

**ANALYSIS OF BROWNFIELDS
CLEANUP ALTERNATIVES
REPORT**

Pleasant Street Cleanup
459, 480 & 492 Pleasant Street
Northampton, MA 01060
RTN: 1-0705
October 2008

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TABLE OF CONTENTS

	PAGE
1.0 INTRODUCTION	1
1.1 Description of the Site	7
2.0 SITE HISTORY	7
2.1 History of Use at the Site.....	7
2.2 Current Operations at the Site.....	8
3.0 PHYSICAL SITE CHARACTERISTICS	8
3.1 Previous Assessment Activities	8
3.2 Additional Assessment Activities	11
3.3 Hydrogeologic Characteristics.....	12
4.0 ENVIRONMENTAL FATE AND TRANSPORT OF OIL/HAZARDOUS MATERIALS	14
4.1 Evaluation of Oil/Hazardous Materials	14
4.2 Migration Pathways.....	16
5.0 NATURE AND EXTENT OF CONTAMINATION	18
5.1 Initial Extent of Free-Phase Gasoline.....	18
5.2 Initial Extent of Soil Contamination.....	18
5.3 Initial Extent of Groundwater Contamination	18
5.4 Operation, Maintenance and Monitoring of the Existing Treatment Systems	18
5.5 Evaluation of Historical Results and Gasoline Recovery Rates.....	22
6.0 SUMMARY OF SITE CONDITIONS THAT WARRANT REMEDIAL ACTIONS	30
7.0 REMEDIAL ACTION PLAN	30
7.1 Identification and Evaluation of the Remedial Technologies	30
7.2 Initial Screening of the Most Applicable Remedial Alternatives.....	31
7.3 Detailed Evaluation of the Remedial Action Alternatives.....	36
7.4 Selected Remedial Action Alternative	40
7.5 Feasibility of Implementing the Selected Remedial Action Alternative.....	40

TABLE OF CONTENTS (con't)

	PAGE
8.0	
<u>REMEDY IMPLEMENTATION PLAN</u>	41
8.1 Design of the Selected Remedial Action Alternative	41
8.2 Required Permits and Licenses	43
8.3 Health and Safety Procedures	43
8.4 Additional Notification Requirements	44
8.5 Imminent Hazard Evaluation.....	44
8.6 Implementation Schedule	44
8.7 Operation and Maintenance.....	45
8.8 Monitoring Program	45
9.0	
<u>PUBLIC INVOLVEMENT</u>	46

FIGURES

Locus Map

Table One – Summary of 1998 Groundwater Results

Table Two – Summary of Groundwater Results, April 25, 2002

Figure One – Groundwater Flow on October 11, 2000

Figure Two – Groundwater Flow on April 25, 2002

Figure Three – BTEX Plume on April 25, 2002

Figure Four – C₅-C₈ Aliphatics Plume on April 25, 2002

Groundwater Contour Plan, November 11, 2003

Table Six – Historical Summary of Results for Influent

Table Seven – Historical Summary of Groundwater Results for MW-9

Table Eight – Historical Summary of Groundwater Results for MW-10

Table Nine – Historical Summary of Groundwater Results for MW-12

Charts of Historical Results

Regression Chart One

Implementation Schedule

Reduced Scale Remedial Action Site Plan and Installation Plan

APPENDICES

Appendix A Copies of our Monitoring Well Sampling Log and the laboratory analysis report for groundwater samples collected on September 18, 2008

Appendix B Boring Logs, Well Data Sheets, and Groundwater Elevation Log

1.0 INTRODUCTION

In accordance with our September 2, 2008 City of Northampton Design Services Contract, Penney Engineering, Inc hereby submits this Analysis of Brownfields Cleanup Alternatives Report to assess the alternatives available to fully remediate the historic release of gasoline under Route 5 from the former Staab's Service Station located at 459, 480, and 492 Pleasant Street in Northampton, MA ("the site"). The site is defined as the area containing significant concentrations of gasoline-related contaminants in the soil and the groundwater. The site is located near the intersection of Pleasant and Conz Streets, as shown on the Locus Map included in the Figures section.

Penney Engineering has worked on the site since 2002. The site is shown on the reduced scale Remedial Action Site Plan included in the Figures section. We designed, fabricated, installed and operated the existing treatment systems at 459 Pleasant Street for 26 months on behalf of Mr. Robert Kalish, one of the affected property owners. Mr. Ralph Penney has been the Licensed Site Professional-of-Record for the site for the past six years. In 2003 we installed a groundwater treatment system and an SVE system at 459 Pleasant Street, located on the western side of Route 5. We operated the systems until June 30, 2006 when they were temporarily shut down until they could be extended across Route 5. As of May 31, 2006, we had treated 2,214,239 gallons of groundwater and as of May 3, 2006, we had recovered 729.05 gallons of gasoline that was recycled off-site as a fuel. We were able to reduce the contaminant concentrations in the groundwater at 459 Pleasant Street, but we found that a majority of the gasoline remained under Route 5 and was migrating to the southeast onto 480 and 492 Pleasant Street. We are now attempting to install the remainder of the treatment systems across Pleasant Street in order to successfully remediate the gasoline under Route 5 for Mass Highway.

We have assessed and remediated the site in accordance with 310 CMR 40.0000, the Massachusetts Contingency Plan. In 2003 we prepared a Phase III Remedial Action Plan which was a detailed evaluation of the available treatment technologies. The evaluation was very similar to a federal Feasibility Study. We have attempted to update and revise our Phase III Plan in order to prepare this Analysis of Brownfields Cleanup Alternatives Report. We have included a discussion of our monitoring results for the past three years and the most recent September 18, 2008 groundwater sampling results. Unfortunately, we were unable to sample the worst well because it had been damaged. Our selected

alternative has not changed primarily because half of the original alternative was installed and successfully operated for three years.

The properties at 459, 480 and 492 Pleasant Street were previously under common ownership and operated as a gasoline station until 1955 when Pleasant Street (Route 5) was constructed through the station. The former tanks at 480 Pleasant Street were reportedly for the original gasoline station, which had dispensers along Conz Street. Reportedly, Conz Street was previously known as Maple Street, the main route into the center of Northampton. We believe that the tanks may have actually been for a gasoline station with dispensers on the opposite or both sides of Pleasant Street. In 1984, Mr. Robert Kalish, the owner of Pleasant Journey Used Cars, Inc and the property at 459 Pleasant Street, remembered seeing pipes that lead to the former dispensers at 459 Pleasant Street when the tanks at 480 Pleasant Street were being removed. There may still be tanks buried at 459 Pleasant Street that were used to supply the former dispensers along Conz (Maple) Street. In 1988, a wellpoint was installed at the car wash at 492 Pleasant Street to evaluate installing a supply well. Gasoline was detected in the groundwater pumped from the wellpoint. On June 14, 1988, the Department of Environmental Protection ("the DEP") was notified of a release at 492 Pleasant Street. Site Number 1-0462 was assigned. The gasoline was traced to the former tanks at 459 Pleasant Street, but no one was sure where the gasoline originated from. Monitoring wells were installed and up to 12 inches of free-phase gasoline was observed in three wells. Groundwater was encountered at a depth of eight to 10 feet.

On October 23, 1989, the DEP was notified of the gasoline release at 459 Pleasant Street based upon the findings presented in an August 30, 1989 report by the former Certified Engineering and Testing Company of Weymouth, MA. Site number 1-0705 was assigned and it later became the Release Tracking Number (RTN) for the site. On January 25, 1990, a Phase II Scope of Work for the site was received by the DEP. On January 21, 1994, a Settlement Agreement was entered into by the prior and current owners of the properties that comprised the site. The Agreement stated that Pleasant Journey Used Cars, Inc, Mr. Robert Kalish and his former partner, Mr. John Guillot, would remediate the gasoline contamination at 459 and 492 Pleasant Street. The owners of 492 Pleasant Street contributed \$70,000 to a fund established to pay for the remediation. The estate of the former owner of the properties also contributed \$98,000 to the fund. The former owner of 492 Pleasant Street contributed \$2,000. Pleasant Journey Used Cars, Inc, Mr. Robert Kalish and Mr. John Guillot agreed to use the contributed monies to remediate the

contamination and contribute any additional monies required for the remediation or refund any monies not used.

Numerous assessments have been conducted at the site since 1988. The surrounding properties, that were once part of the Staab's Service Station, were found to be contaminated with gasoline. Only very limited remediation had been previously conducted at the site over the following 11 years. On December 8, 1998, a Method Three Risk Characterization was prepared for the site by a prior consultant. It determined that there was no significant risk associated with the remaining contamination in the groundwater. There was only a very limited evaluation of the gasoline contamination in the soil. Only two soil samples had been analyzed. On March 26, 1999, the Method Three Risk Characterization, a Phase II Report, and a Phase III Plan were submitted to the DEP. The document stated that no significant risk was identified at the site at that time. The application of oxygen-releasing compounds and an Activity and Use Limitation were recommended as a permanent solution for the site. On June 8, 2000, free-phase gasoline was again discovered in wells MW-9 and VM-1 at thicknesses of 0.69 and 0.14 feet, respectively. On June 29, 2000, an Immediate Response Action (IRA) Plan was submitted to the DEP by a prior consultant. The IRA Plan originally proposed the installation of a groundwater pump and treat system and a separate soil vapor extraction (SVE) system using vapor phase carbon for air emissions control. Bailing of the free-phase gasoline was again proposed to be conducted from specific wells. The groundwater was to be pumped through an oil/water separator and two, 500-lb canisters of aqueous phase carbon before being discharged into a storm drain. On September 1, 2000, the IRA Plan was modified to allow the SVE system to use a catalytic oxidizer instead of vapor phase carbon, presumably because of the high concentrations of gasoline vapors being extracted from the soil.

According to a November 30, 2000 IRA Status Report, the SVE system began operating on August 7, 2000. The pump and treat system only operated at 1.5 gpm from August 8 to 10, 2000 because of mechanical problems. The SVE system utilized an existing monitoring well and did not include a knockout drum. Reportedly, the SVE system operated intermittently from August 7, 2000 until it too experienced mechanical problems on December 7, 2000. The second, June 22, 2001 IRA Status Report by Acadian stated that a Falco Model #500 catalytic oxidizer had been used with the SVE system until the second week of December 2000. According to Mr. Kalish, the oxidizer was damaged when liquid gasoline was drawn into it and exploded.

On January 29, 2002, the DEP issued a Notice of Noncompliance (NON) to Mr. Kalish for his failure to complete the required Comprehensive Response Actions at the site. The NON requested that a third IRA Status Report be submitted by March 29, 2002. The NON also requested that a Phase IV Plan be submitted by April 29, 2002. A Phase IV Plan was originally due by December 4, 1999. The December 4, 1996 Tier II classification for the site expired on December 3, 2001. No extension application was submitted 60 days prior to the expiration date.

Mr. Kalish was told of our successful work on a similar site in Wellesley and he contacted Penney Engineering. On March 12, 2002, Mr. Penney inspected the site. He measured five inches of free-phase gasoline in monitoring well MW-9 located along Pleasant Street. The gasoline appeared weathered, but smelled fresh. On March 22, 2002, we were retained by Mr. Kalish to assume the responsibility of providing LSP services for the site. We briefly reviewed the numerous assessment and status reports that had been prepared for the site. Reportedly, the properties comprising the site were previously owned and operated as a gasoline station by Mr. Carlton H. Staab and his parents from 1912 until 1955 when Route 5 was constructed through the station as part of the federal highway program. A gasoline station continued to operate at 459 Pleasant Street until 1983 when the 21,280 square-foot commercial property was purchased by Mr. Kalish and converted to a retail, used car dealership. Reportedly in 1984, four underground gasoline tanks were removed from 459 Pleasant Street.

On May 15, 2003, we submitted a combined Phase III Remedial Action Plan and Phase IV Remedy Implementation Plan. The Selected Remedial Action Alternative included a groundwater treatment system to circulate the contaminated groundwater through a biodiffuser and an SVE system. On June 2, 2003, we began installing the groundwater and soil treatment systems. Only the portions of the systems at 459 Pleasant Street were installed because we were unable to locate the former product pipes that reportedly crossed Pleasant Street. We had hoped to utilize the existing pipes to connect the portion of the treatment systems at 480 Pleasant Street and avoid having to excavate across Route 5.

