Case Study Abstract

Ciba-Geigy Hamblet & Hayes (H&H) Site
Lewiston, ME

Site Name and Location: Ciba-Geigy Hamblet & Hayes Site	**Geophysical Technologies:** Ground Penetrating Radar (GPR)	**CERCLIS #** Not applicable
Period of Site Operation: 1963 to 1995 solvent repackaging/chemical redistribution **Operable Unit:** Not applicable		**Current Site Activities:** A groundwater pump and treat system and an air sparging/soil vapor extraction system were installed at the site in 1996, and have been operating since early 1997. Additional investigation work on areas where dense nonaqueous phase liquids (DNAPLs) have been found are also ongoing.
Point of Contact: Stephen Walbridge Harding Lawson Associates 511 Congress Street P.O. Box 7050 Portland, ME 04112-7050 (207) 828-3482 swalbrid@harding.com	**Geological Setting:** The surficial unit is the Presumpscot Formation, a marine deposit consisting of varying amounts of clay, silt, and fine sand. Overlying this formation is a unit primarily composed of sandy fill. Below the Presumpscot Formation is a sand and gravel unit.	**Technology Vendor:** Geophysical Survey Systems, Inc. 13 Klein Dr. North Salem, NH 03073-0097 (603) 893-1109 Fax (603) 889-3984 sales@geophysical.com
Purpose of Investigation: The purpose of the GPR survey was to provide information on the continuity and topographic relief of clay layers in near-surface soils beneath the site. Identifying these high and low points of the clay layer would help identify where DNAPL might accumulate.		
Number of Images/Profiles Generated During Investigation: 85 traverses		
Results: The GPR survey successfully identified continuous reflectors that represent silty clay layers in the shallow subsurface soils beneath the site. There was an observed parallel relationship of the various sand, silt, or clay layers that are present in the shallow subsurface soils that suggest the topography of the interpretive layer mimics the topography of the massive silty clay known to exist 19 to 22 feet below the ground surface (bgs) in the area of the GPR survey. This would provide a downward sloping pathway for DNAPL to move along until accumulating in topographically low areas identified, such as beneath the southwest corner of the leachfield.		

EXECUTIVE SUMMARY

The Ciba-Geigy Corporation (Ciba-Geigy) Hamblet and Hayes (H&H) site is a complex of buildings located off of Crowley Road in Lewiston, Maine. The facility was primarily known for its solvent repackaging activities. Suspected site contamination was associated partly with an incident which occurred in 1983 when a valve was inadvertently left open and approximately 1,000 gallons of xylenes were spilled onto the ground. An environmental assessment was conducted and revealed that a contaminated groundwater plume and contaminated soil, primarily consisting of chlorinated solvents and xylenes, existed at the site.

The surficial geologic unit is the Presumpscot Formation, a marine deposit consisting of varying amounts of clay, silt, and fine sand. Overlying the Presumpscot Formation at the site is a unit that is composed of sandy fill to an approximate depth of 7 feet below ground surface (bgs). Underneath the Presumpscot Formation is a sand and gravel unit that extends to depths of 45 feet bgs.

As part of the third Phase of the site investigation process, a ground penetrating radar (GPR) survey was conducted to map the top of the clay surface. The information presented in this report was derived from the interpretive report of the geophysical investigation. At least four reflectors were identified. The four reflectors were interpreted to represent the top of the silty clay layers that comprise the upper portion of the marine clay formation found at the site. The uppermost reflector was interpreted to be a silty clay layer and was chosen for further interpretation. The silty clay layer was present on most profiles and determined to be continuous throughout the study area. A topographic low for potential dense non-aqueous phase liquid (DNAPL) pooling was identified near the western corner of the site.

The GPR data were accurate to site conditions and the confidence level of the decisionmakers in the results was high. Their confidence in the level of accuracy of the GPR data was validated through later investigations and comparisons to soil boring data. Overall the GPR survey was an effective tool for identifying continuous reflectors that represented silty clay layers in the shallow subsurface soils beneath the site.

