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**Hydrogeologic and Petroleum Contamination Assessment  
Whitten Brook site, Skowhegan, Maine  
Maine DEP Spill # A-189-10**

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*Prepared for*  
Maine Department of Environmental Protection  
17 State House Station  
Augusta, Maine 04333-0017

*Submitted by*  
C.A. White & Associates LLC  
One Main Street  
Yarmouth, Maine 04096

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**WHITTEN BROOK–SKOWHEGAN, MAINE  
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## EXECUTIVE SUMMARY

The Town of Skowhegan has embarked on a multi-year assessment and restoration project of the Whitten Brook watershed in Skowhegan Maine. During the initial watershed studies completed in 2010 an oily sheen and petroleum odor was observed in the upper reaches of Whitten Brook. In December 2011 the Maine DEP BRWH collected a pore water sample at the seep discharge and the results confirmed that a plume of petroleum contaminated groundwater is discharging from an unknown source into the upper reach of Whitten Brook.

In May 2012 the Maine DEP issued a Request for Proposals for a hydrogeologic and contamination assessment of the petroleum contamination in the area around the seep at the headwaters of Whitten Brook. The Maine DEP specified that the focus of the study would be a 500 foot radius around the seep, an area that encompasses approximately 4.5 acres. In June 2012 C.A. White and Associates LLC of Yarmouth Maine was hired by the Maine DEP to undertake this study. The primary objective of this investigation was to locate and identify the source or sources of petroleum discharge to the upper reaches of Whitten Brook; to characterize the hydrogeology; and define the vertical and lateral extent of the petroleum contamination.

The initial phase of the project involved a reconnaissance visit, a records review and interviews with individuals knowledgeable about the site. Subsequent field investigations consisting of surface geophysics, geoprobe borings, monitoring well installations, test pits, laboratory testing of soil and groundwater samples, an elevation survey and water level measurements were completed during the months of June through September 2012.

The records research revealed that seven properties within a 500 foot radius of the seep discharge had, or currently have, underground petroleum storage tanks. Only one of these properties, Damon's Quick Stop, has active underground gasoline tanks. The records research uncovered four petroleum spills in the site area. These spills occurred over a period from 1987 through 2010 and had been reported and subsequently investigated by the DEP.

Surface geophysical studies were undertaken by Northeast Geophysical Services to attempt to locate buried underground storage tanks, piping and other subsurface features that may be a source of contamination or a transport pathway for petroleum. A separate survey was done to look for conductive anomalies that might be indicative of a contaminated ground water plume. Several metallic anomalies identified in the surveys are suggestive of buried piping, but no relic tanks were identified.

Subsurface investigations at the site confirmed that the overburden consists of medium to fine sand underlain by a clayey silt. Based on the borings the sand ranged from 7 to 30 feet in thickness across the site. Geoprobe borings revealed that the elevation of the clay surface underlying the sand is somewhat irregular. Closely spaced borings at southern end of the Kyes property indicate that a knob in the clay surface occurs where the depth to the top of clay is only about 7 feet below ground surface.

Soil samples were screened in the field with PID and selected samples were submitted to the HETL lab for Volatile Petroleum Hydrocarbons (VPH) and Extractable petroleum Hydrocarbons (EPH) analysis. Results indicate widespread soil contamination is present along the water table interface at the site. Laboratory analysis reported total VPH concentrations ranging from 450 mg/L at to 2850 mg/kg in the vicinity of the building on the Kyes property.

Petroleum contamination was also reported for groundwater samples collected from monitoring wells situated between the corner of Madison Ave and Silver Street and the headwaters of Whitten Brook. No petroleum contamination was detected in samples collected from the two wells located adjacent to Silver Street, MW-1 and MW-5. Low concentrations of total VPH (100 to 300 ug/L) were reported for samples collected from MW-7 and MW-8, located within 50 feet east of the seep discharge. The most elevated VPH concentrations were reported for groundwater samples collected from wells located 100 to 300 feet northeast of the seep - here groundwater concentration ranged from 4113 ug/L to 7535 ug/L in MW-10 and MW-2, respectively.

Based on the nature of the contamination and the site conditions the most likely sources of contamination are the former tanks and pump island on the Kyes property and the retail petroleum operations on the Damon property. Given the results of the soil and water testing and the proximity of the contamination to the former pump island and tanks it seems likely that a historical spill(s) on the Kyes property is the source of the groundwater contamination discharging to the seep. It is possible that other sources, particularly old spills on the Damon property, may also have impacted the site. The data indicates that currently the petroleum contamination occurs at the water table interface and there are no definitive results indicating contamination in the soils in unsaturated zone on the site. Consequently it is possible that the petroleum contamination observed on the site could have been caused by a free product or dissolved plume originating offsite.

The distribution of the petroleum contamination in site soils and groundwater suggests two or possibly three separate sources/plumes of petroleum contamination may exist:

- one in the vicinity of the former pump island on the Kyes property
- a second at the southeastern portion of the Kyes property near MW-6 and MW-4
- And possibly a third behind the Kyes building near MW-2.

We estimate that the vertical extent of the plume(s) of contaminated groundwater is rather thin and extends a few feet below the water table. Lower concentrations of dissolved petroleum may extend through the saturated zone to top of the clay. In the area of the contamination the saturated zone is generally less than 10 feet thick. The lateral extent of the plume is less certain. In the vicinity of the proposed detention pond, the northern lateral extent of the hydrocarbon plume cannot be determined from the available data - it may be that contaminated groundwater is discharging over a larger area along the northern extent of detention pond than previously thought.

## 1. INTRODUCTION

In 2010 the Town of Skowhegan initiated a multi-year watershed assessment and restoration project of Whitten Brook in Skowhegan Maine. The objective of this project is to restore Whitten Brook so that the water quality meets state standards and can support a healthy native brook trout fishery. A primary goal of the project is to reduce or eliminate pollutants, such as petroleum products, pet waste, road salt and lawn fertilizers that from flow into the headwaters of Whitten Brook. The town is collaborating with several groups including the U.S. EPA, the Maine Department of Environmental Protection (Maine DEP), the Maine Department of Transportation (Maine DOT), FB Environmental (FBE), local citizen volunteers and others to complete this work. In October 2010, FB Environmental completed the *Whitten Brook Stream Survey Report* which summarized the results of the watershed assessment. This work formed the basis for the *Whitten Brook Watershed Restoration Plan* which was completed in March 2011. In April 2012 the town was awarded a federal grant from the Maine Department of Environmental Protection for implementation of the Whitten Brook watershed restoration activities.

During the initial watershed studies completed in 2010 an oily sheen and petroleum odor was observed in the upper reaches of Whitten Brook (FB Environmental, 2010). The study also noted that the upper Madison Ave storm water outfall sporadically discharges petroleum-contaminated water to the brook. During the field work investigators also observed what was described as “smelly, black, oil-contaminated sediments” in the detention basin near the intersection of Silver Street and Madison Avenue (Jespersen, pers. com.). The Watershed Restoration Plan prioritized the proposed watershed restoration activities. Resolving the petroleum contamination in upper stretch of the brook (Reach 2-1) is one of the priority objectives of the watershed restoration, along with improving the quality of the storm water discharge to Whitten Brook. The Plan also identified the restoration of the detention basin as a high-priority. The detention basin is the location of the petroleum contaminated seep discharge. Maine DOT is in the process of redesigning the detention basin near the seep discharge and outfall, but implementation of the design is on hold until the petroleum contamination problem is evaluated.

In 2011 the Maine DEP Bureau of Remediation and Waste Management investigated the report of petroleum odor identified during the watershed study. In December 2011 John Beane of the Maine DEP BRWH collected a pore water sample at the seep discharge identified during the watershed assessment study. The porewater sample tested positive for petroleum hydrocarbons with moderately high concentrations of volatile petroleum hydrocarbons (2500 ug/L) and total extractable petroleum hydrocarbons at (1200 ug/L). These results confirmed that a plume of petroleum contaminated groundwater, resembling gasoline, is discharging from an unknown source into the upper reach of Whitten Brook.

