**PHASE III**
**ENVIRONMENTAL SITE INVESTIGATION**
**FORMER NEW HAVEN WATER COMPANY PROPERTY**
**HAMDEN, CONNECTICUT**

## EXECUTIVE SUMMARY

South Central Connecticut Regional Water Authority (RWA) retained Leggette, Brashears & Graham, Inc. (LBG) to perform an environmental investigation at the Hamden Middle School, athletic field, a portion of the Newhall Community Center and two residential properties (Middle School Site) which were formerly owned by the New Haven Water Company (NHWC). RWA is the successor to the NHWC. The investigation was completed to evaluate environmental conditions and compares concentrations of regulated substances to the Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs) and respond, in part, to CTDEP Order No. SRD-128.

The Middle School Site is located in an area formerly known as the Highwood District. As with much of the Highwood District, most of the Middle School Site was filled during the development of the area. The filling of the Highwood District, and the Middle School Site, occurred over a long period of time, and consisted of several different filling events. Through several transactions, NHWC owned portions of the Middle School Site from 1900 to 1950. The first documented filling of the Hamden Middle School was identified in 1925. The dumping/filling area was referenced to be operated by Winchester Repeating Arms. Prior to filling of the Middle School Site, a significant amount of filling had already occurred in the Highwood District. Areas of documented fill occurred throughout the entire region through the construction of roads, public and private dumping grounds and planned filling areas. In the late 1800s and early 1900s, the Highwood District was a dumping ground for New Haven. During 1917, the Town of Hamden maintained a dump in the Highwood District area which was located on Shelton Avenue between Morse and Goodrich Streets. The block surrounded by Edwards Street, Saint Mary Street, Morse Street and Goodrich Street was reportedly filled in by Winchester Repeating Arms during World War I (1914 – 1918). Filling outside of the Middle School Site continued until at least 1940. Filling of the Middle School Site continued into at least the 1980s.

From the 1970s through 1990s, several environmental investigations were completed by the United States Environmental Protection Agency (USEPA) and CTDEP at the Hamden Middle School property. Remedies to address environmental concerns identified by these agencies were implemented in 1995 and 1996 by the Town of Hamden. Preliminary environmental work completed for the expansion of the Middle School in 2000 created a renewed environmental awareness with the CTDEP of the historic waste present at the school.

Between July 15 and November 11, 2002, LBG completed extensive field investigations at the Middle School Site consisting of 70 soil borings, excavation of 8 test pits, collection and analyses of 105 soil samples, installation of 24 monitor wells and collection and analyses of 32 ground-water samples. Soil and ground-water samples were analyzed for pesticides, total and synthetic precipitation leaching procedure (SPLP) metals and cyanide, total and SPLP polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-VOCs (SVOCs) and extractable petroleum hydrocarbons (ETPH). Ground-water samples were also analyzed for herbicides and landfill leachate parameters.

The results of the field investigation identified filled areas at the Middle School Site were overlain with a sand, silt and gravel cover material. In general, the athletic field has between 2 and 4 feet of cover material. Small areas of shallower coverage are identified on the northwestern portion of the property. The remaining portion of the Middle School Site has approximately 1 to 2 feet of cover material. Areas of less than 1 foot of cover material are present in small areas near the north central site boundary, eastern central boundary and south central boundary. The cap, while not fully compliant with RSR criteria, successfully prevents contact with the underlying soil.

Unconsolidated materials beneath the protective cover material were identified to consist of four primary materials; black matrix fill/industrial waste, construction debris, domestic municipal waste and a non-fill consisting primarily of sands and silt. The fill material was identified to be as much as 22 feet thick and to be underlain by an organic silt and clay layer and/or materials consisting primarily of sands and silt. This layer is related to the former wetlands that were filled.

Regional and the site ground-water flow was determined to flow from the east to the west/southwest. This flow path would support a ground water classification change to GB. Existing GB areas are very close to the site.

The site is currently classified as "GAA" and the land use is consistent with Residential Direct Exposure Criteria (RDEC). In addition to comparing soil sample results to GA Pollutant Mobility Criteria (PMC) and RDEC, soil sample results were compared to the 10 times the GA PMC and/or 10 times the Groundwater Protection Criteria (GWPC), GB PMC, and industrial/commercial (I/C) DEC criteria. This is important because, 1) the RSRs allow 10 times the GA PMC for substances analyzed for total (mass) concentration and 10 times the GWPC for substances analyzed by SPLP to be utilized under certain conditions (which are met for this site), 2) the ground-water flow data show that the site is a strong candidate for reclassification to GB, and 3) future use of the site may reasonably allow for I/C DEC to be applied.