As a result of the GPR survey, the topographic low point of the upper surface of the underlying aquitard was determined. This low point was chosen as a location to install an extraction well, since this would be a potential area where DNAPL might pool. DNAPL was encountered during the installation of the extraction well, confirming the results of the GPR survey. Later comparisons to soil boring data also verified the accuracy of the GPR data.

SITE INFORMATION

Identifying Information

Ciba-Geigy Hamblet & Hayes (H&H) Site
Lewiston, ME 55952
Resource Conservation and Recovery Act (RCRA) Site

Background [1]

Physical Description: The H&H site is a complex of buildings located to the southeastern side of Crowley Road in Lewiston, Maine (Figure 1) which occupies an area approximately 450 feet (ft) wide by 600 ft long on a 5.5 acre parcel of land at approximately 190 ft above mean sea level. The site slopes gently from northeast to southwest, toward No Name Brook. Surface drainage from around the buildings collects and flows into a drainage ditch that encompasses the site. Overall, surface drainage primarily flows southwest from the site into No Name Brook. Swampy conditions exist in the area of monitoring wells MW-205A and MW-205B, which is primarily to the south of the study area (Figure 2). A mounded leachfield was built in 1979 to replace the former leachfield and was used for treating sanitary wastes at the site. The previous leachfield was located beneath what is currently the northeastern portion of the truck loading warehouse/office building.

The study area for the Ground Penetrating Radar (GPR) survey was between Crowley Road and the truck loading warehouse/office building (350 ft by 400 ft in area) and in the immediate area along the southeast side of the building (100 ft by 250 ft in area). This covered an area from the former underground storage tanks (USTs), which is the source area, to the railroad tracks (Figure 2).

Site Use: The facility began operations as a solvent repackaging facility in 1963 as the Polar Chemical Division of Hamblet & Hayes Co. (H&H), which was then was purchased by Ciba-Geigy in 1978. The facility ceased solvent repackaging operations in 1985 and changed to a chemical redistribution facility. While operating as a repackaging facility, bulk chemicals were received by tank truck and railroad freight car and then stored in the warehouse and in a series of eight USTs and two aboveground storage tanks. The USTs were located on the northwestern side of the flammable materials storage building, which is located in the north end of the site. One of the aboveground storage tanks was located adjacent to the flammable materials storage building and the other on the southeastern side of the truck loading warehouse/office building. Chlorinated and non-chlorinated solvents were stored in the storage tank areas. Solvents were pumped from the tanks and repackaged into drums and other containers for distribution. The containers were then loaded onto trucks and shipped for delivery. In 1989, the site was