In April 2012 the Maine DEP issued a Request for Proposals for a hydrogeologic and contamination assessment of the petroleum contamination in the area around the headwaters of the brook. C.A.

White and Associates of Yarmouth Maine was selected by the Maine DEP to undertake this study. This report prepared by CAW for the DEP describes the objectives, methodology and results of this study.

## 1.1 PURPOSE OF OUR INVESTIGATIONS

The primary objective of this investigation was to locate and identify the source or sources of petroleum discharge to the upper reaches of Whitten Brook. As part of this investigation we sought to:

- **Conduct a Water Supply Survey** to identify all drinking water wells within 500 ft. of the contaminated seep.
- **Identify Potential Sources of Petroleum Contamination** through interviews, records research and field reconnaissance. The objective is to identify all current and former petroleum marketing and distribution facilities within 500 ft. of the seep and to determine, where possible, when tanks were installed and removed, and what petroleum products were stored. A secondary objective of this study is to use this information to assess whether petroleum contaminated groundwater from any of the indentified sources may be entering the storm water system and discharging directly into to the stream through the outfall.
- **Conduct a hydrogeologic study** to define the subsurface stratigraphy and ground water flow directions in the vicinity of the hydrocarbon-contaminated seep.
- **Complete a contamination** assessment aimed at developing an understanding of the type(s) of petroleum contamination at the site, the concentrations, and the vertical and horizontal distribution of contamination in the soil and groundwater.
- **Prepare a written report** summarizing the findings in particular the source(s) of petroleum contamination and the extent of the groundwater contamination discharging into Whitten Brook

## 1.2 PROJECT TEAM

The Maine DEP project team consisted of Chris Swain, John Beane and Janet Gorman. The technical project team consisted of Carol White of C.A. White and Associates of Yarmouth Maine. Thomas Winger, a senior geology major at Yale University provided field and office assistance to C.A. White and Associates on the project. Seth Brown and Paul Prescott of MAI Environmental Services of South Portland, Maine provided Geoprobe and vapor sampling services on this project. Sackett and Brake Survey, Inc. of Skowhegan, Maine provided ground survey services. Test pitting was conducted by R.A. Paradis & Sons of Newport, Maine. Maine Environmental Laboratory in Yarmouth, Maine completed the chloride analysis. Water quality samples were submitted to the State of Maine's Health

and Human Services Laboratory (HETL) in Augusta for petroleum hydrocarbon analysis. Vera Maheu at HETL provided invaluable assistance interpreting the laboratory analyses and chromatograms.



## 2. BACKGROUND

The following section presents background information including a site description, site setting, and a brief summary of historical land use on the site.

### 2.1 SITE DESCRIPTION

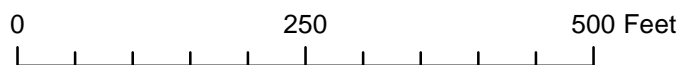
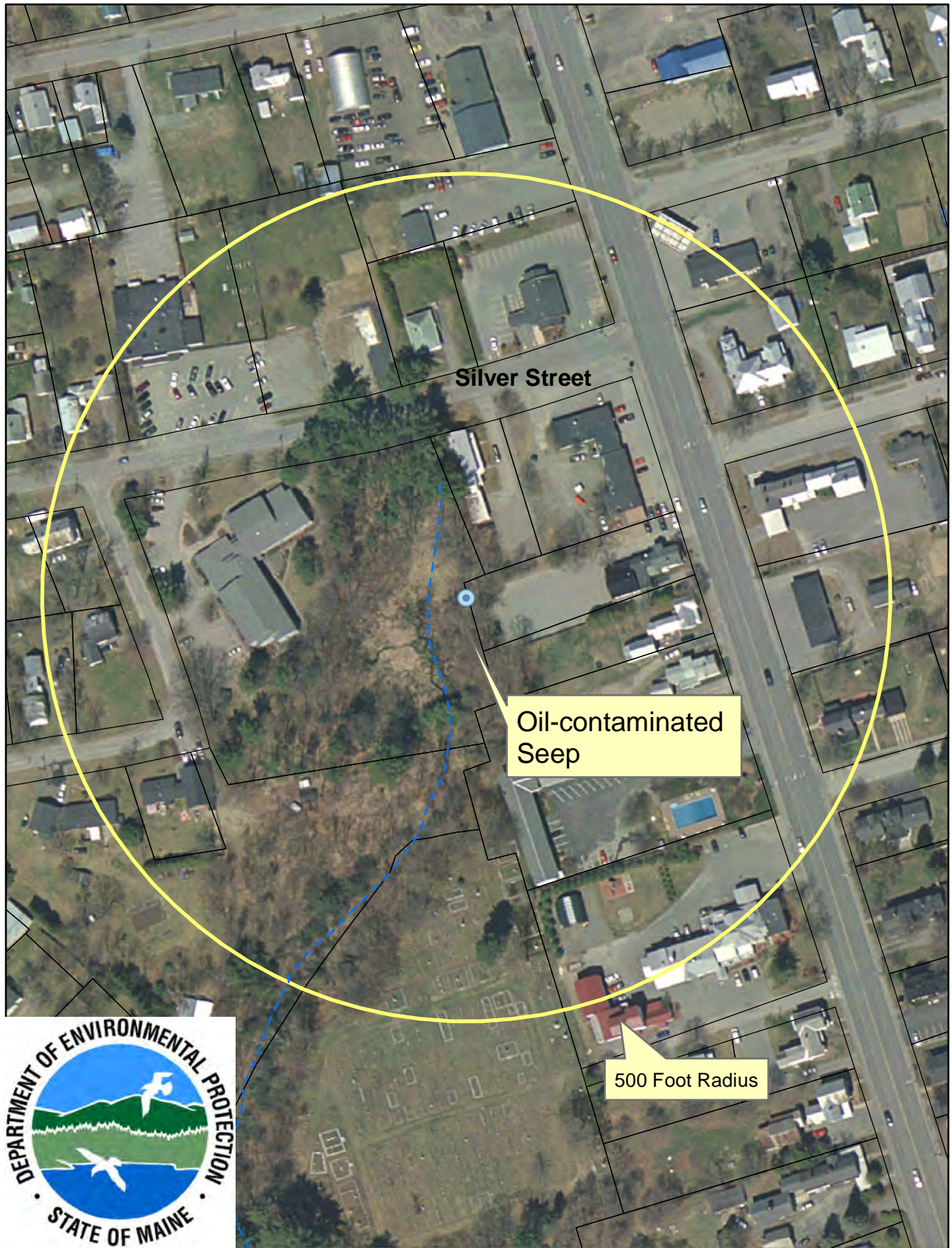
The focus of this investigation is a petroleum-contaminated seep identified on the eastern side Whitten Brook. Figure 2-1 shows the location of the seep and the site boundaries specified by the Maine DEP as a 500 foot radius around the seep. In total the site study area encompasses approximately 4.5 acres. Our field investigations were focused primarily on the four properties located near the intersection of Silver Street and Madison Avenue (Route 201):

- The **Kyes property**, 188 Madison Ave, located at the intersection of Silver and Madison Ave. The Skowhegan tax records references the parcel as Map 32, Lot 64.
- The **Jewell property** located at 10 Silver Street (Tax Map 32 Lot 49), abuts the Kyes property to the west.
- The **Savage property**, 182 Madison Ave (Tax Map 32 Lot 63) abuts the Kyes property to the south.
- The **Spring Garden property** at 22 Silver Street (Tax Map 32 Lot 50) on which the contaminated seep discharge and proposed detention basin are located.