The table below summarizes the quantity of soil samples analyzed for each compound group and quantity which exceeds applicable criteria. Each parameter that was identified to exceed RSR criteria is shown below:

| | Quantity of Soil Samples Analyzed | Quantity Detected | Quantity Exceed RDEC | Quantity Exceed I/C DEC | Quantity Exceed GA PMC | Quantity Exceed GB PMC | Quantity Exceed 10 Times GWPC and/or GA PMC |
|---|---|---|---|---|---|---|---|
| Pesticides | 105 | 12 | 0 | 0 | 0 | 0 | 0 |
| Arsenic | 105 | 51 | 34 | 34 | NA | NA | NA |
| Antimony | 105 | 92 | 13 | 0 | NA | NA | NA |
| Copper | 105 | 32 | 10 | 0 | NA | NA | NA |
| Lead | 105 | 105 | 36 | 24 | NA | NA | NA |
| Mercury | 105 | 65 | 3 | 0 | NA | NA | NA |
| SPLP Antimony | 61 | 19 | NA | NA | 19 | 5 | 5 |
| SPLP Arsenic | 60 | 14 | NA | NA | 14 | 3 | 3 |
| SPLP Cadmium | 60 | 2 | NA | NA | 1 | 0 | 0 |
| SPLP Lead | 61 | 46 | NA | NA | 41 | 7 | 7 |
| SPLP Mercury | 63 | 10 | NA | NA | 3 | 0 | 0 |
| SPLP Nickel | 60 | 37 | NA | NA | 8 | 2 | 2 |
| SPLP Zinc | 63 | 63 | NA | NA | 5 | 0 | 0 |
| PCBs | 105 | 11 | 0 | 0 | NA | NA | NA |

| | Quantity of Soil Samples Analyzed | Quantity Detected | Quantity Exceed RDEC | Quantity Exceed I/C DEC | Quantity Exceed GA PMC | Quantity Exceed GB PMC | Quantity Exceed 10 Times GWPC and/or GA PMC |
|---|---|---|---|---|---|---|---|
| SPLP PCBs | 8 | 0 | NA | NA | 0 | 0 | 0 |
| SVOCs | 105 | 51 | 32 | 18 | 36 | 33 | 4 |
| ETPH | 105 | 87 | 28 | 18 | 32 | 21 | NA |
| VOCs | 105 | 24 | 0 | 0 | 0 | 0 | 0 |

Note: The exceedances of the GB PMC shown above does not adjust for samples collected below the seasonal high water table.
NA = Not Applicable

Metals (primarily arsenic and lead), SVOCs and ETPH are the groups of parameters present at the site above the RDEC. A significant reduction in occurrences is not shown when implementing the I/C DEC; however, an ELUR with 2 to 4 feet of clean cover material would address the exceedances. The distribution of the DEC exceedances is throughout the site; however, they are away from the site boundaries. When utilizing self implementing option in the RSRs (10 time the GWPC and/or GA PMC), only ETPH is identified above PMC in abundance.

Pesticides, herbicides and PCBs were not detected in the ground water. The table below summarizes the quantity of parameters detected in the ground water at each monitor well that exceeds CTDEP RSR criteria.

| | Quantity of Wells Identified with Detection | Quantity Exceed GWPC | Quantity Exceeds Residential Volatilization Criteria | Quantity Exceeds Industrial/ Commercial Volatilization Criteria | Quantity Exceed CTDEP RSR Criteria with GB Classification Change |
|---|---|---|---|---|---|
| Lead | 13 | 2 | 0 | 0 | 0 |
| Barium | 23 | 5 | 0 | 0 | 0 |
| SVOCs | 6 | 5 | 0 | 0 | 0 |
| ETPH | 7 | 7 | 0 | 0 | 0 |
| Halogenated VOCs | 5 | 5 | 1 | 1 | 1 |
| Aromatic VOCs | 12 | 4 | 0 | 0 | 0 |

Note 4 of the 6 SVOC detections were identified to be bis(2-ethyl hexyl)phthalate, which is a common laboratory and field artifact.

While lead, barium, SVOCs, ETPH and aromatic VOCs were identified above the GWPC, no CTDEP RSR exceedances with respect to ground water for these compounds are identified if the site is reclassified to GB.