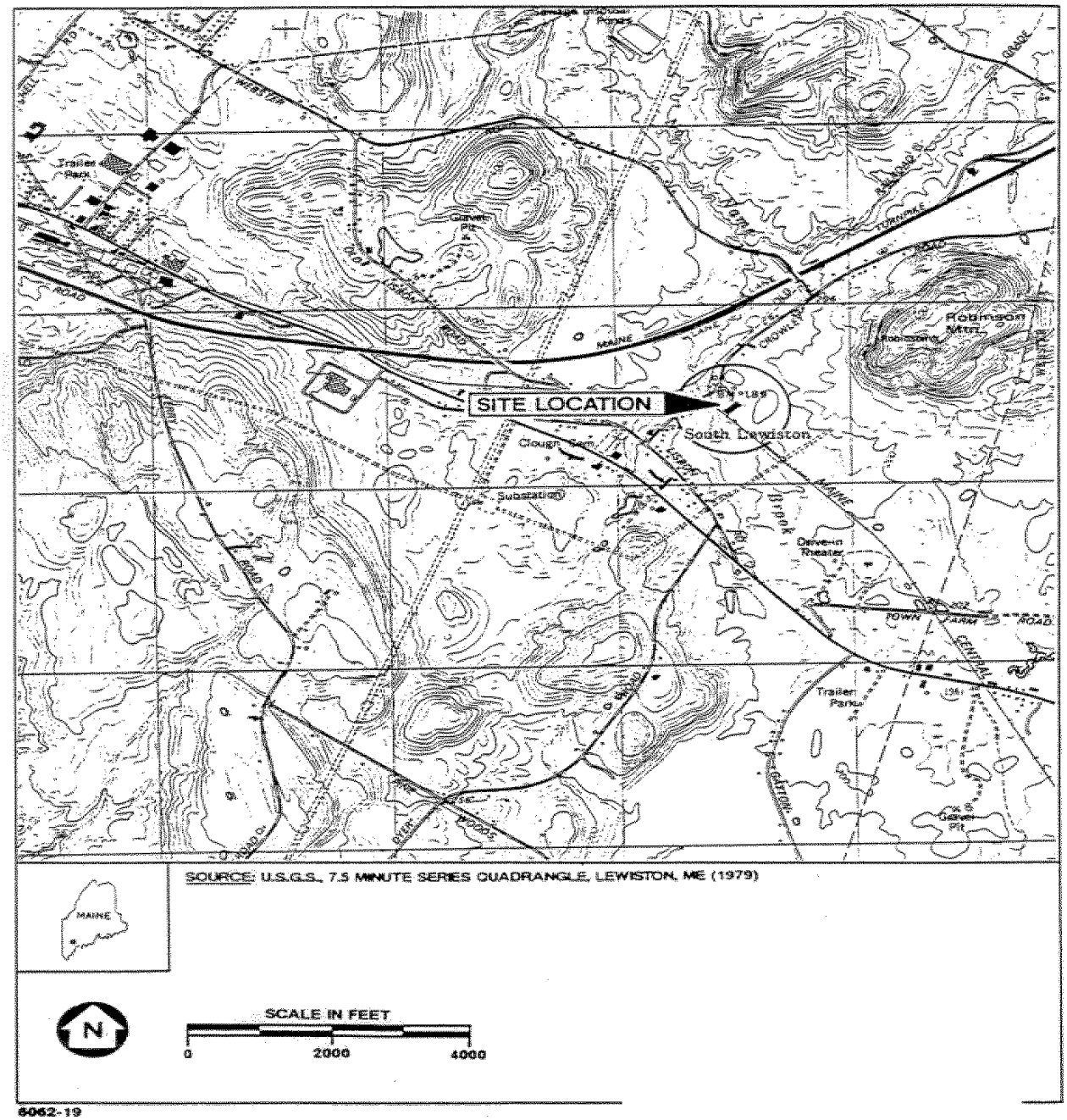

Figure 1: Site Location Map for Ciba-Geigy Hamblet & Hayes[1]