### 2.2 PHYSICAL SETTING

The site is located within the Whitten Brook watershed, an urbanized sub watershed of the Kennebec River. The sub watershed which contains the contaminated seep discharge is identified as *Area 2* in the Whitten Brook Watershed Plan. The headwaters of the brook, an unnamed tributary, are located north of the center of Skowhegan. The unnamed brook flows from Silver Street to the confluence with the main Branch of Whitten Brook just east of Russell Road. The topography is relatively flat in the site area with ground surface elevations ranging from approximately 230 to 235 feet above mean sea level (MSL) near Route 201. The surface topography drops off to the west near the brook to an elevation of about 220 feet MSL in the vicinity of the contaminated seep. Land use west and northwest of the site is primarily residential with houses along Silver Street, Robinson Street and Russell Road. Spring Gardens, a 25 unit housing complex, is situated on Lot 32-50 west of the seep. The land use along Madison Avenue (Route 201) is primarily commercial and includes automotive repair, convenience stores and gas stations, banks, restaurants, funeral homes and motels in the site vicinity. Current land use in site vicinity includes Randy's Auto Repair on the Keyes property; the Heritage restaurant on the Savage property; and an electrical contractor and other mixed uses on the Jewell property.

# Skowhegan - Whitten Brook



## **2.3 SITE HISTORY**

Land use at the site has been a mixture of commercial and residential use for almost a century. Some of the earliest records on the site refer to the West Skowhegan Aqueduct Company which was formed in 1836 to provide water to this area of the community. The reservoir for the West Skowhegan Aqueduct Co. was located between Russell Road and Madison Avenue. The reservoir was located in the present day detention pond on what is now the Spring Gardens property (Map 32-59). This system was developed to serve the residences and business along Madison Ave (Rte 201).

Since the turn of the century, there has been commercial development along the Route 201 corridor in Skowhegan. Numerous manufacturing and transport operations existed both north and south of the site. The Cedar Ridge Nursing home (Map 32-59) was formerly the Reddington Memorial Hospital. Records indicate that Damon's Quick Stop, a convenience store and gasoline retail operation, has operated a petroleum retail business since the 1960s. According to the current owner, Dennis Keyes, the Kyes property operated as a gas station from the 1930's through the 1980's. Currently an automotive repair business and retail consignment shop operate on the Kyes property. More details of the site history are presented in Section 3.1 Records Review.

### 3. METHODS OF INVESTIGATION

#### 3.1 RECORDS REVIEW

Information was compiled from a variety of sources including reports, maps, aerial photographs, and local and state records concerning the ownership and operational history of the site properties. Interviews were conducted with local and state officials, as well as other parties knowledgeable about the site. To supplement our records review we contracted with Environmental Data Resources, Inc. of Milford CT for environmental records search. EDR reports that we requested included historical aerial photos, Sanborn Maps, maps showing spills and facilities of concern using recommended ASTM search distances.

The Skowhegan Fire Department has excellent records on petroleum storage tanks in the town. These records were reviewed and compiled to supplement the DEP records review. In discussions with fireman Shawn Howard about the records he informed me that the town has re-numbered Madison Avenue in 2000 as part of a 911 revision. Consequently street numbers in records prior to 2000 did not match the current street numbers on Madison Avenue. He assisted me in correlating a number of old tank sites records with current property addresses. This issue also meant that many of the spill and tank sites identified in EDR report were plotted incorrectly on their map due to the recent street number revision.

##### 3.1.1 Historical Aerial Photo Review

Historical aerial photos of the site were reviewed to identify any features that might give clues to potential sources of petroleum contamination. These features include structures, pipelines, former gas stations, tanks, pump islands, pipelines and signs. Approximately a dozen historical aerial photos dating from 1955 through 2011 were reviewed as part of this effort. The scale of the majority available photos was too large to be useful in gleaning pertinent site details. Two photos, the May 10, 1955 black and white aerial photo from James W. Sewall Company in Old Town, Maine and the April 18, 1990 black and white photo from Aerial Survey & Photo, Inc. of Norridgewock, Maine were at a sufficient scale that site details could be discerned. A brief description of interesting features on each photo is provided below.

##### **May 10, 1955**

As shown on Figure 3-1, a linear feature can be seen in front of the building on the present day Kyes property – most likely a gas pump island. Also of interest are the square and cylindrical structures in the area of present day detention pond. These could possibly be spring houses associated the former Skowhegan Aqueduct operation; but their purpose remains a mystery. Also seen on this photo, at the corner of York and Madison Ave, are large trucks and a industrial looking building which is consistent with identification of this location as a *Motor Freight* operation and *filling station* on the 1962 Sanborn Map. There appears to be a small building behind the main structure on Heritage Restaurant which is no longer there.



### Figure 3-1

**Aerial Photo  
May 1955  
J.W. Sewall Company**

### **Whitten Brook Site**

Skowhegan, Maine

**Map Notes:**

- 1) Well locations, borings, grid points, structure and electromagnetic line features were collected using a Trimble Geo-XH GPS Unit or digitized from georeferenced DOQs. Wells have an accuracy of <1 meter, all other features +/- 3 meters.
- 2) Background hydrologic, topographic and political features are from Maine OGIS data layers with an accuracy of +/- 40 ft.
- 3) All data is projected to NAD 1983 UTM Zone 19.
- 4) All spatial data specific to Maine DEP Bureau of Remediation and Waste Management programs are post-processed, geo-referenced and maintained by John Lynam and Chris Halsted of the Maine DEP GIS Unit.
- 5) This map is to be used for reference purposes only and does not represent authoritative locations of displayed features.

Base Map Prepared By: John Lynam  
MDEP GIS Unit, 7/10/2012



0 30 60 90 120  
Feet



**Figure 3-2**

**Aerial Photo  
April 1990  
Aerial Photo & Survey, Inc.**

**Whitten Brook  
Site**

Skowhegan, Maine

**Map Notes:**

- 1) Well locations, borings, grid points, structure and electromagnetic line features were collected using a Trimble Geo-XH GPS Unit or digitized from georeferenced DOQs. Wells have an accuracy of <math><1</math> meter, all other features  $\pm 3$  meters.
- 2) Background hydrologic, topographic and political features are from Maine OGIS data layers with an accuracy of  $\pm 40$  ft.
- 3) All data is projected to NAD 1983 UTM Zone 19.
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Base Map Prepared By: John Lynam  
MDEP GIS Unit, 7/10/2012; Modified by C.A. White on 11/10/12



0 20 40 60 Feet

### **April 18, 1990**

As shown on the 1990 photo on Figure 3-2 the notable changes from the previous photo are that that the structure on the Kyes property has expanded and its configuration appears generally consistent with the present day building footprint. The site configuration and the number of cars are consistent with an operating gas station. A pump island canopy (?) may be present in the central portion of the property near Route 201. The photo indicates that the Spring Gardens facility has been not yet built by this time. The tree growth appears more mature than the present day growth around the perimeter of the proposed detention basin.

### **3.1.2 Sanborn Insurance Maps**

Copies of historical Sanborn insurance maps for the site area were obtained through EDR, Inc. of Milford, CT. Sanborn maps were available for the site area for 1914, 1927, 1944 and 1962. On the 1914 Sanborn map buildings are only depicted on the Savage property (Map 32-63). On the 1927 Sanborn map, building structures are shown on both the Jewett and the Savage properties (Map 32-49). On the 1944 Sanborn map, Figure 3-3, a new structure appears at the intersection of Spring Street and Madison Ave., on what is now the Kyes property. The building is identified as a *Filling Station* and two circular features, presumably gasoline storage tanks, are appear as round circles on north side of the building on the 1944 Sanborn map. On the 1944 map a second filling station is shown at the corner of Madison Ave and York Street, about 200 feet north of the Kyes property. Finally, the 1962 Sanborn Map, Figure 3-4, shows an expansion of the building footprint on the Keyes property; the Kyes property is still labeled as a *Filling Station*. The 1962 Sanborn Map also show another filling station at 257 Madison (Map 33-24) which is currently owned by Walter Hight.