Of the halogenated VOC detections, trichloroethylene, (trans) 1,2-dichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were all detected in the ground water samples collected from the LBG-MW-7 cluster (west side of athletic field tennis courts). Trichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were all detected in the saturated and unsaturated soils near LBG-MW-7A. This location is presumed to be the source area of the halogenated VOC occurrences in the site ground water. The historic halogenated VOC plume was identified to be migrating to the west/southwest. The migration pathway of the halogenated VOC plume confirms that the ground water at the Middle School Site discharges to the southwest.

Vinyl chloride was identified above the Residential Volatilization Criteria at LBG-MW-7A (near the tennis courts). No other exceedances of the Volatilization Criteria were identified.

## 1.0 INTRODUCTION

South Central Connecticut Regional Water Authority (RWA) retained Leggette, Brashears & Graham, Inc. (LBG) to perform an environmental investigation at the Hamden Middle School, athletic field, a portion of the Newhall Community Center and two residential properties (Middle School Site) which were formerly owned by the New Haven Water Company (NHWC). RWA is the successor to the NHWC. The individual properties included in the Middle School Site are located at 550 – 560 Newhall Street (Hamden Middle School and athletic field), 496 Newhall Street (Hamden Community Center) 249 – 255 Morse Street (two Town of Hamden owned residential properties) in Hamden, Connecticut (figure 1 and plate 1).

The goal of the investigation was to evaluate environmental conditions and compare concentrations of regulated substances to the Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs). The investigation also responds, in part, to CTDEP Order No. SRD-128, which requires the investigation and remediation of historical fill areas in the Newhall Street area of Hamden, Connecticut. The environmental investigation was completed in accordance with the August 19, 2002, "Revised Work Plan Former New Haven Water Company Property Hamden, Connecticut." Note that the work plan was revised to incorporate comments of the CTDEP.

## 2.0 BACKGROUND

The Middle School site is located in an area formerly known as the Highwood District. As with much of the Highwood District, most of the Middle School Site was filled during the development of the area. The filling of the Highwood District, and specifically Middle School Site, occurred over a long period of time, and consisted of several different filling events.

From the 1970s through 1990s, several environmental investigations were completed by the United States Environmental Protection Agency (USEPA) and CTDEP at the Hamden Middle School property. Remedies to address environmental concerns identified by these agencies were implemented in 1995 and 1996 by the Town of Hamden. Preliminary environmental work completed for the expansion of the Middle School in 2000 created a renewed environmental awareness with the CTDEP of the historic waste present at the school.

Excluding an approximate 1.4-acre parcel consisting of 249 – 255 Morse Street (two Town of Hamden owned residential properties) and a portion of the Newhall Community Center, NHWC acquired the Middle School Site in 1900. NHWC sold an approximate 1.4 acre rectangular parcel located on the southeast portion of the Middle School Site to the Town of Hamden in 1924, while NHWC acquired the approximate 1 acre rectangular parcel that included the two town owned residential properties (249 – 255 Morse Street). In 1947, NHWC sold approximately 6.2 acres of land to the Town of Hamden. This parcel abuts the community center, Newhall Street and Mill Rock Extension. NHWC sold the remaining portion of the Middle School Site to the Town of Hamden in 1950.

A summary of the environmental investigations completed at the Middle School Site and the historic filling and development of the Middle School Site and surrounding area is presented below. The summary of the historic filling and growth of the Highwood District was developed through review of historical maps, aerial photographs, materials available at Hamden Town Hall (aerial photographs, Sanborn maps, annual reports, tax assessor cards, etc.), maps and literature reviewed at the Miller Historic Room in Town of Hamden Library, historic NHWC documents, Town of Hamden Sanitation Inspector Reports and communications provided by the CTDEP.

## 2.1 Filling and Development Summary of Middle School Site and Surrounding Area

The Highwood District area was settled in at least 1850. The 1850 map, located in Appendix I, shows this area to be sparsely developed with a stream extending from the wetlands that currently end on the northern boundary of the Hamden Middle School property. Historical maps presented in Appendix I show the 1850 stream located on the northeast portion of the Hamden Middle School property, extending through future locations of Rochford Field and Mill Rock Park and ending near the westerly edge of Prospect Court (figure 11 of Appendix I).

Moderate development was shown in the Highwood District from the mid to late 1800s (figures 1 through 3 of Appendix I). During the turn of the century, the area was utilized for farming (ref. 1). The United States Geological Survey (USGS) 1892 New Haven, Connecticut Quadrangle Map (Appendix I) shows a greater density of roads present, which more closely mirror the present road system of the area.