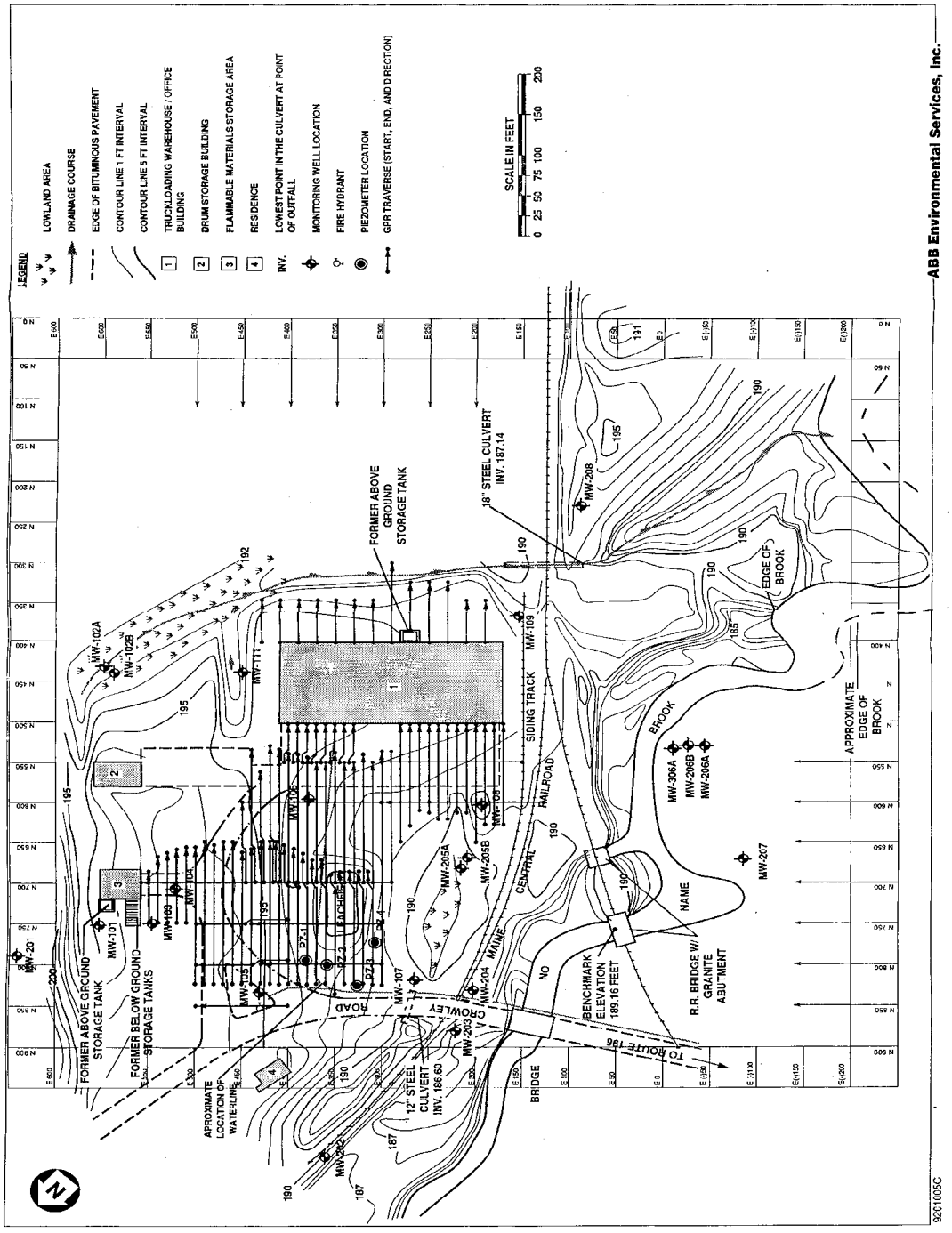

Figure 2: Location of GPR Traverses [1]

purchased by Van Waters & Rogers, Inc., and operations ceased in 1995. In 1997 Ciba-Geigy reacquired the property. Currently, limited truck parking and trailer transferring are the only activities at the site.

A groundwater pump and treat system and an air sparging/soil vapor extraction (SVE) system were installed at the site in 1996, and have been operating since early 1997. The pump and treatment system includes four extraction wells screened in the shallow silty sand aquifer, including EW-401 at the location of dense nonaqueous phase liquids (DNAPLs), and one extraction well (EW-501) screened in the underlying sand and gravel aquifer. The sparging/SVE system is located in the former UST area where light nonaqueous phase liquids (LNAPLs) and very high volatile organic compound (VOC) concentrations have been found in both the saturated and unsaturated zones.

Release/Investigation History: Suspected site contamination occurred in 1983 when a tank valve was inadvertently left open and approximately 1,000 gallons of xylenes were spilled onto the ground. H&H employees reported that xylenes ran along the asphalt driveway surface and ponded in a low area off the asphalt directly across from the front of the truck loading warehouse/office building. The spill was promptly reported to the Maine Department of Environmental Protection (MEDEP) and emergency response crews responded to the spill by excavating the ponded, free product xylenes and contaminated soils. A recovery sump was installed at the corner of the flammable materials storage building in order to recover the portion of xylenes that infiltrated the ground and was floating on top of the groundwater. H&H employees reported that xylenes were skimmed from this sump for approximately four years after the incident. The pumping was discontinued in 1987 due to low or nonexistent levels of recoverable product.

In 1985, the USTs were removed under the supervision of MEDEP personnel. The excavation was backfilled with soils excavated from around the tanks, along with clean, off-site backfill material. The tanks appeared to be in excellent condition, but a solvent odor was noticeable. No soil or water samples were collected as a part of the tank removal process.