On June 25, 2003, we started the groundwater treatment system and began monitoring it. On September 9, 2003, we graded the contaminated soil that had been stockpiled on site during the installation, but was not accepted for asphalt recycling because the volatile organic compounds were above 500 mg/kg. On September 9, we also activated the SVE system and began monitoring it. On September 11, 2003, the graded soil was covered

with bituminous concrete. The graded, contaminated soil was allowed to be remediated on-site by the SVE system as recommended by the DEP. We operated the treatment systems for two years and recovered over 700 gallons of gasoline. We conducted groundwater monitoring and saw the contaminant concentrations on the western side of Pleasant Street decrease. There were only limited reductions on the eastern side of Route 5. On July 13, 2006, we sent written notification to the DEP that the treatment systems had been temporarily shut down on June 30 until we could extend the treatment system across Route 5.

We were able to install one recovery well, the recharge well and two of the SVE zones on the western side of Route 5 in 2003. During the installation we found that the native soil was a fine silt that readily adsorbed the gasoline contamination. We were unable to find a recycling facility that could accept the gasoline-contaminated soil that we had stockpiled on the site. The DEP allowed us to grade and pave over the soil so it could be remediated by the SVE system. We expect to encounter similar soil conditions across Route 5. However, there is a tank grave that was reportedly backfilled with gravel. We have reviewed all the old reports associated with the 480 Pleasant Street property and found that the contaminated soil we will excavate probably can not be recycled off-site. As a result, we shall attempt to remove clean soil from shallow depths in order to bury all the contaminated soil on-site as the DEP allowed us to do at 459 Pleasant Street. The groundwater table is at depths of eight to ten feet. Any excavated soil that is contaminated shall be used as backfill and treated on-site.

On January 31, 2007, Extra Mile, Inc purchased the used car business from Pleasant Journey Used Cars, Inc and began renting the property at 459 Pleasant Street. The new business operates under the name of Pleasant Journey Used Cars. Mr. Kalish formed Robert P. Kalish, Inc, which owns the 459 Pleasant Street property and assumed responsibility for the remediation of the gasoline contamination that originated at its 459 Pleasant Street property.

On September 18, 2008, we held an informal meeting at the site with the two owners of the affected private properties and Ms. Teri Anderson, the Economic Development Coordinator for the City. We discussed trenching across Route 5 and installing the second recovery well and third SVE zone at the 480 and 492 Pleasant Street properties. The Pro Lube oil change business operates six days a week at 480 Pleasant Street. The building at 492 Pleasant Street houses a car wash, offices and a night club. It was agreed that we could close the exit from Pro Lube for two days during the crossing of

Route 5. We could then close the car wash and use the area between the two buildings as a staging area and to install Recovery Well RW-2 and SVE Zone C. The work area shall be secured with temporary fencing.

During the meeting we also inspected and sampled a few of the monitoring wells. Unfortunately the worst well, MW-12, had been damaged and could not be sampled. The results for MW-2A, located at 480 Pleasant Street, were still relatively high.

We shall again retain Grant Brothers Associates for the required excavating. They had helped us install the systems at 459 Pleasant Street. The installation has been scheduled for the first two weeks in November. On September 30, 2008, we submitted a permit application for crossing Route 5 to Mass Highway. On October 6, a permit was issued to the City. Both Grant Brothers and Penney Engineering have been pre-qualified by Mass Highway. Groundwater Analytical, Inc, a DEP qualified laboratory, shall continue to analyze the samples collected from the site.

The first six sections of this Analysis of Brownfields Cleanup Alternatives Report summarize the findings of our limited April 25, 2002 gauging and sampling of specific monitoring wells; our review of the numerous reports prepared for the site; and the installation, operation, maintenance and monitoring of the existing treatment systems. Section 7.0 describes our evaluation of the applicable remedial technologies and the remedial alternatives. It also describes the Selected Remedial Action Alternative. Section 8.0 describes the design of the Selected Remedial Action Alternative. Section 9.0 describes the public notification process under the MCP.

A Locus Map, Table One, a summary of the 1998 groundwater sampling results by ECS, Table Two, a summary of our April 25, 2002 groundwater sampling results, Figure One – Groundwater Flow on October 11, 2000, Figure Two – Groundwater Flow on April 25, 2002, Figure Three – BTEX Plume on April 25, 2002, and Figure Four – C₅-C₈ Aliphatics Plume on April 25, 2002, a November 11, 2003 Groundwater Contour Plan, four tables of historical results, charts of historical results, Regression Chart One, an Implementation Schedule, a reduced scale Remedial Action Site Plan and a reduced scale Installation Plan are included in the Figures section. Appendix A includes copies of our Monitoring Well Sampling Log and the laboratory analysis report for the groundwater samples collected on September 18, 2008. Appendix B includes copies of the most pertinent Boring Logs, Well Data Sheets, and a Groundwater Elevation Log.

1.1 Description of the Site

The site is located at 459, 480 and 492 Pleasant Street in Northampton, MA as shown on the Locus Map. The site has historically been used as a gasoline service station from 1912 until 1984. The immediate area is relatively flat. There are commercial businesses along Conz and Pleasant Streets. There are homes along Pleasant Street to the north of the site. Pleasant Street is a four-lane highway and part of State Route 5. It is the main route leading into the center of Northampton from the south. As shown on the Locus Map, there is an active railroad line located along the rear of 480 and 492 Pleasant Street. Reportedly, coal was transported by train and stored at properties along Pleasant Street. The Mill River flows from the area of the site into the Connecticut River located approximately one mile southeast of the site.

According to a May 17, 2002 BWSC Site Scoring Map, the site is not located within an Interim Wellhead Protection Area, a Zone II or a mapped Potentially Productive Aquifer. Reportedly, there are no private water supply wells located within 500 feet of the site. Municipal drinking water is available along Pleasant Street. The depth to groundwater at the site ranges from eight to 10 feet. There are no occupied residences located within 30 feet of the site. The groundwater at the site is classified as GW-3. There are occupied buildings at the site and therefore the groundwater is classified as GW-2 within 30 feet of the buildings. In the January 29, 2002 NON, the DEP stated that the groundwater at the site should be classified as GW-2 and GW-3. According to previous reports, the groundwater was classified as GW-1.

2.0 SITE HISTORY

2.1 History of Use at the Site

A title search for the site was not conducted. Based upon the prior reports and the October 22, 2001 Warranty Deed, a list of the owners of the property at 459 Pleasant Street and the date of purchase is presented in the Table of Ownership. The deeds have been recorded at the Hampshire County Registry of Deeds.

TABLE OF OWNERSHIP
History of Ownership
459 Pleasant Street

<u>Date of Purchase</u>	<u>Owner</u>	<u>Book and Page Number</u>
	Ralph T. Staab & Gretchen S. Belz	
April 26, 1965	Carlton H. Staab	1461/66
1983	Robert P. Kalish	
May 28, 1986	Robert P. Kalish & John Guillot	2730/231
October 22, 2001	Robert P. Kalish	

The site was reportedly used as a gasoline station. It was commonly known as Staab's Gasoline Station from 1912 until 1983 when the property at 459 Pleasant Street was purchased by Mr. Kalish and Mr. Guillot to be used for selling used automobiles. The properties at 480 and 492 Pleasant Street were also sold to others.

2.2 Current Operations at the Site

The area of the site is zoned for General Business. There are a number of businesses along Pleasant Street. The properties within the site are occupied by Pleasant Journey Used Cars, Pro Lube, a car wash, an office building and night club. Reportedly, there are no longer any underground gasoline storage tanks at the site. Automobiles are still serviced in the two-bay garage at Pleasant Journey and at Pro Lube. Sewer, water, and natural gas are available along Pleasant Street.

3.0 PHYSICAL SITE CHARACTERISTICS

3.1 Previous Assessment Activities

In 1988, a wellpoint was installed at 492 Pleasant Street and gasoline was detected in the groundwater. On October 23, 1989, the DEP was first notified of the gasoline release at 459 Pleasant Street based upon the findings in an August 30, 1989 report by the former Certified Engineering and Testing Company of Weymouth, MA. Site number 1-0705 was assigned and it later became the RTN for the site.

Numerous investigations and limited remedial measures were conducted at the site. On November 30, 1989, Certified submitted a Phase I Limited Site Investigation Report for the site. On November 8, 1993, an Interim Phase I Report was prepared by Cold Spring Environmental, Inc. of Belchertown, MA. In December 1996, a Phase I Completion Report and Tier Classification for the site were submitted by Cold Spring. Previous reports had also been submitted for 492 Pleasant Street.

On December 8, 1998, a Method Three Risk Characterization was prepared by O'Reilly, Talbot & Okun Associates, Inc of Springfield. It had determined that there was no significant risk associated with the remaining contamination at the site. On March 26, 1999, a Phase II Report and a Phase III Plan were submitted to the DEP by Environmental Compliance Services (ECS), Inc of Agawam. ECS had conducted a Phase II Comprehensive Site Assessment at the site to determine the nature and the extent of the soil and groundwater contamination in order to evaluate risk. In 1997, they advanced 25 additional soil borings and installed five additional monitoring wells. Copies of selected Boring Logs and Well Data Sheets from the Phase II Report and prior reports are included in Appendix B. The location of all the borings and wells are shown on the four figures and the Remedial Action Site Plan. The names of the wells have changed over the years. During the advancement of the borings ECS conducted headspace screening of the split-spoon samples with an HNu Model 101 photoionizing detector setup with a 10.2 eV lamp and calibrated to read as benzene. The Model 101 was known to produce false readings for wet soil samples. The readings were recorded on their Boring Logs which are included in Appendix B. The highest, or most representative, headspace readings are shown on the Remedial Action Site Plan for each soil boring. Based upon the headspace results, the soil contamination extends from the office at Pleasant Journey to the rear of the office building at 492 Pleasant Street. Based upon the headspace results, only one soil sample from 18 soil borings advanced on June 25, 1997 was analyzed for volatile organic compounds (VOCs) by EPA Method 8020. The single sample was collected from a depth of 12 to 13 feet from boring SB-4 located adjacent to the northeastern corner of the former dispenser pad at 459 Pleasant Street. Two other soil samples were reportedly analyzed for "hazardous waste treatability", but no results or laboratory reports were reported. The results for the one soil sample analyzed included benzene at 43.5 mg/kg; toluene at 363.5 mg/kg; ethylbenzene at 116.5 mg/kg; xylenes at 555.0 mg/kg and methyl-tert-butyl ether (MTBE) at 5.8 mg/kg. We assumed that the most contaminated soil sample was analyzed. Clearly the results were above the Method One S-1/GW-3 cleanup standards. We do not understand why only one soil sample was analyzed or why the results were expressed by $\mu\text{g}/\text{kg}$ in the laboratory report.

On April 2, 1998, ECS collected groundwater samples from 19 wells at the site. Specific samples were analyzed for volatile aromatic compounds by EPA Method 602, a method for analyzing drinking water; volatile petroleum hydrocarbons (VPHs); and extractable petroleum hydrocarbons (EPHs) with target polynuclear aromatic hydrocarbons (PAHs) by the new DEP method. On July 9, 1998 two groundwater samples were collected from the Shell station at 506 Pleasant Street along with another sample from 492 Pleasant Street. Reportedly, the samples were collected with dedicated, stainless steel bailers which are very expensive. On July 9, 1998, additional groundwater samples were collected from 491 Pleasant Street with a geoprobe. All the previous and 1998 groundwater sampling results were listed in three large tables. We have presented the 1998 VPH results for specific wells and the GW-2 and GW-3 cleanup standards in effect at that time in Table One included in the Figures Section.

As shown in bold in Table One, a number of the wells contained dissolved gasoline-related compounds that exceeded the GW-2 and GW-3 cleanup standards. The significant contamination extended from 459 Pleasant Street to MW-12 across Pleasant Street. ECS did not report any free-phase gasoline in any of the wells they sampled. ECS stated that no significant risk was identified at the site in 1998. The application of oxygen-releasing compounds and an Activity and Use Limitation were recommended as a permanent solution.