Wetlands remained a prominent feature in the Highwood District and their presence represented a significant breeding ground for mosquitoes (ref. 2). The large populations of mosquitoes in the area were identified as a contributing factor to an 1891 epidemic of malaria in the Town (ref. 2). During this period and through the turn of the century, the Highwood District was a disposal area for trash brought in from New Haven (ref. 1 and 3). This garbage was reportedly fed to swine (ref. 3). The dumping created a significant nuisance in the area; the odor of the garbage was noted to create a stench a mile in every direction of the disposal area. In addition to the dumping areas, sewage in this farming community was utilized as fertilizer (ref. 1). The dumping in the area continued through 1909 (ref. 4). To alleviate the disposal problems, the Town of Hamden Health Officer, along with several others, informed the New Haven Board of Health that due to numerous complaints concerning the disposal of garbage in the Town, no licenses would be issued after June 1, 1909. The 1909 Hamden Annual Report indicates that only two collectors were known to be bringing garbage into the town and those cases were to be dealt with (ref. 4).

Development of the Highwood District continued at a rapid pace through the early 1900s (ref. 5). In 1913, a section of Newhall Street between Auger and Morse Streets was hardened, with a sidewalk constructed along the west side (ref. 6). A 1914 map (figures 5 and 6 of Appendix I) of the area shows an increased density of dwellings. The map also shows areas of vegetation present on the northern side of Morse Street, approximately between Shelton Avenue and Wadsworth Street (figure 11 of Appendix I).

A moderate epidemic of typhoid fever occurred in the Highwood District in 1912 (ref. 6). To avoid the epidemic in 1913, the health officer distributed notices to every home in the Highwood District notifying them how to control the disease. The notice indicated that flies spread the disease and that they should be controlled by cleaning out privy vaults before hot weather arrives and should be regularly spreading ashes, crude carbolic acid and chloride of lime on it. Mosquitoes were also a problem of the area; the Hamden Health Officer reported in the 1913 Hamden Annual Report that he would try to have swamps near Newhall Street, Auger Street and Putnam Avenue drained and opened to sunlight (ref. 6).

During 1915, the State of Connecticut took an active role in controlling the mosquito population in the state by passing Chapter 264 of Public Acts of 1915. The legislation placed the problem of mosquito extermination in the hands of the Directors of The Connecticut Agriculture Experiment Station giving almost unlimited powers to carry on surveys and field work, ditching, etc.; however, the legislation failed to provide funds for the act (ref. 7). During this time, the mosquito population remained a concern of town officials for the area.

In 1915, when Town officials learned of Winchester Repeating Arms looking for dump sites for the "rejected industrial refuse and the thousands of tons of clean cinders from the furnaces in the factories", the Town gave permission for the company to fill in a marshy tract near Goodrich Street and Saint Mary Street. The area was reported to have been filled in a period of a few years (ref. 2).

The Town of Hamden Health Officer proposed in 1915 to establish Town public dumping areas under the control of Town officials and requested citizens to report infringements of the ordinance pertaining to the dumping (ref. 7). The 1916 Hamden Annual Report indicates that strived were made with respect to mosquito control by filling an area near the corner of Saint Mary and Morse Streets (figure 6 of Appendix I). Also in 1916, the NHWC and Winchester Repeating Arms were engaged in eliminating the largest single malaria swamp breeding grounds in the Town of Hamden by draining a large tract of land. The location of the tract of land was not identified in the annual report (ref. 8).

During 1917, the Town of Hamden maintained a dump in the Highwood District area (ref. 9) which was located on Shelton Avenue between Morse and Goodrich Streets (figure 11 of Appendix I). Also in 1917, the Town of Hamden installed a drain near Saint Mary and Goodrich Streets to alleviate surface water ponding; the drain discharged into the far corner of the Newhall Street swamp (ref. 10). Other notable events included the partial construction of the current Newhall Community Center in 1917. The block surrounded by Edwards Street, Saint Mary Street, Morse Street and Goodrich Street was reportedly filled in by Winchester Repeating Arms during World War I (1914 – 1918) (ref. 11). In 1919, Morse, Saint Mary and Edwards Streets were raised and sewer lines were installed, presumable when filling was completed in this area (ref. 12 and figure 7 of Appendix I)). Also in 1919, at the request of the Town Health

Authorities, NHWC started clearing the approximate 30-acre Newhall Street Swamp. The clearing was requested because Town Health Authorities indicated the swamp was responsible for a great deal of malaria in the area. NHWC agreed to clear the brush and reopen the main drainage ditch to it (ref. 13).