The investigation that documented the suspected contamination at the site was a result of the 1989 property transfer Phase I investigation program. ABB Environmental Services, Inc. was contracted by Ciba-Geigy Corporation (Ciba-Geigy) to conduct an environmental assessment and develop a plan for any necessary cleanup of suspected soil and groundwater contamination at the H&H site. This assessment generated enough data to determine that a contaminated groundwater plume, primarily consisting of chlorinated solvents and xylenes, existed at the site. Soil contamination was also identified as being present in the vicinity of the former UST area. Contamination has also been identified in the sediments and surface water of No Name Brook. Recent investigations have been conducted in areas where some DNAPL was identified during the installation of extraction well EW-401. The presence of DNAPL was first confirmed in EW-401 in November of 1994. EW-401 is located adjacent to piezometer PZ-4 (Figure 2).

SITE INFORMATION

Regulatory Context: This is a RCRA site where the MEDEP is providing oversight on all aspects of work done at the site, including work plan reviews and approval and field site visits. On March 27, 1997 the MEDEP entered into a compliance order by consent with Ciba-Geigy. This order detailed the requirements and remedial objectives of the groundwater pump and treatment system that was installed in 1996 and has been operational since early 1997 [5].

Site Logistics/Contacts

Federal Lead Agency: None

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MEDIA AND CONTAMINANTS

Matrix Identification

Type of Matrix Sampled and Analyzed: Subsurface soil and clay

Site Geology/Stratigraphy [1]

Native subsurface soils consist of a stratified sequence of outwash sands, peat, marine clay, and sand and gravel layers. The upper layer encountered is a sandy fill layer, which consists of both natural and man-made fill materials that overlay natural organic materials (peat). Debris such as bricks, cinders, and spent coal can also be found in this layer. Beneath the sandy fill layer is a silty sand layer, which consists primarily of fine sands and silts that varies in thickness from 1 foot to 19.5 ft. The silty sand is underlain by a marine clay layer known as the Presumpscot Formation, which was deposited during the recession of the late Wisconsinan glacier. The marine clay primarily consists of a blue-gray silty clay with a trace of fine sand, and with various thickness of fine gray sand lenses with a weathered brown silty clay layer typically overlying the blue-gray

material. On average the clay was encountered at 10 ft below the ground surface (bgs) and ranged in thickness from 14 to 61 ft. The layer encountered beneath the clay is the sand and gravel stratum, which consists of a wide range of soils types and gradations, ranging from clean poorly graded sands to well-graded till with cobbles and boulders throughout. This layer was encountered at depths ranging from 15 ft bgs to 73.5 ft bgs. Depth of bedrock was first determined by borings and a seismic refraction survey conducted in 1993. This investigation indicated that depth to bedrock is believed to be at an average of 55 ft bgs [2]. The silty clay, if present in layers or as a massive deposit, is characterized by very low hydraulic conductivities.

Groundwater was encountered in all the soil borings taken during the site investigation, at depths ranging from the ground surface to 6 ft bgs. Direction of groundwater flow is generally southwest across the site toward No Name Brook and into the surface drainage ditches. This holds true for both normal conditions and after heavy precipitation events have occurred. Hydraulic conductivity values for the various subsurface strata are as follows: silty sand layer has a mean conductivity value of $3.7x10^{-4}$ centimeters per second (cm/sec); silty sand and marine clay interface zone has a value of $1.1x10^{-4}$ cm/sec; the marine clay has a value of $4.2x10^{-8}$ cm/sec; and the sand and gravel stratum has a value of $2.0x10^{-3}$ cm/sec.

Contaminant Characterization [1]

Primary Contaminant Groups: Primary contaminants of concern found at the H&H site include: chlorinated solvents (1,1,1-trichloroethane, tetrachloroethene (PCE), trans-1,2-dichloroethene, and methylene chloride), aromatic hydrocarbons (benzene, ethylbenzene, toluene and xylenes), naphthalene, and ketones. Floating free product organic solvents exist at the former UST area. PCE has been found as a DNAPL at the site.

Matrix Characteristics Affecting Characterization Cost or Performance [1]

Parameters affecting performance of the GPR include a shallow water table and the nature of the soils encountered at the site. To the south side of the truck loading warehouse/office building penetration of GPR was limited by the dense fill that lies above the massive silty clay near the ground surface. Swampy conditions existed in the area of MW-205A and MW-205B to the west of the GPR study area (Figure 2), which limited the use of the GPR system and the extent of the GPR survey, due to limited access to this area. No other factors were reported to impede the effectiveness of the GPR survey or results.