On June 8, 2000, free-phase gasoline was again discovered in wells MW-9 and VM-1 at thickness of 0.69 and 0.14 feet, respectively. On June 29, 2000, an IRA Plan was submitted to the DEP by Acadian Environmental of Springfield. The IRA Plan originally proposed the installation of a groundwater pump and treat system and a separate SVE system using vapor phase carbon. Bailing of the free-phase gasoline was to be conducted at specific wells according to the IRA Plan. The groundwater was to be pumped through an oil/water separator and two, 500-lb canisters of aqueous phase carbon before being discharged into a storm drain. On September 1, 2000, the IRA Plan was modified for the SVE system to use a catalytic oxidizer instead of vapor phase carbon. According to a November 30, 2000 IRA Status Report by Acadian, the SVE system began operating on August 7, 2000. The pump and treat system only operated at 1.5 gpm from August 8 to 10, 2000 because of mechanical problems. Reportedly, the SVE system operated intermittently from August 7, 2000 until it experienced mechanical problems on December 7, 2000.

3.2 Additional Assessment Activities

On March 12, 2002, Mr. Ralph Penney from Penney Engineering met with Mr. Kalish to inspect the site. A few of the wells at 459 Pleasant Street were gauged and inspected. Five inches of free-phase gasoline was measured in a bailer from MW-9. It was apparent that remedial response measures were warranted.

On April 25, 2002, we attempted to locate all the monitoring wells at the site. We were able to inspect and gauge 19 wells. The wells were gauged for depth to water and for the presence of free-phase gasoline with a Solinst interface probe. Free-phase gasoline was measured with the probe and confirmed with a bailer in wells MW-9 and MW-12. Distinct petroleum sheens and/or a strong petroleum odor were observed in the groundwater samples from wells MW-1, 4, 5, 6, 8, 10, 2A, 4CW, ECS-1, and ECS-5. We collected 14 groundwater samples from wells MW-1, 3, 4, 5, 6, 7, 8, 9, 2A, 8, 12, ECS-1 and ECS-5 in order to determine the extent of the dissolved gasoline contamination in the groundwater. A sample was also collected from well Bridal 447 as requested by the DEP. The locations of the wells are shown on Figures Three and Four. Samples could not be collected from MW-2, MW-10 and VM-1. Ten of the groundwater samples were collected according to DEP procedures and transported to RI Analytical, Inc of Warwick, RI under chain-of-custody protocol for analysis. The samples from MW-9 and MW-12 were not analyzed because they contained free-phase gasoline. The sample from MW-4 was not analyzed because it was located in close proximity to MW-5, 7 and 9. The 10 samples were analyzed for VPHs by the DEP method. The results for the compounds detected are summarized and compared to the GW-2 and GW-3 cleanup standards in effect at that time in Table Two located in the Figures section. The results that exceeded the cleanup standards are shown in bold.

The results listed in Table Two are very similar to the 1998 ECS results listed in Table One. As shown in bold in Table Two, a number of gasoline-related contaminants were detected above the cleanup standards. The detection limits on the most contaminated samples were high because of the relatively high concentrations of dissolved gasoline-related contaminants in the samples. We attempted to determine the extent of the dissolved gasoline contaminants by plotting the results on Figures Three and Four. The iso-contours of the BTEX compounds are plotted on Figure Three. The iso-contours for the C₅-C₈ aliphatics fraction are plotted on Figure Four. We also attempted to show the extent of the free-phase gasoline based upon our April 25, 2002 gauging and previous reports of free-phase gasoline. The former dispenser area at 459 Pleasant Street has been reported as the most likely source of the gasoline release. Both figures show that

the dissolved gasoline contaminants in the groundwater generally coincide with the estimated extent of free-phase gasoline as it migrates to the east with the local groundwater flow.

We did not collect any soil samples. Only soil boring samples were analyzed during previous assessments. Gasoline contaminants were detected in soil boring samples collected at or above the groundwater table. No soil samples were collected from beneath Pleasant Street due to access restrictions. No test pitting was conducted at the site. We assumed that the extent of the soil contamination is within the free-phase gasoline floating on the groundwater as shown on Figures Three and Four.

On April 25, 2002 we also conducted limited indoor air screening with an organic vapor meter setup with a 10.6 eV lamp and calibrated with isobutylene to read "as benzene". We were allowed to conduct screening in the office and the garage at Pleasant Journey; the office and garage areas at Pro Lube; the car wash; the Sheriff's Department office; the Community Corrections office; the Community Development office and the pet store. We were not allowed to screen the 591 Food Stop restaurant. None of the buildings had basements. No significant readings were recorded. The highest reading of 3.1 ppm was recorded in the pet store.

3.3 Hydrogeologic Characteristics

3.3.1 Topography and Bedrock Characteristics

The site is located in the Connecticut River Plain. The area is relatively flat. There are no visible bedrock outcrops and bedrock was not encountered during the advancement of any soil borings. The depth to bedrock has been estimated to be 120 to 170 feet. It is known to be New Haven Arkose, a sandstone, according to ECS.

3.3.2 Soil Characteristics

According to the Phase II Report by ECS, the soil at the site is Hadley-Winooski associated soils and Hinckley loamy sands. According to the numerous boring logs included in Appendix C, the soil at site is:

- 0-2 feet of asphalt, fill, ash, fine to medium sand;
- 2-7 feet of fine sand and silt;
- 7-12 feet of medium to fine sand, silt, trace coarse sand; and
- 12-16 feet of medium to coarse sand.

A soil profile is included on the Remedial Action Site Plan. The groundwater is at a depth of approximately eight to 10 feet. The medium to coarse sand at 14 to 16 feet is expected to be of relatively high hydraulic conductivity to allow significant groundwater flow, however, the Connecticut River Plain is known to contain silt which restricts groundwater flow.

3.3.3 Groundwater Characteristics

On April 25, 2002 we measured the depths to groundwater in 19 wells and used the data to calculate the groundwater elevations presented in Table Three. The elevations of the risers were surveyed and reported by ECS.

TABLE THREE
Groundwater Elevation Data
April 25, 2002

<u>Well Location</u>	<u>Top of Riser Elevation (ft)</u>	<u>Depth to Groundwater (ft)</u>	<u>Groundwater Elevation (ft)</u>
MW-1	98.67	8.65	90.02
MW-2	99.64	9.46	90.18
MW-3	99.52	9.32	90.20
MW-4	NA	8.56	NA
MW-5	99.01	9.04	89.97
MW-6	98.87	8.75	90.12
MW-7	98.81	8.92	89.89
MW-8	98.81	8.96	89.85
MW-9	99.03	8.98	0.47' Gasoline
MW-10	98.24	8.23	90.01
MW-12	99.02	9.12	0.05' Gasoline
VM-1	98.80	8.84	89.96
Bridal 447	NA	8.20	NA
MW-2A	98.58	8.79	89.79
MW-1CW	NA	9.36	NA
MW-4CW	NA	9.83	NA
ECS-1	99.15	9.41	89.74
ECS-2	NA	9.60	NA
ECS-5	99.03	9.21	89.82

NA – Not Available

On June 8, August 2, October 11, 2000 and April 4 and April 18, 2001, Acadian had also measured the depths to groundwater and determined the elevation of the groundwater at specific wells. The results were reported in their June 22, 2001 IRA Status Report. We have plotted the groundwater contours based upon the fall, October 11, 2000 results on

Figure One. As shown, the local groundwater flow direction is to the east, toward the Mill River which flows into the Connecticut River. We have also plotted the groundwater contours based upon our spring, April 25, 2002 results on Figure Two. As shown, the local groundwater flow direction is also to the east. ECS had also reported the flow to the east. The direction of the local groundwater flow is dependent upon the stage of the Connecticut River.

On November 11, 2003, we gauged nine monitoring wells at the site to measure the depth to groundwater. We also gauged Recovery Well RW-1 and the Recharge Well. The depth to groundwater measurements were used to determine the elevation of the groundwater table at each well. We plotted the resulting groundwater contours on the November 11, 2003 Groundwater Contour Plan included in the Figures section. Although the data was limited, the contours showed that the influence of the groundwater treatment system was limited to the 459 Pleasant Street, the adjacent section of Pleasant Street and potentially the western extent of the properties at 480 and 492 Pleasant Street.

4.0 ENVIRONMENTAL FATE AND TRANSPORT OF OIL/HAZARDOUS MATERIALS

4.1 Evaluation of Oil/Hazardous Materials

The contaminants of concern at the site are associated with gasoline, a petroleum product. This section presents a full description and evaluation of the contaminants of concern at the site.

Benzene: C_6H_6

Synonyms: Benzol, phenyl hydride, benzole

Chemical and physical properties: Colorless liquid; m.w. 78.11; SpG 0.879 @ 20°C; m.p. 5.5°C; b.p. 80.1°C; v.p. 76 mm at 20°C; solub. 1,780 mg/l at 20°C; sat. conc. 319 g/cu m at 20°C; log P_{oct} 2.13 at 20°C; Henry's Constant 230 atm.

Benzene is used in the manufacture of organic chemicals and pesticides, plastics, resins, paints and coatings. It is a constituent of gasoline. Benzene is considered an occupational carcinogen by NIOSH. If benzene is released to the soil, it will volatilize and leach into the groundwater due to its low to moderate adsorption to mineral soil. It will slowly biodegrade in soil and groundwater.

Toluene: $C_6H_5CH_3$

Synonyms: Methylbenzene, methylbenzol, toluol

Chemical and physical properties: Colorless liquid; m.w. 92.1; m.p. $-95.1^{\circ}C$; b.p. $110.8^{\circ}C$; v.p. 22 mm at $20^{\circ}C$; v.d. 3.14; SpG 0.867 at $20^{\circ}C$; solub. 515 mg/l at $20^{\circ}C$; sat. conc. 110 g/cu m at $20^{\circ}C$; Henry's Law Constant 6.7×10^{-3} atm- m^3 /mole or 217 atm.

Toluene is derived from petroleum distillation and is used in the manufacture of benzene derivatives and dyes, as a solvent for adhesives, paints and coatings, and is a component of gasoline. If toluene is released to soil, it will be lost by evaporation from near surface soil and by microbial degradation. Since it is relatively mobile in soil, it may leach into the groundwater where slow biodegradation may occur.

Ethylbenzene: $CH_3CH_2C_6H_5$

Synonyms: Phenylethane, ethybenzol

Chemical and physical properties: Colorless liquid; m.w. 106.17; m.p. $-94.97^{\circ}C$; b.p. $132.2^{\circ}C$; v.p. 7 mm at $20^{\circ}C$; v.d. 3.66; SpG 0.867 at $20^{\circ}C$; solub. 152 mg/l at $20^{\circ}C$; sat. conc. 40 g/cu m at $20^{\circ}C$; Henry's Law Constant 8.44×10^{-3} atm- m^3 /mole or 359 atm.

Ethylbenzene is a petroleum derivative used in the manufacture of styrene, as a solvent, and is a major constituent of gasoline. When released to the soil, some evaporation may take place from near the surface. It is moderately adsorbed by soil but will leach into groundwater, especially in soil with a low organic carbon content. It will slowly biodegrade in groundwater.

Xylenes (o-, m-, p- isomers): $C_6H_4(CH_3)_2$

Synonyms: Dimethylbenzene, methyltoluene, xylol

Chemical and physical properties: Colorless liquid; m.w. 106.16; m.p. $-25^{\circ}C$; b.p. $144.4^{\circ}C$; v.p. 5 mm at $20^{\circ}C$; v.d. 3.7; Sp G 0.88 at $20^{\circ}C$; solub. 175 mg/l at $20^{\circ}C$; sat. conc. 29 g/cu m at $20^{\circ}C$; Henry's Law Constant 5.27×10^{-3} atm- m^3 /mole or 266 atm.

Xylenes are used as solvents for resins, lacquers, enamels and rubber cements in the manufacture of dyes and insecticides. They are a major constituent of gasoline. Natural sources include coal tar, petroleum, forest fires, and plant volatiles. When spilled on soil,

xylene will volatilize and leach into the groundwater due to their low to moderate adsorption to soil. They will slowly biodegrade in soil and groundwater.

Methyl tert-butyl ether: $(\text{CH}_3)_3\text{COCH}_3$

Synonyms: MTBE

Chemical and physical properties: Colorless liquid with a disagreeable odor; m.w. 88.2; b.p. 5.5°C; v.p. 245 mm at 20°C; solub. 43,000 mg/l at 20°C; SpG 0.741 at 20°C; log P_{oct} 1.1 at 20°C.