By 1919, a significant amount of filling had already occurred in the Highwood District. Areas of documented fill occurred throughout the entire region through the construction of roads, public and private dumping grounds and planned filling areas. The stream identified in the 1850 and 1852 maps is not shown on maps, but remained as a swampy area north of Morse Street. The filling in of the Highwood District continued; however, as shown by the 1924 Sanborn Maps (Appendix I), structural development of the area was primarily complete with the exception of the areas surrounding the former 1850 stream. While roads were constructed on land crossing the former streams, no structures are identified on this land. The headwater area of the 1850 stream was part of a golf course used by Yale students during the early 1900s (ref. 11). It is unclear if any filling occurred during this period to make the land more suitable for this purposes.

By 1924, the southwestern portion of the Highwood District contained a high-density structures. Excluding 249 – 255 Morse Street (Town of Hamden residential housing), information contained in tax cards at Hamden Town Hall indicate all housing on the northern side of Morse Street which abuts the Hamden Middle School athletic field were constructed. Another highly developed area is the western side of Newhall Street, just north of Mill Rock (ref. 14).

By 1925, the swamp area near Newhall Street was identified as the Newhall Street dump by Walter Conner of NHWC in a January 1925 report. The dump was referenced to be operated by Winchester Repeating Arms (ref. 15). This is the first reference to filling of the Middle School Site identified during this investigation. The Town of Hamden Health Officer promoted dumping in wetlands as noted by conclusions in the 1925 Hamden Annual Report (ref. 16) which stated "The establishment of so-called dumps for wastes of all kinds would be far more sanitary and economical, in that such dumps can be located on waste land, swamps, etc., thereby eliminating breeding places and creating play-grounds and public parks, much needed in this community."

By 1933, development of the Highwood District is nearly complete (figure 7 of Appendix I). The only significant region not completely developed is the area of the former 1850 stream. By 1933, the road system south of Mill Rock was nearly identical to the current road system, with the exception of a missing section of Bryden Terrace. As shown in the 1934 aerial photograph (figure 8 of Appendix I), filling appears to have occurred in Rochford Field and on the eastern portion of the Hamden Middle School property. The 1934 photograph shows evidence of the stream or wetland area crossing from the school property toward future Rochford Field. It is completely filled by 1939 (figure 9 of Appendix I). Rochford Field was completed by 1939. The 1939 aerial photograph also shows some filling had occurred in the Mill Rock Park area. This aerial photograph shows no remnants of the 1850 stream east of Newhall Street. The 1940 aerial photograph is similar to the 1939 photograph (figure 10 of Appendix I).

Other than on the Hamden Middle School property, the 1949 and 1951 aerial photograph (figures 13 and 14 of Appendix I) shows no evidence of new filling occurring in Highwood District. As discussed above, NHWC sold its remaining portion of the Middle School Site to the town of Hamden in 1950. Prior to the start of construction of the school in 1955, the Hamden Middle School property was filled with industrial material from Winchester Repeating Arms and illegal dumping of domestic waste (refs. 17 and 18). However, predominant filing material up to the early 1950s consisted of the industrial waste from Winchester Repeating Arms (ref. 18). The Michel J. Whalen Middle School was constructed in 1955 (ref. 19). After the construction of the school, the primary fill at the Middle School Site consisted of construction/building debris with sands and silt, incinerator ash and burn pit ash from the school and domestic waste (ref. 20 through 26). Ash from the school was generated from the interior incinerator operated in 1957 (ref. 20) and an exterior incinerator/burn pit operated from 1958 until at least 1965 (ref. 21, 22, 23 and 24). The construction/building debris may have been deposited by the Town of Hamden Department of Public Works (ref. 19). The department promised they would bulldoze the rear of the school property and cover it with adequate dirt in 1957 (ref. 20).

As shown in 1963 aerial photographs (figure 17 of Appendix I), all filling in the Highwood district is complete, with the exception of the Middle School Site. Areas of dense vegetation remain along the boundaries of the Athletic Field, and filling still appears to be occurring along the north-central boundary of the property.

Dumping of refuse behind the Hamden Middle School property was reported to have occurred as late as 1971 (ref. 25). Filling activities continued behind the school through the late 1970s (ref. 26). Reportedly large amounts of "acidic soils" were removed from behind the school and replaced with approximately 100,000 yards of “clean fill” from the West Woods school site.