The average depth to be surveyed was between 0 and 15 ft bgs. This is the area where the clay layer is almost always encountered, since the average depth to clay is 10 ft bgs. This was an ideal depth for the GPR survey to be effective in detecting the clay layer and whether or not it was continuous across the study area.

A waterline, which was installed by the City of Lewiston, exists approximately 8 to 10 ft bgs on the southeastern side of Crowley Road (Figure 2). The H&H facility's water line connection

between the City of Lewiston water line and the truck loading warehouse/office building parallels the northeastern side of the mounded leachfield and is at a depth of 11 ft bgs. These water lines were not reported to interfere with the effectiveness or the results of the GPR survey.

Investigation Goals [1]

The goal of the geophysical investigation was to provide information on the continuity and topographic relief of the clay layer beneath the site. This would help identify low areas in the clay layer where DNAPL could potentially accumulate.

Geophysical Methods [1]

The GPR technique uses high-frequency radio waves to determine the presence of subsurface objects and structures. A GPR system radiates short pulses of high-frequency electromagnetic (EM) energy into the ground from a transmitting antenna. This EM wave meanders into the ground at a velocity that is related to the electrical properties of subsurface materials (specifically, the relative dielectric permitivity of the materials). When this wave encounters the interface of two materials having different dielectric properties (i.e., soil and water), a portion of the energy is reflected back to the surface, where it is detected by a receiver antenna and transmitted to a control unit for processing and display. The major principles involved for GPR are similar to reflection seismology, except that electromagnetic energy is used instead of acoustic energy.

For this investigation a Geophysical Survey Systems, Inc. (GSSI) Subsurface Interface Radar (SIR) System-3 GPR system equipped with 100 and 500 MHz antennae were used. Two-way travel times of 50 to 75 nanoseconds were used. The GPR system was towed by hand across the study area at a speed of 0.25 miles per hour (mph).

As part of the site investigation process, a GPR survey was conducted to map the top of the clay surface. However, before the GPR study was conducted at the H&H site, a pilot study was conducted by ABB Environmental Services, Inc. on July 2, 1991. This study indicated that GPR would be effective in profiling the shallow subsurface strata. This led to the more comprehensive survey that was conducted on October 23 and 24, 1991. The survey area was between Crowley Road and the truck loading warehouse/office building and in the immediate area along the southeast side of the building. This covered an area from the former USTs (the source area) to the railroad tracks (Figure 2). An 18-inch steel culvert approximately 50 ft south of the main GPR study area was also examined as part of this investigation. This steel culvert was used for depth of penetration calibration.

The survey consisted of two separate grid areas (Figure 2). One grid area was established in the front yard of the H&H site as a 50 foot by 50 foot grid oriented N30°W (magnetic). For this grid the GPR traverses were conducted in northeasterly and southeasterly directions with 50 foot and 10 foot spacing, respectively. The second grid area was located to the rear of the facility and had GPR traverses spaced 20 ft apart with perpendicular orientation to the southeast wall of the truck

GEOPHYSICAL INVESTIGATION PROCESS

loading warehouse/office building. For the 18-inch steel culvert, two short traverses were oriented perpendicular to the culvert.

Technology Justification

The objective of the geophysical investigation was to determine the topographic relief of the clay layer and whether it was continuous across the site. GPR was considered to be an ideal method for being effective in detecting the clay since the average depth to be surveyed was between 0 and 15 ft bgs.

GEOPHYSICAL FINDINGS

Technology Calibration [1]

Boring log information and an onsite steel culvert were used for depth of penetration calibration.

Investigation Results [1]

Close examination of the 85 GPR profiles revealed a minimum of four reflectors that could be identified on most of the traverse profiles that were generated. These four reflectors were interpreted to represent the top of the silty clay layer surfaces within the transitional zone of the upper portion of the Presumpscot Formation.