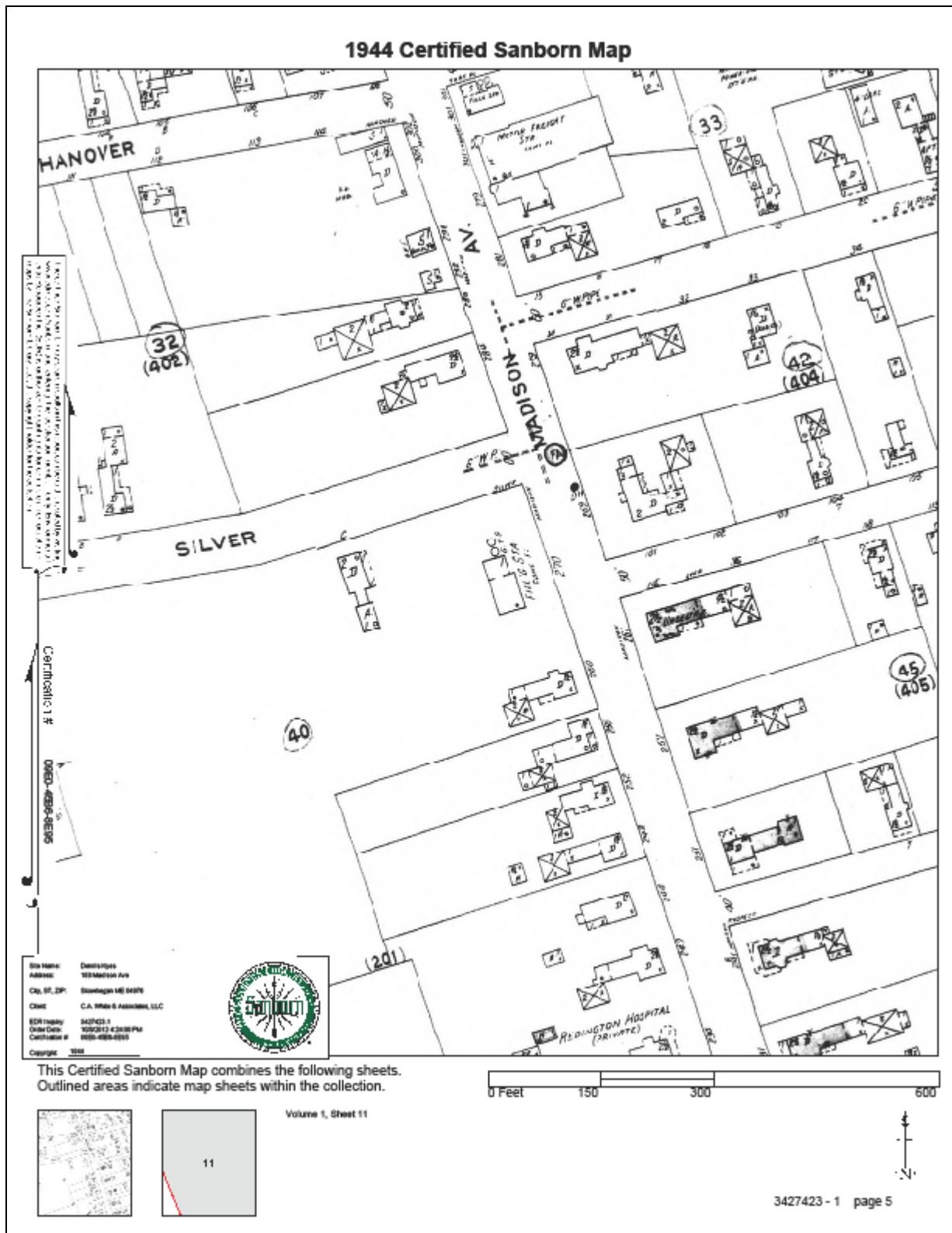


Figure 3-3 1944 Sanborn Fire Insurance Map





### 3.1.3 Potential Sources of Petroleum Contamination

Maine DEP databases, Fire Marshall records, Sanborn Insurance Maps , Fire Department and town records were reviewed to identify all current and former petroleum marketing and distribution facilities within 500 ft. of the seep. We also tried to determine, to the extent feasible, when tanks were installed and removed, and what types of petroleum products were stored.

#### 3.1.3.1 Existing and Former Petroleum Tanks

Seven properties within a 500 foot radius of the seep discharge had or currently have underground petroleum storage tanks. Only one of these properties, Damon’s Quick Stop, has active underground gasoline tanks. According the DEP records 8000 gallon and 6000 gallon steel tanks were installed in 1997. Figure 3-5 shows the properties where petroleum tanks were/are located. Table 3-1 is a summary of the former and existing tanks in the site area

#### 3.1.3.2 Documented Petroleum Spills

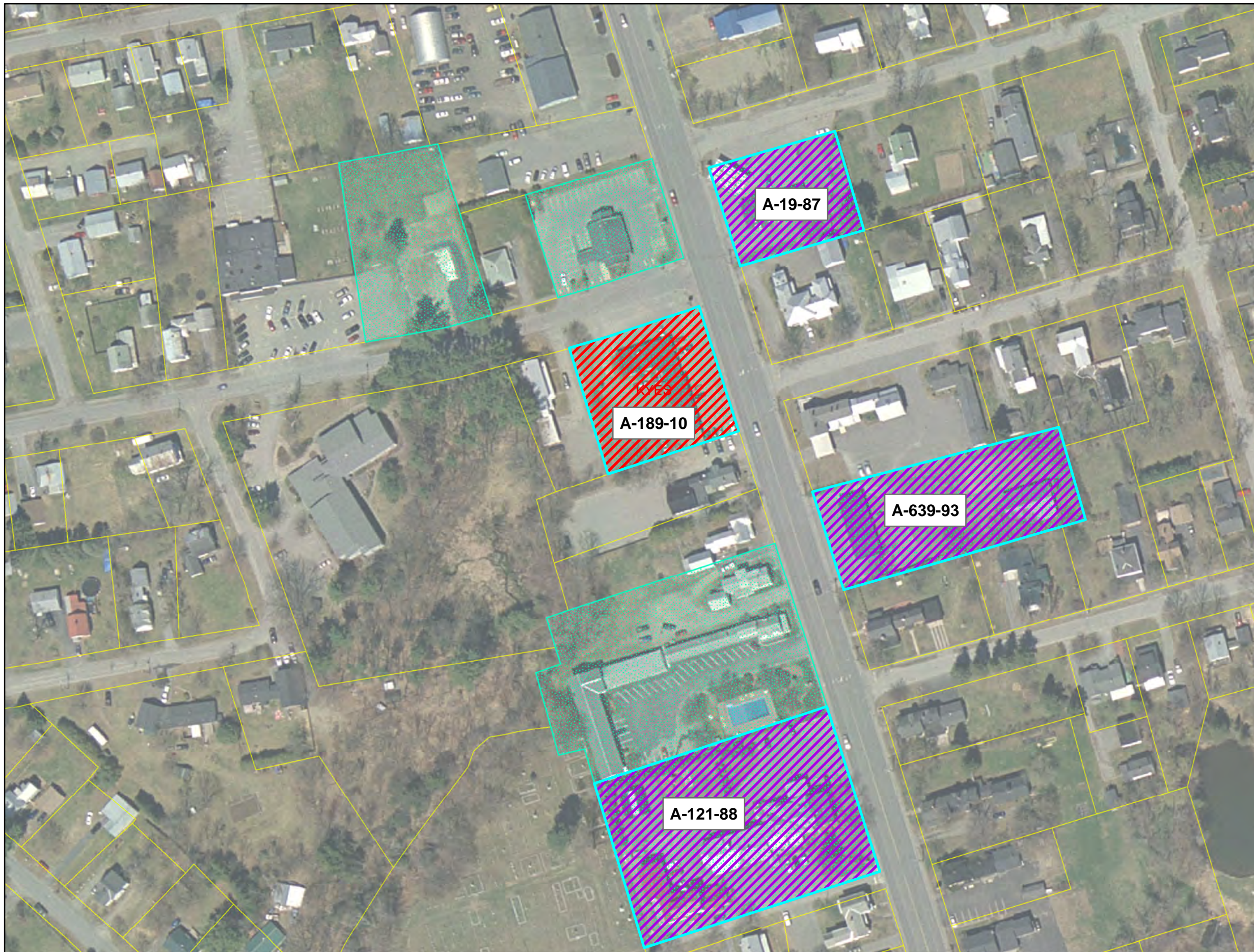
According to Maine DEP records four petroleum spills involving gasoline and, diesel fuel or fuel oil have been identified within 500 feet of the seep, including the “mystery spill” on the Kyes property, the primary focus of this investigation. Table 3-2 summarizes the basic characteristics of each spill. The properties where the reported spills occurred are shown on Figure 3-5. Table 3-2 summarizes the reported spills:

**Table 3-2 – Documented Spills**

Spill Number	Site Name	Tax Map	Address	Type
A-639-93	Cumberland Glass	33-24	257 Madison Ave	waste oil
A-19-87	Savage Oil	33-32	275 Madison Ave	gasoline
A-121-88	Reddington Fairview Hospital	32-59	164 Madison	fuel oil
A-189-10	Dennis Kyes	32-64	188 Madison	gasoline

**Table 3-1  
Summary of Existing and Former Tanks**

Site Name	Tax map & Lot	Current Address	Former Street Addrss	Active Tanks		Removed Tanks		
				Active Tanks	Date Installed	Size & Product	Date Installed	Date Removed
<b>Penny's Petroleum</b>	32-64	188 Madison	266 Madison			4000 g regular 4000 g premium 6000 g unleaded	May-70	May-87
<b>Franklin Savings</b>	32-47	194 Madison	280 Madison Ave			300 g No. 2 fuel oil	Oct-69	Aug-01
<b>Savage Diesel</b>	33-32	191 Madison	275 Madison			1000 g deisel	Jun-81	Jan-86
<b>Damons Quick Stop</b>	33-32	191 Madison		8000 g unleaded gasoline 6000 g unleaded gasoline	Jul-97	3000 g deisel 4000 g unleaded 4000 g unleaded 3000 g unleaded 3000 g Kerosene 3000 g No. 2 Fuel oil	Jan-85	Jun-97
						1000 No. 2 fuel oil		
<b>Town Motel</b>	32-60	172 Madison	248 Madison			1000 No. 2 fuel oil	Oct-69	May-93
<b>Water Varelli</b>	3245	13 Silver Street				1000 No. 2 fuel oil	Jan-74	May-90
<b>Hight Shell Station</b>	33-24	175 Madison	257 Madison			8000 unleaded ? 6000 Diesel /K-1 ? waste oil ?	?	?
<b>Cedar Ridge Home</b>	32-59	164 Madison	234 Madison Ave			2000 No. 2 fuel oil	Jan-71	Dec-97
		164 Madison	234 Madison Ave			2000 gasoline	Oct-69	Dec-97

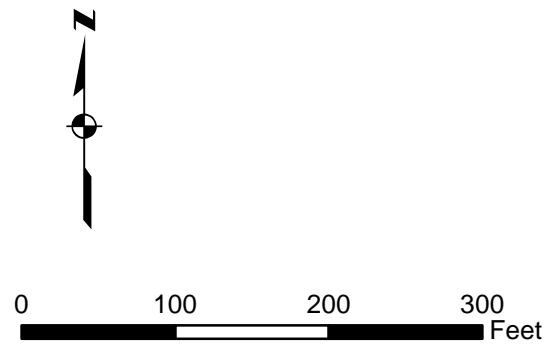


**Figure 3-5**  
**Existing and Former**  
**Petroleum Tanks**  
**&**  
**Known Spills**

**Whitten Brook**  
**Site**  
 Skowhegan, Maine

- Legend**
- Reported Spills
  - Kyes Site
  - Existing and Former Petroleum Tanks
  - Tax Map

**Map Notes:**  
 1) Well locations, borings, grid points, structure and electromagnetic line features were collected using a Trimble Geo-XH GPS Unit or digitized from georeferenced DOQs. Wells have an accuracy of <1 meter, all other features +/- 3 meters.  
 2) Background hydrologic, topographic and political features are from Maine OGIS data layers with an accuracy of +/- 40 ft.  
 3) All data is projected to NAD 1983 UTM Zone 19.  
 4) All spatial data specific to Maine DEP Bureau of Remediation and Waste Management programs are post-processed, geo-referenced and maintained by John Lynam and Chris Halsted of the Maine DEP GIS Unit.  
 5) This map is to be used for reference purposes only and does not represent authoritative locations of displayed features.  
 Map Prepared By: John Lynam; modified by C.A. White 11/10/2012



## **3.2 FIELD INVESTIGATIONS**

Field investigations were conducted during the summer and early fall months of 2012 and consisted of field reconnaissance, surface geophysics, geoprobe drilling and monitoring well installation, water level measurements, groundwater and soil sampling, test pitting. Surface field investigations focused on the four properties located near the intersection of Silver Street and Madison Avenue (Route 201). The locations of the site explorations are shown on Figure 3-6.

### **3.2.1 Water Supply Survey**

A water supply survey was conducted in June 2012 and based on the available information; we concluded that all properties within 500 feet of the contaminated discharge are served by public water. Aqua Maine, a subsidiary of Connecticut Water Service, Inc provides water to the Town of Skowhegan. Billing and connection records were obtained from the water company for Madison Ave and Silver Street. These records and subsequent discussions with water district personnel confirmed that all the site properties are served public water. A few inactive private wells were identified during our field reconnaissance survey on properties west of the site, beyond the 500 ft radius, but it's not likely that these properties would be impacted by the contamination associated with the seep discharge.

### **3.2.2 Surface Geophysics**

In June 14, 2012 Mike Scully of Northeast Geophysical Services, Inc. (NGS) completed an electromagnetic EM-61 survey and a Ground Penetrating Radar (GPR) survey on the site. The objective of the survey was to locate buried underground storage tanks, piping and other subsurface features that may be a source of contamination or a transport pathway for petroleum. The EM-61 and GPR survey focused on the Kyes property where petroleum tanks were known to exist, but had reportedly been removed. As shown on Figure 3-7 several conductive anomalies were identified during the EM-61 survey; GPR was used to confirm the presence and configuration of these anomalies.

- Two linear features (pipes?) exiting the north end of the building toward Silver street
- Two narrow linear features about 60 feet in length situated between the building and Madison Ave oriented parallel to the building
- A circular shaped metallic anomaly located west (behind) the building

An EM-31 survey was conducted on July 9, 2012 by Rudy Rawcliffe of NGS to look for conductive anomalies that might be indicative of a contaminated ground water plume. Three EM-31 lines were completed on the western portion of site between the building on the Keyes property and Whitten Brook. The locations of the lines are shown on Figure 3-6 and the data plots are presented on Figure 3-7. This survey did not yield any useful information to aid in identifying the lateral extent of the groundwater plume. The EM-31 survey did indentify two discrete conductive anomalies on the southern portions of Lines 1 and 3 which are located on the parking lot behind the Heritage Restaurant. According to Rudy Rawcliffe, these signatures may be indicative of a narrow metallic feature, such as






Figure 3-6

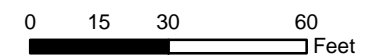
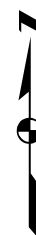
# Explorations

## Whitten Brook Site

Skowhegan, Maine

### Exploration Type

-  Seep
-  Monitoring Wells
-  Soil Borings
-  Test Pits
-  EM Line



Map Notes:  
1) Well locations, borings, grid points, structure and electromagnetic line features were collected using a Trimble Geo-XH GPS Unit or digitized from georeferenced DOQs. Wells have an accuracy of <1 meter, all other features +/- 3 meters.  
2) Background hydrologic, topographic and political features are from Maine OGIS data layers with an accuracy of +/- 40 ft.  
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pipings. No additional studies were completed to further evaluate this feature. A copy of the NGS report is contained in Appendix A.