The 1980 aerial photograph (figure 19 of Appendix I) shows the Middle School Athletic Field to be completely cleared. A pond is evident on the northwestern portion of the Middle School Site. It appears that the pond identified in the 1980 aerial photograph is filled by 1991 (figure 21 of Appendix I).

A minimum of 18-inches of gravel cover material was placed on the Hamden Middle School athletic field during 1995 as part of a lead encapsulation project (ref. 27). An additional 6-inches of top soil was placed throughout the athletic field in 1996 (figure 19 of Appendix I) (refs. 28 and 29).

## 2.2 Investigation History at Middle School Site

The list below presents a chronology of events and historic environmental investigations and actions for the Hamden Middle School property. The results on these investigations identified the presence of metals, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs) and total petroleum hydrocarbons in the subsurface material of the athletic field. Of these constituents, various metals, SVOCs and total petroleum hydrocarbons were identified above the CTDEP RSRs Residential Direct Exposure Criteria (RDEC) and GA Pollutant Mobility Criteria (PMC). The results of the available analytical data from environmental investigations are presented on the included MS Access database (CD) and in Appendix II.

| | |
|---|---|
| 1979 | Local resident notifies Quinnipiac Health District of sunken areas on the playing field and history as disposal area. |
| 1979 | CTDEP collects 2 soil samples; locations and results were not identified for review. |
| 1985 | CTDEP completes Preliminary Assessment (PA) for Michael Whalen Jr. High School. Black material found on athletic field behind school. PA results identify metals in shallow soils. |
| 1987 | USEPA Site Discovery. Site added to CERCLIS List, No. CTD98254435. |
| 1987 | Site added to State Inventory of Hazardous Waste Disposal Sites. |
| 1989 | NUS corporation, on behalf of the USEPA conducts site investigation (SI) in which 11 shallow soil samples are collected between 0.5 and 1.5 ft bg (feet below grade) and analyzed for priority pollutant metals and VOCs. The results identify arsenic and lead detected above the CTDEP Residential Direct Exposure Criteria. Trichloroethane (TCE) and tetrachloroethylene (PCE) are identified in the shallow soils on the northwest portion of the Athletic Field. |
| 1991 | Final SI completed. Report indicates that field area was used for community dumping for several years between 1940s and 1950. Local health department officials allege this was a disposal area of old batteries by the Winchester Repeating Arms. |
| 1991 | Roy F. Weston, on behalf of the USEPA conducts shallow soil investigation. Twenty (20) shallow soil samples were collected and analyzed for nickel, lead, chromium, mercury semi volatile organic compounds and volatile organic compounds. The results identify chromium and lead above the CTDEP Residential Direct Exposure Criteria. |
| 1992 | Connecticut Department of Health Services (DOHS) letter to Quinnipiac Valley Health District states if athletic fields are kept grass-covered, they are safe for use. The DOHS used EPA lead exposure model assuming a concentration of 1600 parts per million (ppm) and children would be exposed 4-hours a day. |
| 1992 | USEPA determines that Removal Action is not appropriate because *"the amount, quantity, or concentration released does not warrant Federal response."* |
| 1993 | CTDEP recommends the Town of Hamden to complete an environmental investigation at the school property. The Town retains HRP to conduct soil sampling for possible addition of school. Six samples were collected from 0 to |

6 inches and four samples from 30 to 36 inches below grade. Lead detections ranged from 11.7 ppm to 5,680 ppm. Black ash-like material with traces of brick/wood pulp or cinders identified within the top 36 inches.

1993 HRP conducts shallow soil investigation in which 40 shallow soil samples were collected and analyzed for lead and/or leachable lead. The results identify lead above the above the CTDEP Residential Direct Exposure Criterion and GA Pollutant Mobility Criterion.

1994 CTDEP receives anonymous complaint about landfill adjacent to Hamden Middle School. The complaint states that it is common knowledge that ammunition, radioactive waste, and other waste are buried in landfill behind school. Rochford Field identified with similar problem.

1994 USEPA Final Site Inspection Prioritization (SIP) completed. SIP states recent excavation to install an elevator at the school exposed domestic waste below the ground surface.

1995 CTDEP Water Bureau receives call from former athletic coach recalling that standing "black water with unnatural characteristics" was present in the ball field. Athletic coach sent letter to CTDEP showing location of standing black water at the northwest corner of the athletic field.