The uppermost reflector was found at about 6 ft bgs at the location of MW-106. This was identified on most of the data profiles performed at the site. This uppermost reflector is interpreted to be a silty clay layer within the upper part of the Presumpscot Formation. The surface of this uppermost silty clay reflector generally slopes westward below the survey area at a rate of 5.5 ft per 100 ft. A local topographic low near the western corner of the leachfield exists at approximately 19 ft bgs. This topographic low exists approximately 10 ft below the elevation of the clay surface at the eastern edge of the survey area. Interpretation of data suggested that the topographic low could be part of a trough that trends in a southerly direction. Unfortunately the survey did not extend far enough westward to define the shape of the clay surface in the vicinity of monitoring wells MW-205A, and MW-205B. This was due to the swampy conditions in this area that would not allow access with the GPR equipment.

The depths to the top of the uppermost reflector were tabulated in nanoseconds of two-way travel time. Travel times were then converted to depth using a conversion factor of 5.75 nanoseconds per foot of depth. Depth in feet was then converted to elevation and an interpretive map of elevation contours of the uppermost reflector was created (Figure 3).

Examination of the data collected from the two traverses above the steel culvert indicated that the culvert is not surrounded by transmissive sands and gravels that would act as pathway for groundwater migration. It is thought that the culvert is most likely surrounded by compacted fill.

GEOPHYSICAL FINDINGS

The general conclusion after examining the GPR results was that there was an observed parallel relationship of the various layers of sand, silt, or clay that are present within the shallow subsurface soils of the Presumpscot Formation. This suggested that the topography of the interpreted layer mimics the topography of the top surface of the massive silty clay found at approximately 19 to 22 ft bgs in the area of the GPR survey. Based on this survey and subsurface explorations, the marine clay formation appears to be continuous across the study area. If present, DNAPL could move downslope along the top surface of the silty clay layers and accumulate in the topographical low areas, such as the low area identified near the southwest corner of the leachfield.

Results Validation

Confidence in the level of accuracy of the GPR data was verified through later investigations and comparisons to soil boring data. A digital model created from the soil boring data would produce the same shape when compared with the GPR data [6]. This confirms the results of the GPR survey that the clay formation appears to be continuous across the study area.

An extraction well (EW-401) was installed in November, 1994 at a location previously determined from the GPR survey to be a topographic low point on the upper surface of the clay formation [4]. PCE was found as a DNAPL along with other VOCs at this well; this confirmed that the location identified by the GPR survey was a topographic low point where DNAPL might accumulate.

