichloroethane	ND< 0.500	ND< 2.70
Trichloroethene	ND< 0.500	ND< 2.66
Vinyl Chloride	ND< 0.500	ND< 1.27

Aromatics	PPBv	ug / m3
Benzene	ND< 0.500	ND< 1.60
Chlorobenzene	ND< 0.500	ND< 2.29
Ethylbenzene	ND< 0.500	ND< 2.17
Toluene	ND< 0.500	ND< 1.88
m,p-Xylene	ND< 0.500	ND< 2.17
o-Xylene	ND< 0.500	ND< 2.17
Styrene	ND< 0.500	ND< 2.13
1,2-Dichlorobenzene	ND< 0.500	ND< 2.99
1,3-Dichlorobenzene	ND< 0.500	ND< 2.99
1,4-Dichlorobenzene	ND< 0.500	ND< 2.99

Ketones	PPBv	ug / m3
Acetone	0.718	1.70
2-Butanone	ND< 0.500	ND< 1.47
2-Hexanone	ND< 0.500	ND< 2.04
4-Methyl-2-Pentanone	ND< 0.500	ND< 2.04

Miscellaneous	PPBv	ug / m3
Carbon Disulfide	ND< 0.500	ND< 1.55
Freon 11	ND< 0.500	ND< 2.78
Freon 113	ND< 0.500	ND< 3.80
Methyl-tert-Butyl Ether	ND< 0.500	ND< 1.80
Vinyl Acetate	ND< 0.500	ND< 1.76

ELAP Number 10958 Method: EPA TO-15 Data File: A1219.d

Comments: ND denotes Non Detect
PPBv = Parts per Billion volume
ug / m3 - Microgram per cubic meter.

Signature:
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Air

Client: Stantec Consulting

Client Job Site: Ward Street Site
Client Job Number: 190500014
Field Location: VAP-1
Field ID Number: N/A
Sample Type: Air

Lab Project Number: 05-4268
Lab Sample Number: 14472

Date Sampled: 12/19/2005
Date Received: 12/20/2005
Date Analyzed: 12/30/2005

Halocarbons	PPBv	ug / m3
Bromodichloromethane	ND< 10.0	ND< 66.3
Bromoform	ND< 10.0	ND< 102
Bromomethane	ND< 10.0	ND< 38.4
Carbon Tetrachloride	ND< 10.0	ND< 49.1
Chlorethane	ND< 10.0	ND< 26.2
Chloroform	E 1,040	E 5,020
Chloromethane	ND< 10.0	ND< 20.4
Dibromochloromethane	ND< 10.0	ND< 84.3
1,2 Dibromoethane	ND< 10.0	ND< 76.1
1,1-Dichloroethane	ND< 10.0	ND< 40.1
1,1-Dichloroethene	E 3,680	E 14,400
1,2-Dichloroethane	ND< 10.0	ND< 40.1
cis-1,2-Dichloroethene	E 94,000	E 369,000
trans-1,2-Dichloroethene	E 20,400	E 80,100
1,2-Dichloropropane	ND< 10.0	ND< 45.8
cis-1,3-Dichloropropene	ND< 10.0	ND< 45.0
trans-1,3-Dichloropropene	ND< 10.0	ND< 45.0
Methylene Chloride	ND< 10.0	ND< 34.4
1,1,2,2-Tetrachloroethane	ND< 10.0	ND< 67.9
Tetrachloroethene	E 53,400	E 358,000
1,1,1-Trichloroethane	ND< 10.0	ND< 54.0
1,1,2-Trichloroethane	ND< 10.0	ND< 54.0
Trichloroethene	E 69,600	E 370,000
Vinyl Chloride	E 32,200	E 81,700

Aromatics	PPBv	ug / m3
Benzene	E 1,170	E 3,730
Chlorobenzene	ND< 10.0	ND< 45.8
Ethylbenzene	15.9	68.9
Toluene	64.4	242
m,p-Xylene	73.4	318
o-Xylene	26.4	114
Styrene	ND< 10.0	ND< 42.5
1,2-Dichlorobenzene	ND< 10.0	ND< 59.7
1,3-Dichlorobenzene	ND< 10.0	ND< 59.7
1,4-Dichlorobenzene	ND< 10.0	ND< 59.7

Ketones	PPBv	ug / m3
Acetone	ND< 10.0	ND< 23.7
2-Butanone	ND< 10.0	ND< 29.4
2-Hexanone	ND< 10.0	ND< 40.9
4-Methyl-2-Pentanone	ND< 10.0	ND< 40.9

Miscellaneous	PPBv	ug / m3
Carbon Disulfide	93.2	290
Freon 11	ND< 10.0	ND< 55.6
Freon 113	ND< 10.0	ND< 76.1
Methyl-tert-Butyl Ether	ND< 10.0	ND< 36.0
Vinyl Acetate	ND< 10.0	ND< 35.2

ELAP Number 10958 Method: EPA TO-15 Data File: A1220.d

Comments: ND denotes Non Detect
PPBv = Parts per Billion volume
ug / m3 - Microgram per cubic meter.
E denotes Estimated. Concentration exceeds calibration range.