1995 Cap material placed on athletic field. Cap consisted of a minimum of 18-inches of gravel and was placed by United Excavating for Town of Hamden.

1996 Additional 6- inches of top-soil placed over athletic field by Furrey, Inc for Town of Hamden.

2000 Phase I ESA completed by Town of Hamden Board of Education by Facility Support Services (FSS). The ESA noted the historical filling at the school.

2000 FSS conducts subsurface investigation in which 15 soil borings are drilled to depth ranging between 17 and 36.5 ft bg. Fill material was identified at depth starting at 2 and 3 ft bg, and extending to depths ranging from 7 to 26 ft bg. Forty-four (44) soil samples are collected and analyzed for total and TCLP metals, extractable total petroleum hydrocarbon, semi-volatile organic compounds, volatile organic compounds. The results of the investigation identified concentrations of various metals, SVOCs and extractable total petroleum hydrocarbon (ETPH) above the Residential Direct Exposure Criteria and GA Pollutant Mobility Criteria.

2000 FSS conducts investigation in which 23 soil-vapor samples are collected from beneath the school foundation and analyzed for methane, hydrogen sulfide and/or VOCs. The results identified methane beneath the boiler room in two locations above the lower explosion limit. The Phase II and subsequent investigations included the collection of soil-vapor samples from beneath the floor of the school during October, November and December 2000. As a result of the soil-vapor investigations, the Town of Hamden installed methane monitoring and ventilation equipment to address this area of concern.

2000 CTDEP collects 10 soil-vapor samples from beneath the Middle School. The samples identify low level aromatic hydrocarbons and methane.

2000 Emergency remedial measures were completed, which included installation of geotextile and earthen caps at three areas surrounding the school. The areas consisted of approximately 120,000 square feet.

2001 CTDEP supervised the drilling of 26 soil borings to a depth of 4 ft bg throughout the school athletic field. Twenty-six (26) surficial samples were collected from these borings at a depth of 0 to 6 inches below grade. The samples were analyzed for priority pollutant metals (PPM), barium and SVOCs. The results showed no exceedances of criteria in the CTDEP RSRs. Fill material was identified at 7 of the 26 soil boring locations. The results of this investigation showed that the depth of the "cap" at the athletic field ranged from approximately 1.5 ft bg to at least 4 ft bg.

2001 CTDEP collects 39 shallow (0-3 inch bg) soil samples from the southeastern portion of the athletic field. The results of this shallow soil investigation identified concentrations of arsenic, lead and SVOCs above criteria in the CTDEP RSRs on the southeastern portion of the athletic field and around the tennis courts. Emergency remedial measures were initiated and included fencing the southeastern area and covering this area with wood chips.

2001 CTDEP issued an Administrative Order to the RWA, Olin Corporation, Town of Hamden and the State of Connecticut Board of Education on July 10, 2001, which requires the investigation and remediation of the Middle School Site, the town-owned Rochford Field and Annex, and several areas which have been developed for residential use.

2001 The Town of Hamden contracted Haley & Aldrich to complete a Phase I ESA of the Middle School Site, the town-owned recreational properties and residential properties in the Newhall area.

2002 Haley & Aldrich draft ESA issued January 2002. As part of the ESA, six test pits were completed in August 2001 at the Middle School Site under the supervision of Haley & Aldrich. Fill material was encountered in all of the test pits and the base of the fill was observed at 2.5 ft bg to at least 7.3 ft bg. The fill material was observed to contain various industrial and domestic wastes.

## 3.0 REGULATORY ISSUES

The primary focus of this environmental site investigation is to gather information regarding the location and characteristics of fill material located at the former Middle School site, as well as determine potential impacts to soil and ground water. In addition, the environmental site investigation presented below was designed to determine potential avenues of compliance available within the CTDEP RSRs. Note that the sampling plan completed during this investigation did not focus on an assumed remedial action; however, it was designed to explore potential remedial options available in the CTDEP RSRs. The current ground-water classification beneath the site is GAA-impaired. For GAA-impaired areas, the following criteria in the RSRs apply:

### 3.1 Soils

Direct Exposure Criteria (DEC): The residential DEC is applicable to the top 15 feet of material at the site. It is important to characterize the top 4 feet of material due to options in the RSRs. With an environmental land use restriction (ELUR), only the top 4 feet of soil must comply with the residential DEC. If the soil is capped with a certain thickness of pavement (with an ELUR in place), only the top 2 feet must comply.