Since 1978, MTBE has been used as an octane booster in unleaded gasoline. It can be present at up to 15 percent by volume in gasoline blends. MTBE is very soluble in water and has a low potential for adsorption to soil. It is generally the most mobile groundwater contaminant in releases of gasoline. Acute effects of exposure to MTBE may include skin, eye and nasal irritation. The use of the MTBE is currently being re-evaluated by the EPA.

Volatile Petroleum Hydrocarbons:

The VPH constituents are separated into three fractions as the $\text{C}_5\text{-C}_8$ aliphatic hydrocarbons, $\text{C}_9\text{-C}_{12}$ aliphatic hydrocarbons and $\text{C}_9\text{-C}_{10}$ aromatic hydrocarbons. The fractions represent the lighter petroleum compounds primarily associated with gasoline. The Method One cleanup standards for VPH were developed using conservative site scenarios to evaluate risks to human health, public welfare and the environment via exposure pathways such as direct contact, ingestion and volatilization.

4.2 Migration Pathways

The free-phase and dissolved gasoline detected at the site may potentially migrate through the vadose zone and escape to the atmosphere. However, based on the localized area of groundwater contamination and the low permeability of the shallow soil above the groundwater table, it is unlikely that the contamination shall result in detectable concentrations of VOCs in the air at the site. Nothing was detected during our limited indoor air screening. In 1984 and 1988, a majority of the contaminated soil was removed from the former tank areas at the site. Free-phase gasoline remains in the area of the former dispensers at 459 Pleasant Street and across Pleasant Street at 480 and 492 Pleasant Street. The potential for the migration of any gasoline in the soil through the air by wind erosion is insignificant.

The gasoline contamination shall continue to migrate with the groundwater to the east. The migration of the contamination in the upper portion of the aquifer may not be influenced by underground utilities because the utilities are probably bedded above the groundwater table.

The groundwater at the site and in the vicinity is not reportedly used as a drinking water source. Therefore, exposure by ingestion of the groundwater is not a potential pathway. The groundwater velocity was estimated in an effort to characterize the groundwater as a potential migration pathway. Based upon variable-head slug tests conducted by ECS, the hydraulic conductivity (K) was estimated to be 6.41 feet per day. According to Darcy's Law, the estimated K value, the hydraulic gradient measured between wells and an assumed porosity were used to calculate an estimated groundwater velocity across the site. The formula is presented below:

Darcy's Law $V=KI/N$
Where V =velocity (ft/day)
 K =hydraulic conductivity
 I =hydraulic gradient (ft/ft)
 N =porosity

The hydraulic gradient on April 25, 2002 was calculated to be 0.003 ft/ft between wells MW-2A and 5, which are 156 feet apart. The soil porosity was estimated using typical values for gravelly, silty sand. The porosity was estimated to be 0.28. The annual velocity of the groundwater across the site is calculated as follows:

$$V=[(6.41 \text{ ft/day}) \times (0.003 \text{ ft/ft}) / 0.28] \times (365 \text{ days})$$
$$V= 0.0002 \text{ ft/year}$$

The calculated annual groundwater velocity is very low due to the low hydraulic gradient. It is less than the Condition of Substantial Release Migration threshold of 200 feet per year. Although free-phase gasoline has been detected floating on the groundwater, there have been no reported releases of gasoline to the ground surface. The contaminated groundwater is not expected to affect any public or private water supply wells. All the known tanks have been removed from the site in the 1980s. The free-phase gasoline continues to remain in the area between the former dispensers along Pleasant Street and the former tanks at 480 Pleasant Street. There have been no recent releases to the groundwater reported. Vapors are not expected to discharge into any basements. No

one has reported gasoline odors in their buildings. A Condition of Substantial Release Migration, as defined in Section 40.0006 of the MCP, has not been identified at the site.

5.0 NATURE AND EXTENT OF CONTAMINATION

Figures Three and Four clearly show our estimated extent of the free-phase and dissolved gasoline contamination in the groundwater based upon our April 25, 2002 sampling results. Previous reports have identified a similar extent. The presence of the free-phase gasoline has not been consistently reported. In 1998, no free-phase gasoline was observed and the site was to be closed. However, on June 8, 2002, free-phase gasoline was again observed in wells MW-9 and VM-1 at 0.69 and 0.14 feet, respectively.

5.1 Initial Extent of Free-Phase Gasoline

Our estimated initial extent of the free-phase gasoline is shown as NAPL on Figures Three and Four. Our estimate is based upon previous reports of free-phase gasoline in specific wells and our April 25, 2002 observation of free-phase gasoline in wells MW-9 and MW-12. The presence of free-phase gasoline is associated with the height of the groundwater table. We have assumed that it extends under Pleasant Street.

5.2 Initial Extent of Soil Contamination

We initially assumed that the extent of the gasoline contamination in the soil is similar to the extent of the free-phase gasoline shown in Figures Three and Four. Reportedly, contaminated soil was removed in 1984 when the underground storage tanks were removed from 459 and 480 Pleasant Street. No contaminated soil has been removed from the former dispenser area at 459 Pleasant Street.

5.3 Initial Extent of Groundwater Contamination

The initial extent of the dissolved gasoline contamination in the groundwater is shown on Figures Three and Four as the 10,000 and the 2,000 iso-contours. Again, our estimated extent is similar to what has previously been reported.

5.4 Operation, Maintenance and Monitoring of the Existing Treatment Systems

On June 2, 3, 4, 5, and 6, 2003, we installed the underground portions of the treatment systems at 459 Pleasant Street. We also constructed the concrete pad for the treatment

trailer, placed the trailer on the pad, placed the regenerative carbon vessel on the pad and filled the vessel with approximately 1,300 lbs of vapor phase carbon. We encountered approximately 100 cubic yards of overtly, gasoline-contaminated soil and stockpiled it on site. On June 11, 12 and 13, 2003, we completed the setup of the treatment trailer and tested the equipment.

At 10:20 AM on June 25, 2003, we started the groundwater treatment system installed on the western side of Pleasant Street. The groundwater began being pumped at 5.0 gpm from the large diameter Recovery Well RW-1 installed where the former dispenser pad had been located. The groundwater was treated through a reconditioned, Model #BD-5-E8 biodiffuser that was designed and manufactured by Penney Engineering. The biodiffuser has a built-in oil/water separator as the first stage followed by seven air stripping stages and a clearwell chamber. Approximately 92 gallons of treated groundwater was periodically pumped from the clearwell at approximately 35 gpm into the large diameter Recharge Well installed where the former tanks were located.

Since being activated, the groundwater treatment system was operated and maintained by Penney Engineering with help from the mechanics at Pleasant Journey. The mechanics and Mr. Kalish were trained to safely bail any recovered gasoline from Recovery Well RW-1 on a weekly basis. Any gasoline that accumulated in RW-1 was manually removed with a newly designed, Kalish skimmer. The systems were inspected almost daily. We monitored them almost every two weeks. We routinely screened the off-gas from the biodiffuser with an OVM. We conducted quarterly groundwater monitoring by sampling the influent from the groundwater treatment system along with groundwater from monitoring wells.

On November 23, 2004, we began manually applying remedial additives to monitoring wells MW-12 and ECS-5 located at 492 Pleasant Street. A 55-gallon drum was filled with treated groundwater from the biodiffuser. Five pounds of granular, 20-20-20 microbe nutrients and ¼ lb of powdered Munox 10x Multiplier, a mixture of 35 varieties of petroleum metabolizing bacteria, were dissolved in the water. A small, battery-powered pump was used to transfer approximately 27 gallons of the remedial additives solution into each well. On March 24, 2005, we began to periodically apply remedial additives to wells MW-2A, MW-10, MW-12, and ECS-5.

The treatment systems continued to operate continuously, except for brief shutdowns for repairs, maintenance and regeneration of the vapor phase carbon until December 2005.

On December 14, 2005, we temporarily shut down the SVE system for the winter. On March 21, 2006, we attempted to restart the SVE system but found that the blower had been damaged. On April 18, 2006, we replaced the blower and restarted the SVE system. As of May 31, 2006, we had treated 2,214,239 gallons of groundwater and as of May 3, 2006, we had recovered 729.05 gallons of gasoline that has been or shall be recycled off-site as a fuel. On June 30, 2006, we temporarily shut down the treatment systems located at the 459 Pleasant Street property to evaluate how best to install the remainder of the systems across Route 5 at 480 and 492 Pleasant Street. We also temporarily suspended injecting remedial additives into the effluent from the biodiffuser and periodically, manually applying remedial additives to specific wells. Our monitoring results showed that we have significantly reduced the gasoline contamination at 459 Pleasant Street. On November 16, 2006, Mr. Penney drained and winterized the groundwater and the SVE treatment systems.

On September 18, 2008, we collected samples from monitoring wells MW-2A, MW-9, MW-10 and ECS-5 according to DEP procedures. MW-12 could not be sampled because the well was damaged and there was a bailer stuck in the well. The four samples were transported to Groundwater Analytical under chain-of-custody protocol. The samples were analyzed for VPHs by the DEP method and for total and dissolved lead. The results for the compounds detected are summarized and compared to the applicable GW-2 or GW-3 cleanup standards in Table Four. The wells were also analyzed for nitrates and nitrites, total phosphorus and heterotrophic bacteria to evaluate the biological activity in the groundwater. We also inspected the wells for gasoline and measured the oxygen reducing potential (ORP), dissolved oxygen (DO), pH and temperature in well MW-9. A gasoline sheen and odor of gasoline were observed in wells MW-9 and MW-10. Wells MW-2A and ESC-5 had a slight odor of gasoline and no sheen. The measurements and our normal ranges are listed in Table Five. Copies of our Monitoring Well Sampling Log and the laboratory analysis report are included in Appendix A. As stated in the report, the samples were collected in the appropriate containers with the required preservatives. No duplicate samples were collected because the total number of samples was less than 20. No holding times were exceeded. There was one modification of the methods. All four samples were diluted to keep the target analytes with calibration prior to VPH analysis. There were no non-conformances and no analysis issues. Only lead was requested to be reported by EPA Method 6010B, not all 14 of the MCP metals. The laboratory filtered and then preserved the samples to be analyzed for dissolved lead. All the surrogate recoveries were within the quality control limits. Quality control protocols were conducted and met the prescribed recovery limits. The detection limits were below the applicable

cleanup standards. The results appear to have achieved presumptive certainty under the Compendium of Analytical Methods for the field collection and laboratory analysis. The laboratory report meets the requirements of 310 CMR 40.0017.

TABLE FOUR
Summary of Groundwater Results
September 18, 2008

<u>Parameters (ug/l)</u> (Applicable Standard)	<u>MW-2A</u>	<u>MW-9</u>	<u>MW-10</u>	<u>ECS-5</u>	<u>Cleanup Standards</u>	
	(GW-2)	(GW-3)	(GW-3)	(GW-2)	<u>GW-2</u>	<u>GW-3</u>
VPHs						
C ₅ -C ₈ aliphatics	9,000	9,500	15,000	410	3,000	50,000
C ₉ -C ₁₂ aliphatics	5,000	6,300	17,000	380	5,000	50,000
C ₉ -C ₁₀ aromatics	3,400	6,600	18,000	390	7,000	50,000
Target VOCs						
MTBE	<250	<120	<250	<50	50,000	50,000
Benzene	3,400	2,400	1,500	82	2,000	10,000
Toluene	6,600	4,200	11,000	<50	50,000	40,000
Ethylbenzene	1,000	780	2,100	73	20,000	5,000
Xylenes	4,200	3,900	13,000	110	9,000	5,000
Naphthalene	<250	240	540	<50	1,000	20,000
Metals						
Lead, Total	23	<5	<5	<5	NS	NS
Lead, Dissolved	<5	<5	<5	<5	NS	10

NS – Not Specified

As shown in bold in Table Four, benzene and the C₅-C₈ aliphatics and C₉-C₁₂ aliphatics fractions in MW-2A were above the applicable GW-2 cleanup standards. Xylenes in MW-10 were above the applicable GW-3 cleanup standards. The results for the VPHs and target VOCs were all below the applicable GW-2 and GW-3 cleanup standards in the remaining wells. Total lead was detected at 23 ug/l in MW-2A, but the cleanup standards are based on dissolved lead. Dissolved lead was not detected at levels below the GW-3 cleanup standards in all four wells.