Signature: _____
Bruce Hoogesteger: Technical Director

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Volatile Analysis Report for Air

Client: Stantec Consulting

Client Job Site: Ward Street Site
Client Job Number: 190500014
Field Location: VAP-1
Field ID Number: N/A
Sample Type: Air

Lab Project Number: 05-4268
Lab Sample Number: 14472

Date Sampled: 12/19/2005
Date Received: 12/20/2005
Date Analyzed: 12/30/2005 & 01/09/2006 & 01/10/2006

Halocarbons	PPBv	ug / m3
Bromodichloromethane	ND< 10.0	ND< 66.3
Bromoform	ND< 10.0	ND< 102
Bromomethane	ND< 10.0	ND< 38.4
Carbon Tetrachloride	ND< 10.0	ND< 49.1
Chlorethane	ND< 10.0	ND< 26.2
Chloroform	E 1,040	E 5,020
Chloromethane	ND< 10.0	ND< 20.4
Dibromochloromethane	ND< 10.0	ND< 84.3
1,2 Dibromoethane	ND< 10.0	ND< 76.1
1,1-Dichloroethane	ND< 10.0	ND< 40.1
1,1-Dichloroethene	* 8,320	* 32,700
1,2-Dichloroethane	ND< 10.0	ND< 40.1
cis-1,2-Dichloroethene	** 638,000	** 2,510,000
trans-1,2-Dichloroethene	* 66,400	* 261,000
1,2-Dichloropropane	ND< 10.0	ND< 45.8
cis-1,3-Dichloropropene	ND< 10.0	ND< 45.0
trans-1,3-Dichloropropene	ND< 10.0	ND< 45.0
Methylene Chloride	ND< 10.0	ND< 34.4
1,1,2,2-Tetrachloroethane	ND< 10.0	ND< 67.9
Tetrachloroethene	** 412,000	** 2,760,000
1,1,1-Trichloroethane	ND< 10.0	ND< 54.0
1,1,2-Trichloroethane	ND< 10.0	ND< 54.0
Trichloroethene	** 443,000	** 2,360,000
Vinyl Chloride	* 399,000	* 1,010,000

Aromatics	PPBv	ug / m3
Benzene	* 1,520	* 4,850
Chlorobenzene	ND< 10.0	ND< 45.8
Ethylbenzene	15.9	68.9
Toluene	64.4	242
m,p-Xylene	73.4	318
o-Xylene	26.4	114
Styrene	ND< 10.0	ND< 42.5
1,2-Dichlorobenzene	ND< 10.0	ND< 59.7
1,3-Dichlorobenzene	ND< 10.0	ND< 59.7
1,4-Dichlorobenzene	ND< 10.0	ND< 59.7

Ketones	PPBv	ug / m3
Acetone	ND< 10.0	ND< 23.7
2-Butanone	ND< 10.0	ND< 29.4
2-Hexanone	ND< 10.0	ND< 40.9
4-Methyl-2-Pentanone	ND< 10.0	ND< 40.9

Miscellaneous	PPBv	ug / m3
Carbon Disulfide	93.2	290
Freon 11	ND< 10.0	ND< 55.6
Freon 113	ND< 10.0	ND< 76.1
Methyl-tert-Butyl Ether	ND< 10.0	ND< 36.0
Vinyl Acetate	ND< 10.0	ND< 35.2

ELAP Number 10958

Method: EPA TO-15
* & ** Tedlar Bag Dilution

Data File: A1220.d
& *V34009.D
& **V34040.D

Comments: ND denotes Non Detect
PPBv = Parts per Billion volume
ug / m3 - Microgram per cubic meter.
E denotes Estimated. Concentration exceeds calibration range.