### 3.2.3 Geoprobe Borings and Monitoring Well Installations

On July 3, 5, 9 and August 10th MAI Environmental (MAI) completed 33 geoprobe soil borings in



the site area. The locations of the borings, designated B-1 through B-33, are shown on Figure 3-6. Seth Brown of MAI operated a track mounted rig using direct-push drilling method. A 2-3/4-inch diameter borings was drilled in the overburden to depths ranging from 15 to 35 feet bgs. Continuous soil samples were collected in all borings using a 5-foot geoprobe sampler outfitted with an internal plastic sleeve. Soil samples were retrieved in the tube and the tube was cut open for screening and logging purposes. All soil samples will be collected and logged onsite.



Samples were examined for the presence of free product and screened with a photoionization detector (PID). Select samples were placed in metalized bags and screened with PID in accordance with MDEP SOP TS004. Six confirmatory samples were collected for VPH and TEPH analysis at HETL in Augusta, Maine.



One-inch diameter PVC monitoring wells, designated MW-1 through MW-10, were installed in ten of the geoprobe borings. Screened sections of the monitoring wells were 10 feet in length and generally split the water table. Once the screen was installed, any remaining open portion of the borehole was backfilled with clean sand and a bentonite seal was placed at about 2 depth to ground surface. The majority of wells were secured with flush mount road boxes, but the four wells closest to Whiten Brook, MW-7, MW-8, MW-9 and MW-10, were completed with above ground protective casings. The ten monitoring wells were developed on July 9<sup>th</sup> using a peristaltic pump. Wells were pumped until the discharge water was visibly clear. Boring logs and monitoring well construction diagrams are contained in Appendix B.

### 3.2.4 Test Pits

On September 14, 2012 three test pits, designated TP-1, TP-2 and TP-3, were excavated on the Kyes property by R.A. Paradis & Sons of Newport, Maine. The location of the test pits are shown on Figure 3-6. Test pits were excavated to the depths ranging from eight to ten feet below ground surface and did not intersect the water table. Grab soil samples were collected continuously from each test pit at approximately two foot intervals. PID field screening results were non-detect (less than 1 part ppm) for all test pit samples and no odor was detected. TP-1 was located



behind the building in the area of the EM-61 anomaly to assess whether it was a buried tank or structure. The anomaly was created by a buried piece of sheet metal, possibly a car door or hood, but no surface pipes, drains or tanks were uncovered.

## 3.3 LABORATORY ANALYSIS OF SOIL SAMPLES

### Grain Size Analysis

Six representative soil samples from the borings and test pits were selected for grain size analysis. The tests were done at Sevee and Maher's soil lab in Cumberland, Maine. Copies of the grain analysis reports are contained in Appendix C.

### Petroleum Hydrocarbon Analysis

Six representative soil samples with elevated levels field headspace readings were selected for laboratory analysis of VPH and TEPH at the HETL lab in Augusta, Maine. The results of laboratory soil analysis are in Appendix C.

#### 3.3.1 Ground Elevation Survey

On July 17, 2012 an elevation survey was completed by Sackett & Brake Survey, Inc of Skowhegan, Maine. Ground surface elevations and top of riser elevations were measured at each of the ten monitoring wells. As requested by the Maine DEP, elevations were referenced to horizontal datum NAD83 and vertical datum NGVD 88.

#### 3.3.2 Water Level Measurements

On July 9<sup>th</sup>, 17<sup>th</sup> and August 13<sup>th</sup>, Carol White and Tom Winger collected water level measurements from the ten monitoring wells installed in this study. Elevation survey data was used to



convert the groundwater measurements to water table elevations. Table 3-3 summarizes the elevation and water level measurement data.

**Table 3-3 Water Level Measurements**

Monitoring Well	Ground Surface, Feet MSL	Top Of Casing, Feet MSL	Depth to water, Feet	GW Elevation 8/13/12
MW-1	235.92	235.83	11.98	223.85
MW-2	234.50	234.41	10.85	223.56
MW-3	234.49	234.45	10.84	223.61
MW-4	234.06	234.29	10.2	224.09
MW-5	234.45	234.3	9.89	224.41
MW-6	234.80	234.55	10.32	224.23
MW-7	229.37	229.29	7.17	222.12
MW-8	229.15	229.3	7.75	221.55
MW-9	231.96	234.7	11.92	222.78
MW-10	233.74	233.58	10.62	222.96
SEEP-1	221.69			221.69
SW	218.66			218.66

### 3.3.3 Groundwater Sampling

Ground water samples were collected from the newly installed monitoring wells during July and August 2012 using Maine DEP approved sampling protocols. The first sampling event was completed on July 9<sup>th</sup>, immediately following the well installations. Only a partial set of wells were sampled during the July event, which was undertaken to provide some immediate information about the site water quality. The second sampling event occurred August 13<sup>th</sup> and all ten site wells were sampled as



part of this event. Water level measurements were collected in each monitoring well prior to sampling and field parameters measurements of pH, temperature, DO, specific conductance and ORP were recorded at the time of sample collection. Water samples were analyzed for petroleum hydrocarbons using VPH and TEPH methods at Maine's HETL lab in Augusta. At the request of the DEP Water Bureau samples collected during the August event were also analyzed for chloride at MEL. Laboratory reports are contained in Appendix C.

## 4. SUMMARY OF FINDINGS

The following summarizes the results of this study and our interpretation of the geologic and chemical data from the site investigations.

### 4.1 SURFICIAL GEOLOGY

The Maine Geological Survey (MGS) has mapped an extensive sand and gravel aquifer that extends from the upper reaches of Whitten Brook about 1 mile northeast to Cold Brook, encompassing much of the urban part of the town (MGS, 2000). Surficial geologic maps of the Skowhegan quadrangle prepared by L. Hanson and D. Caldwell (2000) depict the site as sandy glaciofluvial outwash deposits overlying fine grained glaciomarine clays and silts known as the Presumpscot Formation. The extensive sand deposits that comprise the aquifer represent a glaciomarine delta which was formed when the melting glaciers which carried sediment to the ocean at the edge of ice sheet over 10,000 years ago.

Subsurface investigations at the site confirm the geologic interpretation by MGS of sand underlain by clayey silt. Based on the geoprobe borings the sand ranged from 7 to 30 feet in depth. Grain size analysis of sand samples collected from borings and test pits classify the material as a medium to fine sand with less than 10% fines. Geoprobe borings completed at the site revealed that the elevation of the clay surface underlying the sand is somewhat irregular. In the area between Madison Ave and Whitten Brook clay elevations range from 205 to about 220 feet above mean sea level. Figure 4-1 is a contour map of the clay surface. These closely spaced borings indicate that a knob or hill in the clay surface occurs at southeast corner of the Kyes property where the depth to the top of clay is only about 7 feet below ground surface. No bedrock was encountered during the drilling program. Geologic investigations and drilling records compiled by the Maine Geological Survey report bedrock depths ranging from 65 feet to greater than 85 feet below ground surface in the area.

### 4.2 HYDROGEOLOGY

Water levels measurements in the ten monitoring wells installed as part of the investigation indicate that the groundwater is fairly shallow with depths of 7 to 12 feet below ground surface during the summer months. Calculated groundwater elevations range from about 224 feet MSL near Madison Ave to about 221.5 feet MSL at the seep discharge. As expected, a groundwater contour map of these data, Figure 4- 2, indicates that groundwater flows southwesterly across the site properties towards the upper reach of Whitten Brook. It's likely that the clay elevation controls the shallow groundwater discharge at the contaminated seep and into the headwaters of the brook. Interestingly at MW-8, located near the discharge seep, the clay elevation is about 10 feet below the elevation of the groundwater discharge point.