TABLE FIVE
Summary of Antecedent Groundwater Measurements
September 18, 2008

<u>Parameters</u>	<u>MW-2A</u>	<u>MW-9</u>	<u>MW-10</u>	<u>MW-12</u>	<u>ESC-5</u>	<u>Normal Ranges</u>
ORP (mV)	NT	(-)134.7	NT	NT	NT	50 - 300
Dissolved Oxygen (mg/l)	NT	0.49	NT	NT	NT	1.0 – 3.0
pH	NT	6.9	6.9	NT	NT	5.7 – 8.2
Temp (°C)	NT	18.2	NT	NT	NT	5.0 – 20.0
Bacteria Counts (cfu/ml)	60,000	<10,000	1,000	NT	NT	0 – 2,500
Nitrate plus Nitrite (mg/l)	23	0.34	0.05	NT	23	0 – 0.5
Total Phosphorus (mg/l)	19	290	6.0	NT	1.0	0 – 20.0

NT – Not tested

As shown in Table Five, the bacteria counts in MW-2A were high, indicating that bioremediation was occurring. The nitrate and nitrite concentrations were very high in MW-2A. Phosphorus was very high in MW-9. The ORP was negative in MW-9 indicating reducing conditions and the DO was below our normal range.

5.5 Evaluation of Historical Results and Gasoline Recovery Rates

In order to evaluate the effectiveness of the SVE and the groundwater treatment systems at 459 Pleasant Street, we continually reviewed our monitoring results. To evaluate the SVE system, we reviewed the influent screening concentrations, the volume of gasoline recovered during each regeneration of the vapor phase carbon, the elevation of the groundwater table, and the duration between breakthroughs of the vapor phase carbon vessel. The initial SVE influent concentration on September 9, 2003 was 121.0 ppm, measured as air sample AS-2. After the first month of operation it had decreased to 95.0 ppm on October 7, 2003. During the next two months it decreased further to 60.2 ppm on November 5 and 39.7 ppm on December 2, 2003. On January 12, 2004, it had decreased to 13.1 ppm. On February 12, 2004, it had increased slightly to 18.3 ppm. By February 26, 2004, it had risen to 22.9 ppm. The increase was attributed to the dropping of the groundwater table allowing more contaminated soil to be exposed and vented by the SVE system. It continued to rise to 32.1 ppm on March 25, 2004 and then began to decrease as the groundwater table rose in the spring. On May 24, 2004, the SVE system influent screening concentration began to rise with the summertime drop of the groundwater table. As a result, the quantity of gasoline we recovered during each regeneration also increased to 11 gallons. On August 16, 2004, the influent peaked at

43.7 ppm and we recovered 14 gallons of gasoline. So after one year of operating the SVE system, the influent had decreased from 121.0 to 43.7 ppm. As of August 31, 2004, we had recovered a total of 11.25 gallons of gasoline by manually bailing from Recovery Well RW-1 and 465.30 gallons from regenerating the vapor phase carbon. Clearly, a majority of the recovered gasoline came from the SVE system. That was a substantial amount in one year, considering that a majority of the recovered gasoline originated as gasoline vapors drawn from the pore spaces of the soil and because of the very low intrinsic permeability of the soil at the site.

From September 7, 2004 until January 27, 2005, the SVE system influent decreased from 41.1 to 21.3 ppm. We also recovered an additional 139.75 gallons of gasoline during the period. On March 4, 2005, the SVE influent concentration had decreased to 10.5 ppm and we only recovered 6.50 gallons of gasoline although the system had operated for 36 days. On April 6, 2005, the influent further decreased to 5.5 ppm, and we recovered 7.25 gallons of gasoline after 32 days of operation. On May 17, 2005, the groundwater table was found to be dropping. The SVE influent rose to 41.0 ppm and 7.25 gallons of gasoline was recovered after 41 days of operation. In July and August 2005, the groundwater table continued to drop exposing the gasoline globules trapped in the previously submerged soil. The amount of gasoline recovered increased and the duration decreased to 14, 21 and 19 days. The prior summer the durations were 13, 9, 7, 6, 6, 7, 4, 5, and 6 days for the same two months. The amount of gasoline recovered was slightly more. The increased duration meant that the volume of gasoline trapped in the pores spaces had greatly decreased.

From January 27, 2005 until December 14, 2005, the SVE system influent continued to fluctuate with the groundwater table. The SVE influent concentrations were much lower, the durations of operation between regenerations were longer and the volume of gasoline recovered during comparable regenerations was less, but there was still a direct correlation between the height of the groundwater and the performance or effectiveness of the SVE system. The correlation was a result of the smear zone above the groundwater being more exposed when the groundwater table drops and less exposed when the groundwater table rises.

From December 14, 2005 until June 30, 2006, when both systems were shut down, the SVE system had only operated for 72 days. On December 14, 2005, we had shut down the SVE system because of the low recovery expected during the winter months. The SVE system was not restarted until April 18, 2006 after we replaced the damaged blower.

The SVE influent concentrations were only 0.4, 3.1, and 1.8 ppm during this period. On May 3, 2006, we regenerated the carbon after 14 days of known operation and 1,535 hours or 64 days of assumed operation over the winter. We recovered only 3.5 gallons of gasoline.

In order to better evaluate the SVE system data, we prepared a series of plots. The SVE system influent concentrations, the volumes of gasoline recovered during each regeneration, and the number of days between each regeneration have been plotted on Charts One, Two, Three and Four, included in the Figures section. Charts Three and Four also show the elevation of the groundwater table in well MW-5, located east of the office building at 459 Pleasant Street. The amount of gasoline recovered during regeneration is a direct indicator of the effectiveness of the SVE system. Chart Three shows that the fall of 2004 rising of the groundwater table caused decreases in the SVE system influent concentrations and the volumes of gasoline recovered, but increases in the duration between regenerations of the carbon. The response was repeated in the fall of 2005, as shown in Chart Four. Chart Four also shows that the falling groundwater table in the summer of 2005 caused increases in the SVE system influent concentrations and the volumes of gasoline recovered, but decreases in the duration between regenerations. Those responses clearly indicate that there were still globules of gasoline remaining in the pore spaces of the soil in the smear zone at the groundwater table. As shown in Charts One through Four, the volume of gasoline recovered during each regeneration has steadily decreased. Clearly the SVE system has almost adequately remediated the gasoline in the pore spaces of the soil at 459 Pleasant Street.

In October, 2005 we began to plot the ratio of the gasoline recovered during each regeneration of the carbon to the duration of operation and the date of the regeneration since we began regenerating the carbon on September 22, 2003. Regression Chart One, included in the Figures section, shows dramatic increasing during the late summers of 2003 and 2004. In the late summer of 2005, there was only a slight increase, which indicated that much less gasoline remained trapped in the pore spaces of the contaminated soil at the site. The chart also shows that the SVE system was removing much less gasoline after January 2005.

In summary, the soil at 459 Pleasant Street was highly contaminated with gasoline and the SVE system has been very effective at removing it, but there are still gasoline globules left to vent. It may also be removing gasoline that has been drawn back to

Recovery Well RW-1 from under the adjacent section of Pleasant Street and the properties at 480 and 492 Pleasant Street.

In order to evaluate the effect of the groundwater treatment system, we monitored the presence of free-phase gasoline, developed a plan of the groundwater elevation contours in order to determine the zone of influence of the Recovery Well RW-1, and evaluated the quarterly groundwater and influent monitoring results. Since April 25, 2002, we routinely observed free-phase gasoline in wells MW-1, MW-9, MW-10, MW-12 and ECS-5. On September 19, 2003, we observed four-inches of free-phase gasoline in well MW-12. On November 11, 2003, after starting the SVE system on September 12, 2003, we gauged nine monitoring wells at the site to measure the depth to groundwater and to inspect each for the presence of free-phase gasoline. We also gauged Recovery Well RW-1 and the Recharge Well. No free-phase gasoline was observed in any of the wells, but a sheen was observed in RW-1 and MW-10. Wells MW-1, RW-1, MW-9, MW-10, MW-12, ECS-5 and MW-2A had a gasoline odor. On March 18, 2004, we observed one-sixteenth inch of free-phase gasoline in well MW-1. On September 21, 2004, we only observed a sheen in wells MW-9, 10, 12 and ECS-5. On December 9, 2004, we only observed a sheen in wells MW-1, 9, 10, 12 and ECS-5.

The depth to groundwater measurements were used to determine the elevation of the groundwater table at each well. We plotted the resulting groundwater contours on the November 11, 2003 Groundwater Contour Plan. Although the data was limited, the contours showed that the influence of the groundwater treatment system was limited to the 459 Pleasant Street, the adjacent section of Pleasant Street and potentially the western extent of the properties at 480 and 492 Pleasant Street. Recovery Well RW-1 was not significantly affecting the groundwater at 480 Pleasant Street. The groundwater was being circulated between the Recharge Well and Recovery Well RW-1. As shown on Figures One and Two, on October 11, 2000 and April 25, 2002, respectively, the groundwater table at the site was relatively flat. The elevation only decreased from approximately 90.15 to 89.75 feet across the site. On November 11, 2003, Recovery Well RW-1 had created a drawdown of approximately one-foot, which was expected to greatly affect the groundwater over a large area in the low permeability soil at the site. As shown on the Remedial Action Site Plan, the installation of Recovery Well RW-2 would allow the groundwater treatment system to circulate treated groundwater through the contaminant plume that is shown on Figures Three and Four.

In order to evaluate the effect of the groundwater treatment system, we tabulated and plotted the quarterly monitoring results for the influent from Recovery Well RW-1. Influent results are normally a better indicator of the overall groundwater conditions because the water is actively being drawn from a large area, as opposed to a monitoring well that is one stagnant point. The results are summarized and compared to the applicable GW-3 cleanup standards in Table Six, included in the Figures section. The results for the C₅-C₈ aliphatics and the C₉-C₁₀ aromatics fractions are plotted in Chart Five, also included in the Figures section. The 4,000 ug/l GW-3 cleanup standard, which is common to both fractions, is also plotted.

As shown in Table Six, the treatment system reduced the two VPH fractions by 50% between June 25 and September 22, 2003 and by 65% between September 22 and December 18, 2003. From December 18, 2003 to December 14, 2005, the influent concentrations remained relatively constant, which indicated that gasoline was being drawn into Recovery Well RW-1. The reductions are more apparent in Chart Five. Only gradual reductions can occur until all the globules of free-phase gasoline are removed from the pore spaces of the contaminated soil by the SVE system. The last three rounds of VPH influent results were at or below the GW-3 cleanup standards. The installation of Recovery Well RW-2 at 480 Pleasant Street shall greatly increase the radius of influence of the groundwater treatment system and force the aerated, nutrient rich discharge water to move through the contaminant plume under Pleasant Street. It shall also allow us to periodically alternate the flow patterns between the Recharge Well and the two recovery wells.

In order to evaluate the groundwater treatment system, we also tabulated the historical quarterly monitoring results for well MW-9, which is located east of Recovery Well RW-1. The results are shown in Table Seven, included in the Figures section. As shown, the results decreased since we activated the groundwater treatment system on June 25, 2004 until September 21, 2004 when there was a dramatic increase. The results for the C₅-C₈ aliphatics and the C₉-C₁₀ aromatics are plotted in Chart Six, included in the Figures section. The plotted results show the dramatic increase. The results indicate that the groundwater in the area of MW-9 was re-contaminated sometime between our June 16 and September 21, 2004 sampling. The increase may have been caused by free-phase gasoline being drawn back to the Recovery Well RW-1 from under and across Pleasant Street during the low, summertime level of the groundwater table. On March 24, 2005 we began to periodically manually apply surfactant and remedial additives to well MW-9. Initially, the results slightly increased, as shown by the June 13, 2005 results, but have

since shown a steady decrease. The most recent March 21, 2006 results and the most recent September 18, 2008 results were all below the GW-3 cleanup standards. Again, only moderate decreases can be expected until the globules of gasoline in the pore spaces can be removed by the SVE system and the gasoline under the adjacent section of Pleasant Street is remediated.