Signature: _____
Bruce Hoogesteger: Technical Director

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PHC Analysis Report for Non-potable Water

Client: Stantec

Client Job Site:	Ward St. Site	**Lab Project Number:**	06-0145
		Lab Sample Number:	1113
Client Job Number:	N/A		
Field Location:	GTS - 5A	**Date Sampled:**	01/05/2006
Field ID Number:	N/A	**Date Received:**	01/05/2006
Sample Type:	Water	**Date Analyzed:**	01/06/2006

PHC Classification	Results in ug / L
Petroleum Hydrocarbon	ND< 500

ELAP Number 10958 Method: NYSDOH 310.13

Comments: ND denotes Non Detect
ug / L = microgram per Liter
PHC = Petroleum Hydrocarbon

Signature: _____
Bruce Hoogesteger, Technical Director

PARADIGM
ENVIRONMENTAL SERVICES, INC. 179 Lake Avenue Rochester, New York 14608 (585) 647 - 2530 FAX (585) 647 - 3311

Volatile Analysis Report for Non-potable Water

Client: Stantec

Client Job Site:	Ward St. Site	**Lab Project Number:**	06-0145
		Lab Sample Number:	1113
Client Job Number:	N/A		
Field Location:	GTS -5A	**Date Sampled:**	01/05/2006
Field ID Number:	N/A	**Date Received:**	01/05/2006
Sample Type:	Water	**Date Analyzed:**	01/06/2006

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 2.00	trans-1,2-Dichloroethene	ND< 2.00
Bromomethane	ND< 2.00	1,2-Dichloropropane	ND< 2.00
Bromoform	ND< 2.00	cis-1,3-Dichloropropene	ND< 2.00
Carbon Tetrachloride	ND< 2.00	trans-1,3-Dichloropropene	ND< 2.00
Chloroethane	ND< 2.00	Methylene chloride	ND< 5.00
Chloromethane	ND< 2.00	1,1,2,2-Tetrachloroethane	ND< 2.00
2-Chloroethyl vinyl Ether	ND< 2.00	Tetrachloroethene	ND< 2.00
Chloroform	ND< 2.00	1,1,1-Trichloroethane	ND< 2.00
Dibromochloromethane	ND< 2.00	1,1,2-Trichloroethane	ND< 2.00
1,1-Dichloroethane	ND< 2.00	Trichloroethene	ND< 2.00
1,2-Dichloroethane	ND< 2.00	Trichlorofluoromethane	ND< 2.00
1,1-Dichloroethene	ND< 2.00	Vinyl chloride	ND< 2.00

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 0.700	1,2-Dichlorobenzene	ND< 2.00
Chlorobenzene	ND< 2.00	1,3-Dichlorobenzene	ND< 2.00
Ethylbenzene	ND< 2.00	1,4-Dichlorobenzene	ND< 2.00
Toluene	ND< 2.00		

ELAP Number 10958 Method: EPA 624 Data File: V33994.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

PARADIGM
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PHC Analysis Report for Non-potable Water

Client: Stantec

Client Job Site:	Ward St. Site	**Lab Project Number:**	06-0147
		Lab Sample Number:	1119
Client Job Number:	N/A		
Field Location:	GTS - 5B	**Date Sampled:**	01/06/2006
Field ID Number:	N/A	**Date Received:**	01/06/2006
Sample Type:	Water	**Date Analyzed:**	01/06/2006

PHC Classification	Results in ug / L
Petroleum Hydrocarbon	ND< 500

ELAP Number 10958 Method: NYSDOH 310.13

Comments: ND denotes Non Detect
ug / L = microgram per Liter
PHC = Petroleum Hydrocarbon

Signature: _____
Bruce Hoogesteger: Technical Director

PARADIGM
ENVIRONMENTAL SERVICES, INC. 179 Lake Avenue Rochester, New York 14608 (585) 647 - 2530 FAX (585) 647 - 3311

Volatile Analysis Report for Non-potable Water

Client: Stantec

Client Job Site:	Ward St. Site	**Lab Project Number:**	06-0147
		Lab Sample Number:	1119
Client Job Number:	N/A		
Field Location:	GTS -5B	**Date Sampled:**	01/06/2006
Field ID Number:	N/A	**Date Received:**	01/06/2006
Sample Type:	Water	**Date Analyzed:**	01/06/2006