GEOPHYSICAL FINDINGS

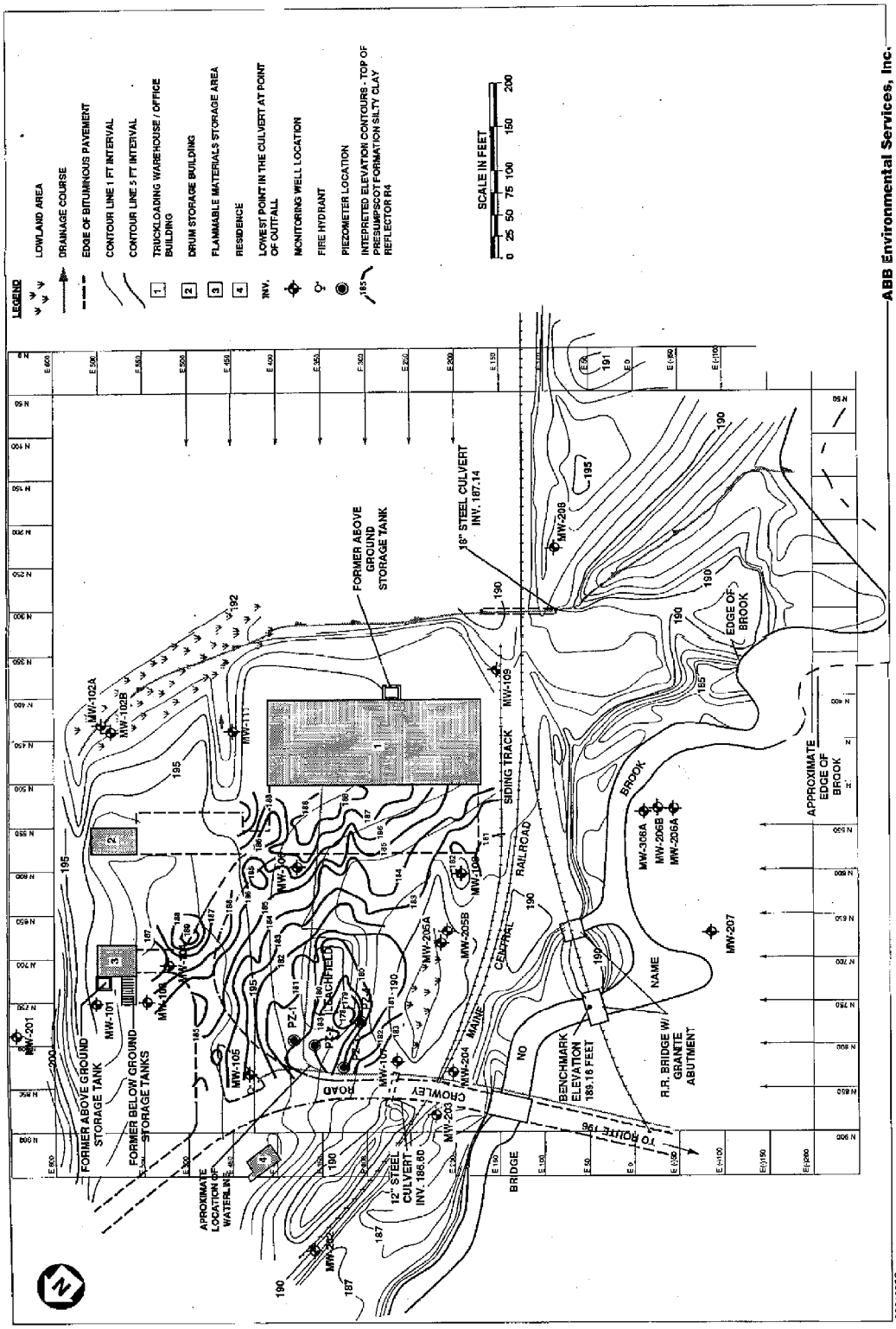

Figure 3: Interpreted Elevation Contours of the Top of Presumpscot Formation (Silty Clay Reflector R4) [1]

LESSONS LEARNED

Some of the lessons learned during this investigation include:

- Overall, the GPR survey was an effective tool for identifying continuous reflectors that represented silty clay layers in the shallow subsurface soils beneath the site [6]. The confidence level of the decisionmakers in the results was high. Confidence in the level of accuracy of the GPR data was verified through later investigations and comparisons to soil boring data.

- Penetration of the GPR survey was limited on the southeast side of the truck loading warehouse/office building, since it did not identify subsurface reflectors. This is interpreted as a result of the presence of dense fill that lies above the massive silty clay near the ground surface [1].

- As a result of the GPR survey, the surface of the clay layer underneath the site was mapped, and the topographic low point of the upper surface was determined. This low point was chosen as a location to install an extraction well, since this would be a potential area where DNAPL might pool. DNAPL was encountered during the installation of the extraction well, as suspected [4].

REFERENCES

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- ABB Environmental Services, Inc. *Site Investigation Report Addendum.* Prepared for Ciba-Geigy Corporation, Hamblet & Hayes Site, Lewiston, Maine. March 1993.
- ABB Environmental Services, Inc. *Work Plan: Well Installation and Decommissioning.* Prepared for Ciba-Geigy Corporation, Hamblet & Hayes Site, Lewiston, Maine. August 1994.
- ABB Environmental Services, Inc. *Work Plan: Well MW-408A Investigation and Dense Non-Aqueous Phase Liquid Assessment.* Prepared for Ciba-Geigy Corporation, Hamblet & Hayes Site, Lewiston, Maine. February 1995.
- Personnel Communication with Mr. Peter J. Blanchard of the Maine Department of Environmental Protection. September 3, 1998.
- Personnel Communication with Mr. Tom Smith of Ciba-Geigy. September 3, 1998.
- Personnel Communication with Mr. Stephen Walbridge of Harding Lawson Associates. September 18, 1998.