In order to evaluate the groundwater treatment system, we also tabulated the quarterly monitoring results for well MW-10, which is located in the southern curb cut along 459 Pleasant Street, downgradient of the area between Recovery Well RW-1 and the Recharge Well. The results are shown in Table Eight, included in the Figures section. As shown, the results have remained relatively the same since we activated the groundwater treatment system on June 25, 2003. The results for the C₅-C₈ aliphatics and the C₉-C₁₀ aromatics are plotted in Chart Seven, included in the Figures section. The plotted results show a slight increase in the spring of 2004 followed by a gradual decrease. The results indicate that the groundwater treatment system has had very little affect on the groundwater around well MW-10. The results may also indicate that the gasoline contamination is being partially drawn back toward Recovery Well RW-1 from under and across Pleasant Street. The contamination being detected in MW-10 shall not decrease until gasoline is no longer being drawn to Recovery Well RW-1 from under Pleasant Street. On March 24, 2005, we began to apply remedial additives the MW-10. The dramatic increase of the subsequent, June 13, 2005 result for the C₉-C₁₀ aromatics was probably caused by the surfactant dissolving the gasoline trapped in the surrounding soil. The September 18, 2008 results were similar to the prior March 21, 2006 results, but were now below the GW-3 cleanup standards which had increased to 50,000 ug/l on December 14, 2007. The September 18, 2008 benzene results were now above the GW-3 cleanup standards which had decreased to 5,000 ug/l on December 14, 2007.

In order to evaluate the groundwater treatment system, we also tabulated the quarterly monitoring results for well MW-12, which is located across Pleasant Street at 492 Pleasant Street, as shown on the Remedial Action Site Plan. The results are shown in Table Nine, included in the Figures section. As shown, the results remained relatively the same since we activated the groundwater treatment system on June 25, 2003 until December 9, 2004 when we began to periodically manually apply remedial additives directly into well MW-12. The results for the C₅-C₈ aliphatics and the C₉-C₁₀ aromatics are plotted in Chart Eight, included in the Figures section. The plotted results remained relatively constant until March 24, 2005. The results show that the groundwater treatment system had very little affect on the groundwater around well MW-12. The dramatic

increase of the March 24, 2005 results was probably caused by the surfactant dissolving the gasoline trapped in the surrounding soil. The most recent March 21, 2006 results were all below the GW-3 cleanup standards. The effectiveness of the manually applied remedial additives may be limited to the area immediately around well MW-12, but the effects were significant.

In order to evaluate the groundwater treatment system, we also tabulated the temperature and the dissolved oxygen measurements of the groundwater from specific wells along with the influent and the effluent from the treatment system. The DO results showed that the treatment system was drawing in groundwater from Recovery Well RW-1 with a very high DO concentration and discharging the aerated water to the Recharge Well at higher concentrations. A cold, mountain stream has the highest DO content of 9.0 mg/l, so the bioremediation system was doing a great job of aerating the water to enhance aerobic bacteria to metabolize the gasoline contamination. It is a different story with the wells. The DO content from all the monitoring wells is within our normal range of 1.0 to 3.0 mg/l. The DO results indicate that the discharged groundwater may have developed channels and was flowing directly back to Recovery Well RW-1. We had determined that the recharged groundwater may be short-circuiting by flowing through channels or the more permeable layer of medium to coarse sand beginning at a depth of 14 feet. This is one more reason to install a second recovery well. The prior recirculation of the groundwater was producing a large area of oxygen and nutrient rich groundwater that was naturally migrating under and across Pleasant Street to enhance the bioremediation of the downgradient contaminants.

Since April 25, 2002, we routinely observed free-phase gasoline in wells MW-1, MW-9, MW-10, MW-12, and ECS-5. On September 19, 2003, we observed four-inches of free-phase gasoline in well MW-12. March 18, 2004, we observed one-sixteenth inch of free-phase gasoline in well MW-1. On June 16, 2004, we only observed a sheen in wells MW-9, 10, and 12. On September 21, 2004, we only observed a sheen in wells MW-9, 10, 12 and ECS-5. On December 9, 2004, we only observed a sheen in wells MW-1, 9, 10, 12 and ECS-5. On March 24, 2005, we observed a sheen in MW-1, MW-7, MW-10 and MW-12. On June 13, 2005, there was no sheen in any of the wells. The current SVE system may have removed a majority of the free-phase gasoline from both sides of Pleasant Street. A third SVE located along the 492 and 480 sides of Pleasant Street would allow any remaining free-phase gasoline to be vented from the pore spaces of the soil. The effects of the bioremediation shall not be apparent until the free-phase gasoline has been removed.

On March 18, 2004, we analyzed the influent from Recovery Well RW-1 for biochemical parameters. We found that the counts of naturally occurring heterotrophic bacteria was very high at 15,000 cfu/ml. However, no nitrogen or phosphorous was detected. Most bacteria require nitrogen and phosphorous. On September 21, 2004, we began continuously injecting liquid fertilizer into the discharge water, as previously described. On March 18, 2004, we began to monitor the bacteria counts in specific wells. High bacteria counts generally indicate high biological activity associated with the bioremediation of contaminants. The counts had greatly increased since we began injecting microbe nutrients into the biodiffuser and applying remedial additives to specific wells. The three wells across Pleasant Street, MW-2A, MW-12 and ECS-5, had bacteria counts over one million. The bacteria counts in wells MW-9 and MW-10, located at 459 Pleasant Street, steadily decreased, indicating that we were achieving adequate remediation of that portion of the site. The counts indicate that the remedial additives were effectively bioremediating the petroleum contamination in the immediate area of the wells.

Prior consultants have assumed that the source of the gasoline release was limited to the tanks and dispensers at 459 Pleasant Street. The former tanks at 480 Pleasant Street and the piping across Pleasant Street may be other sources. The extremely high bacteria counts in well MW-2A may indicate a source of petroleum, possibly diesel, contamination in the area of the former tanks. There may also have been additional tanks that supplied the former dispensers along Conz Street.

The current treatment systems and remaining treatment systems across Pleasant Street shall be operated in accordance with our August 2002 Phase III/IV Remedial Action and Remedy Implementation Plan, the Phase IV Performance Standards, described in 310 CMR 40.0872, and the Response Action Performance Standards, as defined in 310 CMR 40.0191, until the significant risk has been reduced and the conditions for a Class A-2 Response Action Outcome have been achieved. Remedial additives, including microbe nutrients, surfactant, and specific bacteria, shall be injected into the biodiffuser and manually applied to specific wells. We shall continue to conduct quarterly monitoring of the groundwater. We shall also sample the contaminated soil to insure that it has been adequately remediated. We shall also continue to attempt to evaluate the potential worker exposure to the indoor air in Building A. We may also conduct a subsurface investigation to determine if there are any abandoned tanks or other sources of contaminants at the site.

6.0 SUMMARY OF SITE CONDITIONS THAT WARRANT REMEDIAL ACTIONS

In 2003, a Method One risk characterization determined that the groundwater exposure point concentrations at the site were above the applicable Method One GW-2 and GW-3 cleanup standards. Therefore, remedial actions were warranted at the site to reduce the risk of harm to human health, public welfare or the environment. Additional sampling and investigations are required to determine if the soil contamination presents a risk.

7.0 REMEDIAL ACTION PLAN

As discussed in Section 6.0, a Method One risk characterization determined that the gasoline contaminated groundwater at the site presented a significant risk and required that comprehensive remedial actions be implemented at the site. As a result, in 2003 an evaluation of the applicable remedial technologies was conducted. The most applicable technologies were screened to determine the most applicable remedial technologies which were then combined as remedial action alternatives. A detailed evaluation of the alternatives was then conducted to determine the most applicable remedial action alternative. This section of the Analysis of Brownfields Cleanup Alternatives Report presents the results of our Identification, Evaluation and Selection of Comprehensive Remedial Action Alternatives. Our original 2003 evaluation has been updated and revised.

7.1 Identification and Evaluation of the Remedial Technologies

In order to effectively identify and evaluate the applicable remedial technologies for the site, the following assumptions were made:

1. The gasoline contamination in the groundwater at the site exceeds the Method One, GW-2 and GW-3 cleanup standards and must be remediated within three to five years.
2. A heated and secure area for the treatment equipment is not available at the site. The equipment is housed in a treatment trailer to be located adjacent to the office building at 459 Pleasant Street.
3. The amount of iron and manganese in the groundwater is assumed to be relatively high and shall cause fouling of conventional air stripping equipment.

4. Permanent electrical service of 230 VAC, 100A, single-phase is available on the outside of the office building to operate the treatment equipment.
5. Explosion-proof equipment shall not be required. All wiring within the treatment trailer shall be installed a minimum of 18 inches above the floor of the treatment trailer.
6. The treated groundwater shall be recharged into the groundwater upgradient of the release area which is thought to be the former dispensers along Pleasant Street.
7. Recovery wells and SVE zones shall be installed on both sides of Pleasant Street to expedite the remediation of the site. The owner of 480 and 492 Pleasant Street has issued written authorization to install a recovery well on his property.
8. The existing soil conditions require the installation of large diameter recovery wells with French drains to allow flow rates up to five gpm from each well.
9. All the piping shall be installed underground to prevent freezing and not restrict use of the properties.
10. Dewatering shall not be conducted during the installation, but provisions shall be made to quickly conduct dewatering if required.
11. Access must not be restricted to the northern curb cut at 480 Pleasant Street. The exit can be closed during the crossing of Route 5.
12. Any significantly contaminated soil encountered during the installation of the treatment system shall be used as backfill in the SVE zones.

7.2 Initial Screening of the Most Applicable Remedial Action Alternatives

A wide range of technologies to remediate the gasoline in the soil and the groundwater at the site were evaluated based upon the assumption that the individuals and expertise needed to effectively implement the available technologies are available. The technologies selected during the initial screening were subsequently assembled into combinations of remedial action alternatives. The following technologies were

determined to be applicable to achieve a level of no significant risk at the site as defined by 310 CMR 40.0900:

Aqueous Phase Carbon Adsorption

The contaminated groundwater would be pumped through large canisters of aqueous phase carbon where the dissolved gasoline contaminants would be adsorbed onto the carbon. The treated groundwater could be recharged back into the groundwater. Particle filters would be required and need periodic replacement. Dissolved iron would precipitate out in the carbon canisters causing premature clogging. Spent carbon canisters must be disposed of off-site as a hazardous waste. Aqueous phase carbon cannot be regenerated on-site. The carbon canisters must be housed and heated to prevent freezing. This technology was considered applicable.

Air Stripping

Air stripping is a mass transfer process where the dissolved gasoline contaminants would be transferred from the groundwater into an airstream. Ambient air is usually forced up through a packed tower as the groundwater is sprayed into the top of the tower. Low-profile, cascading units are also available. Heating of the air improves the transfer. As with carbon adsorption, dissolved iron produces fouling of the packing and freezing is a problem during winter months. Similarly, the treated water must be recharged back into the groundwater. This technology was considered applicable.

Biodiffused Aeration

Biodiffused aeration is a mass transfer process similar to air stripping where the dissolved gasoline contaminants would be transferred from the groundwater into an airstream. Bacteria and nutrients are also injected into an aeration tank to allow biodegradation of the contaminants in the tank and in the recharge area of the aquifer. A vacuum is applied above water in the aeration tank with multiple stripping stages. Ambient air is drawn into the bottom of the water through diffusers. The diffusers allow for uniform distribution of the air bubbles throughout the water column. Diffused aeration is not as efficient as air stripping, but it simultaneously allows for iron and manganese removal, therefore fouling is greatly reduced. As with air stripping, heating the air improves the transfer. Similarly, freezing is a problem during the winter months and the treated water must be discharged in an appropriate manner. This technology was considered applicable.

Bioremediation

In-vessel or in-situ bioremediation promotes the biological metabolism of the dissolved gasoline compounds. Nutrients are usually required. For in-vessel bioremediation, groundwater would be pumped into a large bioreactor tank from a recovery well. For in-site bioremediation, bacteria, nutrients and oxygen are injected into the contaminated groundwater. As the concentrations of the dissolved gasoline contaminants decrease, so too does the metabolic rate. Based upon this limitation and the relatively small amount of contamination, this technology was only considered of combined with another technology.