Halocarbons	Results in ug / L	Halocarbons	Results in ug / L
Bromodichloromethane	ND< 2.00	trans-1,2-Dichloroethene	ND< 2.00
Bromomethane	ND< 2.00	1,2-Dichloropropane	ND< 2.00
Bromoform	ND< 2.00	cis-1,3-Dichloropropene	ND< 2.00
Carbon Tetrachloride	ND< 2.00	trans-1,3-Dichloropropene	ND< 2.00
Chloroethane	ND< 2.00	Methylene chloride	ND< 5.00
Chloromethane	ND< 2.00	1,1,2,2-Tetrachloroethane	ND< 2.00
2-Chloroethyl vinyl Ether	ND< 2.00	Tetrachloroethene	5.35
Chloroform	ND< 2.00	1,1,1-Trichloroethane	ND< 2.00
Dibromochloromethane	ND< 2.00	1,1,2-Trichloroethane	ND< 2.00
1,1-Dichloroethane	ND< 2.00	Trichloroethene	ND< 2.00
1,2-Dichloroethane	ND< 2.00	Trichlorofluoromethane	ND< 2.00
1,1-Dichloroethene	ND< 2.00	Vinyl chloride	ND< 2.00

Aromatics	Results in ug / L	Aromatics	Results in ug / L
Benzene	ND< 0.700	1,2-Dichlorobenzene	ND< 2.00
Chlorobenzene	ND< 2.00	1,3-Dichlorobenzene	ND< 2.00
Ethylbenzene	ND< 2.00	1,4-Dichlorobenzene	ND< 2.00
Toluene	ND< 2.00		

ELAP Number 10958 Method: EPA 624 Data File: V33997.D

Comments: ND denotes Non Detect
ug / L = microgram per Liter

Signature: _____
Bruce Hoogesteger: Technical Director

APPENDIX D

Hydrocarbon Recovery Summary

Stantec

Appendix D
Summary of Hydrocarbon Recovery
Germanow-Simon Corporation - Ward Street Site
Multi Phase Vacuum Extraction Pilot Study

Date	Hour Meter (hrs)	Elapsed Time (days)	Vapour			Biodegradation			Dissolved			Total	
			Hydrocarbon Removal Rate (L/hr)	Total Hydrocarbons Removed (L)	Percentage	Hydrocarbon Removal Rate (L/hr)	Total Hydrocarbons Removed (L)	Percentage	Hydrocarbon Removal Rate (L/hr)	Total Hydrocarbons Removed (L)	Percentage	Hydrocarbon Removal Rate (L/hr)	Hydrocarbons Removed (L)
19-Dec-05	0.9	0.0	0.0	0.0	11%	0.02	0.0	89%	0.0	0.00	0.00%	0.0	0.0
19-Dec-05	4.3	0.2	0.0	0.0	19%	0.02	0.1	81%	0.0	0.00	0.00%	0.0	0.1
19-Dec-05	7.1	0.3	0.0	0.1	43%	0.01	0.1	57%	0.0	0.00	0.17%	0.0	0.2
19-Dec-05	13.4	0.6	0.0	0.2	15%	0.14	1.0	85%	0.0	0.00	0.09%	0.2	1.2
20-Dec-05	23.9	1.0	0.1	1.3	44%	0.06	1.7	56%	0.0	0.00	0.08%	0.2	3.0
21-Dec-05	49.2	2.1	0.0	2.4	33%	0.13	4.9	67%	0.0	0.01	0.09%	0.2	7.3
21-Dec-05	54.1	2.3	0.0	2.6	34%	0.02	5.0	66%	0.0	0.01	0.09%	0.1	7.6
21-Dec-05	56.5	2.4	0.0	2.6	34%	0.01	5.0	66%	0.0	0.01	0.10%	0.0	7.7
21-Dec-05	71.3	3.0	0.2	6.2	55%	0.00	5.0	45%	0.0	0.01	0.09%	0.2	11.3
5-Jan-06	79.9	3.3	0.3	8.8	63%	0.01	5.1	37%	0.0	0.01	0.08%	0.3	13.9
6-Jan-06	100.2	4.2	0.2	12.7	71%	0.00	5.1	29%	0.0	0.02	0.09%	0.2	17.8
9-Jan-06	171.9	7.2	0.1	18.0	78%	0.0	5.1	22%	0.0	0.03	0.13%	0.1	23.1
10-Jan-06	183.5	7.6	0.1	18.7	78%	0.0	5.1	21%	0.0	0.03	0.13%	0.1	23.8
10-Jan-06	189.1	7.9	0.0	18.8	79%	0.0	5.1	21%	0.0	0.03	0.14%	0.0	24.0
11-Jan-06	204.6	8.5	0.0	19.1	79%	0.0	5.1	21%	0.0	0.04	0.15%	0.0	24.2