Due to the moderately permeable soils, the water table is relatively flat and the calculated horizontal groundwater gradient is 0.008ft/ft. Assuming an average porosity of 30% and an estimated



**Figure 4-1**

**Contour Map  
Top of Clay Surface**

**Whitten Brook  
Site**

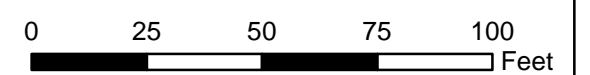
Skowhegan, Maine

**Legend**

— Clay Surface, Ft MSL

Map Notes:  
 1) Well locations, borings, grid points, structure and electromagnetic line features were collected using a Trimble Geo-XH GPS Unit or digitized from georeferenced DOQs. Wells have an accuracy of <1 meter, all other features +/- 3 meters.  
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**Figure 4-2**  
**Ground Water Contour Map**  
**Whitten Brook Site**  
 Skowhegan, Maine

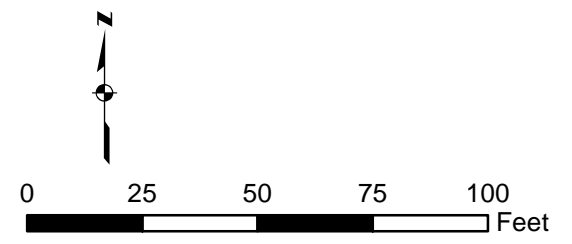
**Legend**

-  Monitoring Well
-  Ground Water Elevation, Ft MSL

**Map Notes:**

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hydraulic conductivity of  $10^{-3}$  cm/sec, the estimated flow rate of the groundwater is about 10 to 30 feet per year. At this estimated seepage rate, it would take approximately 10 years for groundwater to travel from the location of pump island on the Kyes property to the contaminated seep.

### 4.3 PETROLEUM CONTAMINATION ASSESSMENT

#### 4.3.1 Soil

##### 4.3.1.1 PID Headspace Field Screening

Geoprobe borings and associated PID readings indicate that petroleum contamination is present at water table in the sand, especially in the borings completed on the Kyes property. PID readings ranged from 0 to 950 ppm based on bagged headspace readings. The results of the PID soil bag screening (depicting the highest reading in each boring) are shown on Figure 4-3. As evident from this map, the most elevated readings were recorded for samples collected in front of building and at the southeast corner of the building. A third area of heavily contaminated soil is found west of the building on the Kyes property where readings ranged from 300 to 350 ppm. It is important to note that these PID readings are useful for qualitative assessment of the presence of VOCs and cannot be used to represent quantitative identification of specific compounds or concentrations.

##### 4.3.1.2 Laboratory Analysis

Six soil samples were submitted for laboratory testing based on elevated PID readings. No elevated PID readings were obtained in unsaturated soils so all of these soil samples were collected at the water table interface from depths ranging from 10 to 15 feet bgs. The soil samples were contaminated with total VPH in concentrations ranging from 450 mg/L at B-16 located near the southeast corner of the Kyes building to 2850 mg/kg at B-4 located immediately west of the Keyes building. Table 4-1 is a summary of the soil sample test results.

**Table 4-1  
Results of Laboratory Analysis of Soil Samples**

Location	C5-8	C9-12 Al	C9-12 Ar.	TVPH	TEPH
B-4	1300	390	1200	2890	
B-8	720	340	250	1310	
B-16	230	200	20	450	
B-18	360	670	500	1530	
B-19	1300	940	490	2730	
B-22	860	520	1100	2480	57



**Figure 4-3**  
**Soil PID Readings**  
**Highest Reading in**  
**each Soil Boring**

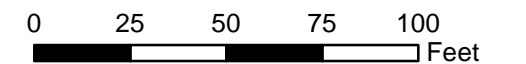
**Whitten Brook**  
**Site**  
 Skowhegan, Maine

**Soil - Bag PID Readings in ppm**



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### **4.3.3 Groundwater**

Ground water samples were collected from the monitoring wells installed at the site July 9th and August 13<sup>th</sup>, 2012. Five monitoring wells were sampled in July for screening purposes and all ten wells were sampled in August. In the August sampling event total VPH concentrations ranged from non detectable levels in three wells (MW-1, MW-5 and MW-9) to 7535 ug/L in MW-2. Results of the August groundwater sampling are presented on Figure 4-4. These results show petroleum contamination in groundwater south and west of the building on the Kyes property and extending to area of the seep discharge.

The chemical and chromatographic results of these analyses are consistent with gasoline. As shown on Table 4-2 groundwater samples from MW-2, MW-4 and MW-10 exceed the Maine DEP guidelines for petroleum. It's important to note that these guidelines were set to address human consumption of the groundwater as drinking water. No benzene or MTBE was reported in the contaminated groundwater samples, suggesting that it the result of an old spill. Groundwater samples did not show very consistent results between the July and August sampling event, though the wells had just been developed prior to the July sampling event so that may account for the difference..

The compositional characteristics of the petroleum contamination appear to vary across the site as evidenced by the ratios for carbon fractions and a visual inspection of the chromatograms. The toluene, ethylbenzene, xylenes and naphthalene compounds are present groundwater sample collected from MW-2 and MW-10. In addition these samples have a higher relative proportion of C-9 and C-10 aromatics as compared with the other petroleum contaminated samples. The chromatograms from MW-2 and MW-10 look similar to one another, but somewhat different from the remaining samples. It is not certain if these different characteristics are indicative of a separate source or artifacts of chemical degradation – according the HETL chemist Vera Maheu either cause is plausible.

#### **4.3.3.1 Field Measurements**

Field parameters measured during sample collection included pH, temperature, specific conductance, DO and ORP. As expected, petroleum contamination generally correlated with depressed DO and ORP readings in the groundwater. Conductivity values were rather elevated ranging from 250 at MW-1 at to greater than 1000 mg/L at MW-6 and MW-9.

#### **4.3.3.2 Chloride**

At the request of the DEP, chloride concentrations were measured in water samples collected from the ten monitoring sample during the August event. Chloride concentrations ranged from a low of 38 mg/L at MW-8 to 644 mg/L at MW-6. MW-1 and MW-5, located near Silver Street and Madison Ave had chloride concentrations of 330 and 304 mg/L, respectively. In general, chloride concentrations in the groundwater showed a good correlation with field measurements of specific conductance obtained in field during sampling. Table 4-3 summarizes the chloride and field measurements.

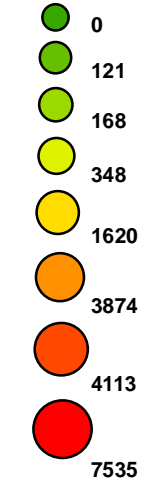


**Figure 4-4**  
**Total Volatile Petroleum Hydrocarbons**  
**In Groundwater**  
**August 2012**  
**Whitten Brook**  
**Site**  
 Skowhegan, Maine

Volatile Petroleum Hydrocarbons in ug/L

• <all other values>

VPH



**Map Notes:**

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**Table 4-2  
Summary of Laboratory Results - Groundwater**

		MDEP VPH Guidelines ug/L											
		35	5	600	30	1000		10	300	700	200		
	Date Sampled	MTBE	Benzene	Toluene	Ethyl-benzene	m,p-xylene	o-xylene	naphthalene	C5 - C8 aliphatics	C9-C12 aliphatics	C9-C10 armoatics	Total VPH	Total TEPH
MW-1	9-Jul-12	<1	<1	<1	<1	<2	<1	<1	<50	<50	<10	0	
MW-1	10-Aug-12	<1	<1	<1	<1	<2	<1	<1	<50	<50	<10	0	
MW-2	13-Aug-12	<1	<1	2.2	55	89	8.8	80	1000	<50	6300	7535	
MW-3	9-Jul-12	<1	<1	<1	6.4	11	<1	6.8	1300	280	230	1834	1100
MW-3	13-Aug-12	<1	<1	<1	1.4	2.2	<1	<2	80	<50	84	168	gasoline
MW-4	9-Jul-12	<1	<1	<1	2.2	25	2.1	20	1700	500	1700	3427	
MW-4	13-Aug-12	<1	<1	<1	3.1	34	2.7	34	1600	<50	2200	3874	
MW-5	9-Jul-12	<1	<1	<1	<1	<2	<1	<2	<50	<50	<10	0	
MW-5	13-Aug-12	<1	<1	<1	<1	<2	<1	<2	<50	<50	<10	0	
MW-6	9-Jul-12	<1	<1	<1	<1	<2	<1	<2	1600	660	520	2780	1200
MW-6	13-Aug-12	<1	<1	<1	<1	<2	<1	<2	1100	290	230	1620	gasoline
MW-7	13-Aug-12	<1	<1	<1	<1	<2	<1	<2	88	<50	33	121	
MW-8	13-Aug-12	<1	<1	<1	1.5	<2	<1	4.5	190	76	76	348	
MW-9	9-Jul-12	<1	<1	<1	<1	<2	<1	<2	<50	<50	<10		
MW-9	13-Aug-12	<1	<1	<1	<1	<2	<1	<2	<50	<50	<10	0	
MW-10	13-Aug-12	<1	<1	11	150	300	82	110	760	<50	2700	4113	