Soil Vapor Extraction

Soil vapor extraction (SVE) is a very economical method of removing volatile organic compounds from soil located above the groundwater table. A series of vertical or horizontal recovery wells are normally installed in dry, contaminated soil. The soil gas is then withdrawn from the contaminated soil with a blower or compressor and treated through vapor phase carbon or an incinerator before being discharged to the air. Based upon the brief success of the SVE system installed by Acadian, this technology was considered.

Air Sparging

With this technology air is bubbled into the uppermost portion of an aquifer. The air bubbles induce a transfer of the dissolved gasoline contaminants as they travel up through the groundwater and vadose zone of the saturated soil. The air would then be drawn into the suction side of a blower through a buried collection network of perforated piping as with an SVE system. The air would be passed through vapor phase carbon or an incinerator before being discharged to the atmosphere. Ambient air containing oxygen can be fed into the airstream along with nutrients to promote biological activity. No heating of the system is required and there is no water discharge. Due to the low permeability of the soil and the restricted access created by Pleasant Street, this technology was not considered.

Vapor Phase Carbon

Vapor phase carbon is used for air emissions control by passing an airstream containing gasoline contaminants from an air stripper, a biodiffuser or an SVE system process

through a large vessel of vapor phase carbon where the gasoline compounds would be adsorbed onto the carbon. The treated air would then be discharged to the atmosphere. Disposable canisters of carbon could be used or a specially designed carbon vessel could be periodically regenerated before a breakthrough of contaminants occurs. The regeneration procedure utilizes steam to strip the contaminants from the carbon. The contaminated steam is then condensed into contaminated condensate water and free-phase product which must be properly disposed of or treated. The contaminated condensate could be treated through a groundwater treatment system. This technology was considered.

Bioslurping

Bioslurping attempts to skim free-phase petroleum products off the top of the groundwater by vacuum. A large volume of air, water and petroleum are withdrawn from the groundwater table through a skimmer pipe, a phase separator and a blower. The air is drawn through the vadose zone of the soil as in soil venting. The elevation of the skimmer pipe must be periodically adjusted to remain just above the fluctuating groundwater table. Because access to the free-phase gasoline is restricted by Pleasant Street, this technology was not considered.

Catalytic Incineration

Catalytic incineration is used for air emissions control by passing an airstream containing the gasoline contaminants from either an air stripper, a biodiffuser or an SVE system through a catalytic incinerator where temperatures are held above 600°C. Inside the catalytic incinerator more than 99% of all combustibles are oxidized to CO₂ and H₂O. It cannot be used with non-combustible contaminants such as chlorinated solvents. The treated air would then be discharged to the atmosphere. This process is often used when the contaminant concentrations are very high, when the contaminants do not adsorb onto carbon very well, or if the disposal of the recovered contaminants from vapor phase carbon is very expensive or impractical. As the concentrations of the contaminants decrease, propane, electricity or natural gas must be supplied to maintain the temperature in the incinerator which can be expensive. This technology was not considered due to the relatively high capital costs and the low concentrations expected.

Soil Removal

The removal and recycling or disposal of contaminated soil can be an effective method for remediating soil contamination. The removal of contaminated soil also aids in the remediation of groundwater by achieving a reduction in the contaminant mass with the potential to leach into the groundwater. Soil removal is often limited by the presence of contaminated soils beneath buildings or at great depth. In cases where the contaminated area is extensive, soil removal becomes less cost effective. This technology was not considered applicable for the remediation of soil contamination at the site because it extends under Pleasant Street and buildings.

Activity and Use Limitation

As an alternative to active remediation of soil, an Activity and Use Limitation (AUL) could be applied to contaminated soil areas. Engineering controls (e.g. concrete and/or paving) would be used to prevent exposure to the contaminated soil. A survey, a recordable plan and recording at the Registry of Deeds is required. Given the nature of the contaminants in soil at the site and the tendency for some of these contaminants to leach from soil into groundwater, this remedial alternative was only considered if combined with another alternative.

Monitored Natural Attenuation and Enhanced Natural Attenuation

Monitored natural attenuation is a remedial alternative where the natural processes of dispersion and biodegradation are monitored over time to observe the reduction of contaminants in groundwater. In most cases, the removal of the vast majority of contaminated soil must occur prior to observing satisfactory groundwater contaminant reduction trends. The natural processes can be enhanced by the introduction of remedial additives, such as oxygen releasing compounds or bacteria. The time necessary for remediating a site using natural attenuation is typically longer than when an active remedial alternative is used. Given that the gasoline at the site has not been remediated by this technology for the past 20 years it was not considered. It may be employed once a majority of the gasoline contamination is removed by active means.

Oxidation with Hydrogen Peroxide

With this technology, organic hydrocarbons are oxidized in place with a solution of hydrogen peroxide. Normally, drums of a 33% hydrogen peroxide solution are used to inject the solution into the soil or groundwater containing hydrocarbons. The oxidation

results in the destruction of the hydrocarbons and the formation of carbon dioxide and water. Confined areas must be vented during the application of the peroxide because carbon dioxide, methane, ethane and steam are produced. After applying the peroxide solution, rumbling sounds can be heard and steam may discharge from the injection wells indicating that the peroxide solution is reacting with the hydrocarbons. The application of the peroxide solution can cause enough heat to melt PVC piping. The high temperature also destroys beneficial bacteria. Additional applications and extended periods of groundwater monitoring are usually required. Bioremediation is also usually required to achieve cleanup standards. Due to the low permeability of the soil at the site, the large extent of the contamination and the proximity of occupied buildings, this technology was not considered.

7.3 Detailed Evaluation of the Remedial Action Alternatives

After screening the applicable technologies, the following alternatives were selected to provide for the quickest, most cost-effective cleanup of the gasoline in the soil and the groundwater at the site.

The associated risks with implementing any of the remedial alternatives would be minimal during the excavation of required trenching, installation and operation of the treatment system.

The criteria used to evaluate the Remedial Action Alternatives included:

1. Are the technologies used in the alternative proven?
2. Is the contamination destroyed, transformed to be less toxic, reused, or recycled?
3. Can the alternative be safely constructed and operated?
4. Shall the operation of the alternative reduce the risk at the site in a timely manner?
5. Is the alternative economical to construct and operate?
6. Shall the operation of the alternative produce waste?
7. Does the alternative require approvals, permits or licenses?
8. Can the alternative be economically removed and salvaged?

The alternatives included:

1. A groundwater treatment system utilizing disposable aqueous phase carbon and a soil vapor extraction system initially utilizing a catalytic incinerator then disposable vapor phase carbon for air emissions control.
2. A groundwater treatment system utilizing a biodiffuser and a soil vapor extraction system both utilizing steam regenerative vapor phase carbon for air emissions control.

A brief evaluation of the two remedial action alternatives is as follows:

Alternative #1 - Disposable Carbon Adsorption Treatment System

Groundwater would be pumped at approximately 200 gallons per minute from two recovery wells and then passed through two, 2,000-pound canisters of aqueous phase carbon. The canisters would be installed in a large trailer or container to prevent freezing. The treated water would be discharged into a recharge well located upgradient of the release area. Free-phase gasoline could be manually bailed from the recovery wells. All the piping would be installed underground. The carbon would be periodically replaced as it becomes saturated. The SVE system would be installed as three zones. The blower and two, 1,000-pound canisters of vapor phase carbon would be installed on a separate trailer or container. Freezing would not be a problem.

The technologies are proven. They have been successfully used at numerous sites. The gasoline contaminants in the groundwater would be readily adsorbed onto the carbon and ultimately destroyed during the incineration or reactivation of the spent carbon. The gasoline vapors from the SVE system would also be readily adsorbed onto the carbon and destroyed. The system would reduce the risk from the contamination in two to five years. The operation of the system would be very expensive because of the required analysis to monitor breakthrough of the carbon and the costs to frequently recharge the carbon. Spent carbon would be produced as a waste. Only a building and electrical permit would be required to install the system. Hazardous waste manifest would be required to transport the spent carbon off-site. The system could be very easily removed. The piping would be cut and capped to safely remain underground. There would be very little salvage value. An estimate of the costs is as follows:

<u>Task</u>	<u>Estimated Cost</u>
1. Review reports, conduct limited assessment activities and prepare a Phase III/IV Plan for submission to the DEP	\$ 12,000

2. Prepare construction plans then specify, order, purchase and receive equipment		10,000
3. Apply for a building permit		850
4. Select contractors and coordinate the installation		3,500
5. Install recovery wells, install SVE zones, connect to existing piping under Pleasant Street, pour pad for trailers, and install recharge well		32,000
6. Purchase treatment equipment and install carbon canisters, trailers, used incinerator and the required valves, gauges, filters		55,000
7. Operate the system at 20 gpm for five years; inspect weekly to change filters and bail gasoline; sample well quarterly; and prepare reports for the DEP		
	Analysis:	30,000
	Labor:	46,000
8. Recharge one aqueous, and phase one vapor phase carbon canister every two months for five years, with off-site disposal of carbon and gasoline		
	Materials:	60,000
	Labor:	53,500
	Disposal:	20,000
9. Sample soil		8,000
10. Remove system	Labor:	<u>3,000</u>
	Subtotal:	333,850
11. Salvage value		(500)
12. Prepare RAO Statement without an AUL		8,500
13. Contingency at 20%		68,370
	Total Estimated Cost:	\$ 410,220

Alternative #2 - Biodiffused Aeration with Regenerative Vapor Phase Carbon

Groundwater would be pumped from the existing recovery well and a second recovery well and then passed through a biodiffuser located in the trailer, as shown on the Remedial Action Site Plan. The treated groundwater would then be discharged into the existing recovery well. Bacteria shall also be added to the biodiffuser to inoculate the contaminated groundwater to promote the biological breakdown of the gasoline

contamination in the biodiffuser and in the recharge area. The airstream from the biodiffuser would be piped to the existing regenerative vapor phase carbon vessel located on a pad adjacent to the trailer.

<u>Task</u>	<u>Estimated Cost</u>
1. Review reports, conduct limited assessment activities and revise our existing plans	\$ 10,000
2. Prepare construction plans then specify, order, purchase and receive equipment	15,000
3. Apply for all permits	2,500
4. Select contractors and coordinate the installation	3,500
5. Install recovery well RW-2, install SVE Zone-C and connect to existing piping under Pleasant Street	50,000
6. Operate the entire system for three years; inspect weekly to change filters and bail gasoline; sample quarterly; and prepare reports for the DEP	
	Analysis: 15,000
	Labor: 36,000
7. Regen carbon vessel monthly for the first year then every other month.	48,000
8. Sample Soil	8,000
9. Remove System	Labor: <u>3,000</u>
	Subtotal: 191,000
10. Salvage value	(15,000)
11. Prepare RAO Statement without an AUL	8,500
12. Contingency at 10%	18,450
	Total Estimated Cost: \$ 202,950

The associated costs represent estimated values based upon our experience on similar sites and from installing and operating the existing systems for two years. We have estimated the cleanup to take three to five years depending upon the selected alternative.

Alternative #3 - Do Nothing

The do nothing alternative was only briefly considered. If nothing is done, the gasoline shall remain trapped in the pore spaces of the soil under Route 5. It shall slowly dissolve into the groundwater and migrate to the southeast. It shall continue to present a significant risk of harm to health, safety, public welfare and the environment.

7.4 Selected Remedial Action Alternative

We have evaluated the applicable remedial technologies and determined that the most appropriate alternative would complete the installation of the existing treatment systems. Once installed, the contaminated groundwater would be pumped by the two recovery wells from the center of the free-phase gasoline and the dissolved plume located directly under Pleasant Street as shown on Figures Three and Four. The second recovery well to be installed at 480 Pleasant Street shall greatly expedite the remediation. A third SVE system shall allow the gasoline vapors to be removed from both sides of Pleasant Street.

The treatment equipment is already housed in an enclosed trailer located adjacent to the office building at Pleasant Journey on a concrete pad, enclosed by chain link fence. The remainder of the treatment system shall be installed underground to prevent freezing and damage. The groundwater shall be treated through a biodiffuser with regenerative vapor phase carbon for air emission controls. The treated groundwater shall be recharged back into the ground, upgradient of the contamination in the existing recharge well, to promote flushing and biological remediation. The SVE shall remove the bound free-phase gasoline from the pore spaces of the dewatered saturation zone above the depressed groundwater table. Once the SVE system has removed the bound free-phase gasoline, it shall be shut down and the groundwater shall continue to be pumped, treated and discharged upgradient of the contamination until the dissolved gasoline contaminants are consistently reduced below the Method One GW-2 and GW-3 cleanup standards for four consecutive sampling quarters. Remedial additives may be periodically injected into the recharged groundwater.

7.5 Feasibility of Implementing the Selected Remedial Action Alternative

The installation of the selected biodiffused aeration and soil vapor extraction treatment system is feasible. The associated technology is proven and relatively simple to install. The treatment technology utilizes air stripping and bioremediation of the gasoline contaminants in the groundwater. The three SVE zones shall allow the remaining 10% of

the free-phase gasoline to be removed from the soil. Both are proven technologies. The proposed pumping and recharge scheme has successfully circulated clean, oxygen rich water with bacteria and nutrients through the limited area of contamination for two years. The pumping rate can be increased in order to decrease the treatment period. The contaminant concentrations shall be reduced to approach background. The installation of the remainder of the biodiffused aeration treatment system shall result in a permanent solution to the risk at the site. The system is also relatively inexpensive to install and operate. The expenditure of funds to install and operate the selected remedial action alternative is justified.

8.0 REMEDY IMPLEMENTATION PLAN

8.1 Design of the Selected Remedial Action Alternative

The design of the proposed treatment system is shown on the Remedial Action Site Plan and the Installation Plan included in the Figures section. The remainder of the systems shall be installed as shown. We propose to first remove the free-phase gasoline by depressing the groundwater in the two recovery wells. Any accumulated gasoline shall be manually skimmed from the recovery wells and stored in two collection drums. Once the free-phase gasoline is removed, we shall activate the SVE system installed as three zones. The SVE system shall remove the remaining approximately 30% of the free-phase gasoline that normally remains in the pore spaces of the soil as globules. Pleasant Street limits the extent of the SVE system. The pumped groundwater shall be treated through the biodiffuser and the clean, oxygen-rich water shall be recharged into a recharge well located south of the former tanks and dispensers. The recharged water shall promote biological remediation of the gasoline contamination in the surrounding soil and groundwater. It shall also drive any free-phase gasoline and dissolved gasoline contaminants toward the two recovery wells. The biodiffuser is expected to continue operating one to three years after any free-phase gasoline has been removed and the SVE system has done its work. The biodiffuser, SVE blower, moisture separator, and the electronics are housed in the heated trailer located adjacent to the office building as shown. The regenerative vessel of vapor phase carbon has been set up adjacent to the trailer along with the two gasoline collection drums and three drums used to steam clean (regenerate) the carbon. The area is secured with a six-foot high, green vinyl coated, chain link fence. Approximately once a month we shall use our regen trailer to steam clean the carbon vessel.

The recovered groundwater shall be discharged into the biodiffuser at two to 20 gpm. The ideal flow rate shall be determined by measuring the drawdown in the monitoring wells near the recovery wells. The groundwater shall flow through a series of bafflers and weirs in the tank. Ambient air, from outside the trailer, at approximately 100 cfm, shall be drawn through the water causing the volatile gasoline contaminants to be "stripped" from the water. The discharge pump shall be wired to only operate if the blower is running. There may be a manual override. The contaminated air shall be drawn into a 2.0 HP regenerative blower, which shall slightly raise the air temperature to reduce the relative humidity and discharge it through the SVE blower into a vessel of vapor phase carbon located outside the trailer. The SVE blower shall operate at 250 cfm with 100 cfm coming from the biodiffuser. The 150 cfm airflow shall remove soil gas from the three SVE zones and discharge the air into the carbon vessel. The Model 10-M3-E7 carbon vessel shall be 3.0 feet in diameter with a seven-foot bed of approximately 1,330 lbs of 4x10 mesh, coconut-based, vapor phase carbon. The carbon shall readily adsorb the volatile gasoline contaminants. The carbon vessel contains sample ports at 12" intervals in order to monitor breakthrough or saturation of the carbon. The clean air shall be discharged to the atmosphere at a height of at least 12 feet. Valving shall be installed to allow the carbon vessel to be by-passed once the concentrations decrease.

The treated groundwater shall collect in a clear well within the biodiffuser tank. Level controls shall activate a 1.0 HP discharged pump. The treated groundwater shall be periodically pumped through a filter and discharged into the recharge well located upgradient of the contamination. The treated water shall be reinjected into the groundwater to flush the gasoline contaminants toward the recovery well. The discharged water shall be saturated with oxygen which shall promote biological remediation of the gasoline contaminants in the groundwater. Specific bacteria may be added to the first stage of the biodiffuser to promote bioremediation in the tank and in the groundwater.

An off-gas opinion shall be prepared to determine the limits of the air discharge. The carbon vessel shall be periodically monitored with an organic vapor meter. Once the carbon has become saturated, the system shall be shutdown and the carbon shall be regenerated with steam from a mobile source by Penney Engineering. Any recovered gasoline shall be appropriately stored in one of the gasoline drums and properly disposed of by a licensed hazardous waste transporter. A permit to store the recovered gasoline has been issued by the Northampton Fire Department and has been posted at the site.

The contaminated condensate from the regeneration process shall be allowed to cool and treated through the biodiffuser.

The objective of the Phase IV Remedy Implementation Plan is to remediate the gasoline-contaminated soil and groundwater at the site. The proposed treatment systems shall be operated until the concentrations of the dissolved, gasoline-related contaminants in the groundwater at the site are consistently reduced to below their respective Method One GW-2 and GW-3 cleanup standards for a period of 12 months. The system shall also operate until the residual soil contamination is reduced below the S-1/GW-2 and S-1/GW-3 cleanup standards. The system may be shut down and the groundwater simply monitored once the concentrations are below the cleanup standards.

8.2 Required Permits and Licenses

The following permits are anticipated to be required to install and operate the selected remedial action alternative:

1. Hazardous waste manifests shall be required to transport any recovered gasoline from the carbon regeneration process.
2. A Bill of Lading or manifest may be required to transport any contaminated soil encountered during the installation of the recovery well and underground piping for recycling or disposal.
3. An electrical permit from the Northampton Building Department.
4. A permit from the Northampton Fire Department to store less than 65 gallons of recovered gasoline. The current permit expires on December 31, 2008

An LSP Opinion shall be prepared to determine the discharge limits for the air, in accordance with 310 CMR 40.0049 and the DEP's Off-Gas Treatment Policy, as amended. The opinion shall be submitted to the DEP with the first monitoring report. The opinion shall be submitted to the DEP prior to by-passing the vapor phase carbon and directly discharging to the atmosphere.

8.3 Health and Safety Procedures

Health and safety procedures designed to protect health, safety, public welfare and the environment shall be implemented during the performance of all the proposed response actions. The procedures to be implemented shall be described in a separate Health and Safety Plan which shall comply with 310 CMR 40.0018.

8.4 Additional Notification Requirements

Robert P. Kalish, Inc shall continue to be responsible for notifying the DEP of any new information which becomes available while conducting the response actions which shall require a modification of the Phase III/IV Remedial Action and Remedy Implementation Plan. Any evidence of additional releases or threats of release shall be immediately reported to the DEP in accordance with the notification requirements of the MCP.

8.5 Imminent Hazard Evaluation

Based upon our current understanding of the available information for the site, the limited area of free-phase and dissolved gasoline contaminated groundwater does not present an imminent hazard or a threat of a substantial release migration. After the treatment system has been installed, we shall conduct an investigation of the utilities. The presence of an imminent hazard and a substantial release migration shall be continuously evaluated during the implementation of the remedial response measures, in accordance with 310 CMR 40.0321 and 40.0006.

8.6 Implementation Schedule

On June 2, 3, 4, 5, and 6, 2003, we installed the underground portions of the treatment systems at 459 Pleasant Street. We also constructed the concrete pad for the treatment trailer, placed the trailer on the pad, placed the regenerative carbon vessel on the pad and filled the vessel with approximately 1,300 lbs of vapor phase carbon. We encountered approximately 100 cubic yards of overtly, gasoline-contaminated soil and stockpiled it on site. On June 11, 12 and 13, 2003, we completed the setup of the treatment trailer and tested the equipment. On June 25, 2003, we started the groundwater treatment system installed on the western side of Pleasant Street.

The installation of the remainder of the treatment system has been scheduled for the first two weeks in November 2008. A copy of the Implementation Schedule is included in the Figures section.

8.7 Operation and Maintenance

The proposed treatment system shall be operated and maintained by Penney Engineering. Initially, the system shall be inspected daily until the inlet concentrations stabilize and the breakthrough period for the vapor phase carbon is established. The system shall then be inspected weekly or more often if needed in accordance with 310 CMR 40.0191.

All piping shall be installed underground. The site is currently occupied during the day by the employees of Pleasant Journey. A notice shall be installed on the exterior wall of the fenced area to alert residents to contact Pleasant Journey or Penney Engineering if there are any problems. The biodiffuser is supplied with a high-level shutoff switch wired to an alarm and an exterior strobe light on the trailer and a dialer to call Mr. Kalish and Penney Engineering. The moisture separator for the SVE system is wired similarly. It may be wired to an alarm in the station. The Northampton Fire and Police Departments shall be provided with telephone numbers to be called for routine questions and in emergencies.

8.8 Monitoring Program

In accordance with 310 CMR 40.0047(3), Penney Engineering shall inspect the treatment system on a weekly basis or as needed. A monitoring log shall be completed during each inspection. Groundwater samples shall be periodically submitted to a Massachusetts-qualified laboratory and analyzed for VPHs. The biodiffuser is expected to remove up to 95% of the gasoline contaminants. The biodiffuser has not been designed to remove 100% of the contaminants because the treated water shall be recharged into the groundwater, upgradient of the contamination to be recaptured by one of the recovery wells.

The existing monitoring wells MW-1, MW-2A, MW-9, MW-12 and ECS-5 shall be sampled immediately before the system is started. Specific monitoring wells shall be sampled on a quarterly basis. The groundwater samples shall be analyzed for concentrations of volatile petroleum hydrocarbons by the DEP method. The samples shall also be monitored for heterotrophic bacteria, pH, temperature, dissolved oxygen, nitrites and nitrates if bacteria is applied.

Initially, the air from the SVE system and the biodiffuser shall be periodically screened with an organic vapor meter for the first two weeks until the carbon breakthrough period is determined. One air sample may be analyzed by a Massachusetts-certified laboratory for

identification of the specific contaminants. After the first week of operation, the system shall be inspected and air samples shall be screened weekly or as warranted.

In 1997, ECS conducted an extensive indoor air sampling program in the utilities and the four buildings. No significant vapors were detected. On April 25, 2002, we failed to detect any significant vapors while screening the four buildings with an OVM. Based upon the results of these two air sampling events, no additional air sampling shall be conducted.

After the free-phase gasoline has been removed the residual gasoline down to 1.0 or 2.0 ppm in the soil gas, we shall collect representative soil samples from the former area of the free-phase gasoline. Up to 10 soil samples shall be collected from above and below the groundwater table. The samples shall be analyzed for VPHs.

The results of the groundwater analyses, air sampling and monitoring logs shall be included in periodic monitoring reports sent to the DEP every six months, in accordance with 310 CMR 40.0892, until the groundwater remains below GW-3 cleanup standards for a 12-month period. The remedial additives shall be monitored on a monthly basis. The monitoring reports shall describe the dates of the inspections. They shall describe any significant modification made to the treatment system since the prior report. They shall describe any problems and what measures were implemented to resolve the problems. The reports shall bear the name, license number, signature and seal of Ralph P. Penney as the LSP-of-Record for the site. Any unusual results shall be immediately orally reported to the DEP.

9.0 PUBLIC INVOLVEMENT ACTIVITIES

In accordance with the public involvement requirements of the MCP, the Mayor of Northampton and the Health Agent were notified by Penney Engineering in writing of the implementation of the Phase III/IV Remedial Action and Remedy Implementation Plan. The notification included information about the purpose, nature and expected duration of the Phase IV activities. In accordance with our September 2, 2008 City of Northampton Design Services Contract, Penney Engineering shall make one public meeting presentation and upon completion of remedial activities shall prepare a non-technical summary report of the cleanup activities for public distribution. The City of Northampton shall be responsible for coordinating the public meeting and community outreach activities.