**Table 4-3 - Groundwater Field & Chloride Measurements  
August 13, 2012**

	<b>pH</b>	<b>Conductivity</b>	<b>Temp</b>	<b>DO</b>	<b>ORP</b>	<b>Chloride</b>
	<b>units</b>	<b>umohs/cm</b>	<b>Cent.</b>	<b>mg/L</b>	<b>millivolts</b>	<b>mg/L</b>
MW-1	5.65	764	14.04	5.4	365	330
MW-2	5.71	540	14.17	1.1	240	217
MW-3	6.02	348	11.7	5.61	237	112
MW-4	6.56	924	12.38	0.7	158	338
MW-5	5.87	851	15.49	8.6	365	304
MW-6	6.39	1805	13.95	1.59	198	644
MW-7	6.02	600	12.8	192	258	185
MW-8	6.44	392	16.37	1.54	190	37.9
MW-9	5.52	1042	11.84	7.71	382	367
MW-10	6.21	250	13	0.6	191	43.0

#### 4.4 DATA GAPS

A few data gaps have been identified:

1. In the vicinity of the detention pond, the northern lateral extent of the hydrocarbon plume has not been established. Total VPH concentrations in MW-10 were over 4000 ug/L during the August sampling. It may be necessary to define the northern limit of the contamination in order to evaluate the feasibility of restoring the groundwater quality impacting the headwaters of Whitten Brook near the detention pond.
2. The lack of borings on the north side of the building and immediately west of the northwest corner makes it impossible to confirm that petroleum contamination is not present in these locations.
3. Test pits and geoprobe samples indicate that the petroleum contamination is located at the water table. The lack of any evidence of petroleum contamination in the unsaturated zone may be the result of weathering of an onsite spill or may be indicative of an offsite source. Analysis of the unsaturated soils was limited by the soil recovery in the tubes – in many cases less than 2-feet was recovered over a 5 foot interval. Consequently evaluating the presence of contamination in unsaturated zone was difficult.
4. Based on available data, it is uncertain if the contamination on the site is the result of a spill on the Kyes property or if an offsite spill of floating product may have migrated along the water table onto the site. The data suggests that the most likely source is the former pump island and storage tanks on the Kyes property. Nevertheless the lack of groundwater data between MW-5 and MW-6 near Madison Ave makes it difficult to conclusively rule out the possibility of free product or contaminated groundwater entering the site from the Madison Ave side of the Kyes property.
5. The large screen lengths (10 feet) in the monitoring wells, although appropriate for this type of investigation, may dilute narrow zones of contamination in sand confounding the comparison of water quality data.
6. The EM-31 anomaly identified behind the Heritage Restaurant may be caused a relic pipeline or other feature whose presence could impact the brook water quality. Further evaluation of this feature may be advisable as part of the restoration work.
7. Observations of the discharge from the stormwater outfall near the detention pond suggest that suspended clay is present in the discharge. This suggests that the stormwater piping may be degraded and that groundwater may be infiltrating the pipe. Also there is no data on the water quality of this discharge to confirm if petroleum or other contaminants are discharging from this point into the brook.

## 5. CONCLUSIONS

The primary objective of this investigation was to locate and identify the source or sources of petroleum discharge to the upper reaches of Whitten Brook. As part of this study we characterized the surficial geology and defined ground water flow directions in the vicinity of the hydrocarbon-contaminated seep. Data on the soil and water quality was used to develop an understanding of the nature and extent of petroleum contamination and to surmise the most likely source of petroleum contamination. Finally, in conjunction with the Maine DEP, we have developed recommendations for addressing the cleanup of the contamination at the site.

Our studies indicate that numerous potential sources of petroleum contamination exist near the site. Based on the nature of the contamination (gasoline) and the site conditions the most likely sources of contamination are the former tanks and pump island on the Kyes property and the retail petroleum operations on the Damon property. Given the results of the soil and water testing and the proximity of the contamination to the former pump island and tanks it seems likely that a historical spill(s) on the Kyes property is the source of the groundwater contamination discharging to the seep. In either case the characteristics of the VPH analysis, in which no MBTEX or MTBE compounds were detected, suggests that the source of the groundwater contamination is an old spill, rather than a current leak.

The distribution of the petroleum contamination in site soils and groundwater suggests two or possibly three separate sources/plumes of petroleum contamination may exist:

- one in the vicinity of the former pump island on the Kyes property
- a second at the southeastern portion of the Kyes property near MW-6 and MW-4
- and possibly a third behind the Kyes building near MW-2.

The interpretation of two separate plumes is supported by the different chromatographic signatures and chemical compounds in MW-2 and MW-10, as compared with MW-4 and MW-6. It may be that the contamination at former pump island is related to the petroleum detected in MW-2 and MW-10; but the lack of groundwater data from the vicinity of the former pump island makes this difficult to assess.

The lateral extent of the plume has not been completely defined. As previously described the northern extent of plume, beyond MW-10, cannot be determined from the available data. If more than one plume exists upgradient of the brook, it may be that contaminated groundwater is discharging over a larger area around the detention pond than previously thought. The petroleum detected in the discharge at Seep001 may originate from the plume emanating from the area around MW-4 and MW-6. The different character and more elevated concentrations of the petroleum contamination near MW-10 raises the possibility a separate plume is impacting that well and discharging further north on the edge of the basin. The fact that no petroleum was detected in soil or groundwater samples from the MW-9, located between the seep and MW-10, support this interpretation.

The overall flow regime of groundwater discharge and underlying low permeability clay exerts influence on vertical groundwater flow which in all likelihood limits the vertical migration of the petroleum contamination. Field investigations suggest that the highest concentrations of petroleum occur in the upper few feet of the water table. Lower concentrations of dissolved petroleum may extend through the saturated zone on top of the clay which is generally less than 10 feet thick. Consequently, I would envision that the vertical extent of the plume(s) of contaminated groundwater is rather thin, generally on the order of a few feet and less than 10 feet in thickness in most cases.

## **6. RECOMMENDATIONS**

Based on discussions with the Maine DEP during a project meeting on December 13, 2012 we agreed on the following recommendations for additional investigations:

1. Installation of 4 or 5 additional borings and minimum 2-inch diameter monitoring wells on the east, north and west side of the building on the Keyes property. The proposed locations of the borings are shown on Figure 6-1.
2. A second complete round of water quality sampling, including the additional monitoring wells.

Figure 6-1

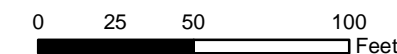
# Additional Borings

## Whitten Brook Site

Skowhegan, Maine

### Exploration Type

-  Additional Monitoring Wells (2-inch)
-  Seep
-  Monitoring Wells
-  Soil Borings
-  Test Pits
-  EM Line



Map Notes:  
1) Well locations, borings, grid points, structure and electromagnetic line features were collected using a Trimble Geo-XH GPS Unit or digitized from georeferenced DOQs. Wells have an accuracy of <1 meter, all other features +/- 3 meters.  
2) Background hydrologic, topographic and political features are from Maine OGIS data layers with an accuracy of +/- 40 ft.  
3) All data is projected to NAD 1983 UTM Zone 19.  
4) All spatial data specific to Maine DEP Bureau of Remediation and Waste Management programs are post-processed, geo-referenced and maintained by John Lynam and Chris Halsted of the Maine DEP GIS Unit.  
5) This map is to be used for reference purposes only and does not represent authoritative locations of displayed features.

Map Prepared By: John Lynam; modified by C.A. White 11/10/2012



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## **APPENDICIES**

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