Pollutant Mobility Criteria (PMC): The GA PMC apply to soils above the water table. For all parameters except metals, the listed criteria are based on total (mass) concentrations of the parameter in the soil. For metals, the remediation criteria is based on the results of a leaching test, typically the synthetic precipitation leaching procedure (SPLP). For the other parameters, SPLP analyses can also be run and compared to GA ground-water protection criteria (GWPC); however, the total concentrations are usually determined first.

With an ELUR, the DEC and PMC do not apply beneath a building (except for VOCs that exceed the PMC).

## 3.2 Ground Water

Ground-Water Protection Criteria: The GWPC apply to ground water beneath the site, and are generally consistent with drinking water standards.

Surface Water Protection Criteria (SWPC): The SWPC apply to ground water prior to it discharging into a surface-water body.

Residential Volatilization Criteria (RVC): The RVC apply to VOC concentrations in ground water within 15 feet of the ground surface. Note that the CTDEP is currently re-evaluating the Volatilization Criteria. The CTDEP reports that numerical criteria are likely to be lowered for many constituents and apply to ground water at depths greater than 15 feet. Compliance of RVC can also be met with analysis of VOCs in soil-vapor beneath a building. Compliance with the RVC for soil vapor may also be met through interior air sampling, calculating site-specific volatilization criteria or implementing an ELUR.

## 3.3 Alternatives

For all of the criteria listed above, there are numerous exemptions and alternative criteria that can be applied. Those exemptions and alternatives that are most frequently discussed in this report are as follows:

With an ELUR, the Industrial/Commercial (I/C) DEC can be applied to site where access is limited and future land use is industrial or commercial. In certain situations, the

CTDEP allows changes in ground-water classification from GA/GAA to GB. This removes GWPC as a standard and changes the GA PMC to GB PMC.

For soils contaminated with metals, SVOCs PCBs and pesticides, the mass analysis may be compared 10 times the GA PMC or SPLP analysis may be compared to 10 times the GWPC if the following conditions are met: 1) the release area is within 25 feet from the nearest legal boundary; 2) no non-aqueous phase liquids are present; and 3) the water-table is at least 15 feet above the surface of the bedrock. All of the aforementioned conditions are met at the site and this option is self implementing.

## 4.0 FIELD INVESTIGATION

Between July 15 and November 11, 2002, LBG completed extensive field investigations at the Middle School site consisting of 70 soil borings, excavation of 8 test pits, collection and analyses of 105 soil samples, installation of 24 monitor wells and collection and analyses of 32 ground-water samples. Tables 1 and 2 presents a summary of all samples collected and analyses performed.

The field investigations presented below was conducted to investigate the environmental condition at the formerly owned NHWC properties, which constitute the Middle School Site (figure 1 and plate 1). This work was completed in a phased approach so that sample points would be optimally located. The purpose of the initial investigation was to identify the extent and quality of the fill material, determine a ground-water flow direction and identify the general ground-water quality at the subject property. The data gathered from the initial investigation was utilized to expand the initial monitor well network during the second phase of the investigation, identify locations of test pits for the further defining characteristics of fill material and identify locations of any potential additional test borings to define the limits of fill at the Middle School Site.

Photographs were taken of nearly all soil samples inspected during each of the investigations. Select photographs of soil samples, test pits and test pit artifacts are presented in Appendix V. All photographs are stored on the attached CD.

All excess soil cuttings generated were containerized in 55-gallon drums and disposed of at Northland Environmental, Inc. facility in Providence, Rhode Island. The top four feet of all soil borings and test pits were filled with either top soil brought from offsite, Filtersil sand or grout/bentonite.

All Quality Assurance/Quality Control protocols presented in the August 19, 2002, "Revised Work Plan Former New Haven Water Company Property Hamden, Connecticut" were adhered to during the investigation.

## 4.1 Drilling of Soil Borings and Installation of Monitor Wells

### 4.1.1 Initial Phase Investigation Drilling Program

Between July 15 and July 19, 2002 LBG completed the drilling portion of the initial field investigation. The initial investigations included the drilling of 35 soil borings, collection and analyses of 100 soil samples and installation of 6 monitor wells. Table 1 presents a summary of the samples collected and analyses performed.

Table 3 contains a summary of monitor well and soil boring depths and/or construction of the 35 test borings (LBG-TB-7 through LBG-TB-18 and LBG-TB-26 through LBG-TB-29) that were drilled by Zebra Environmental of Lynbrook, New York using the direct push method (Geoprobe drill rig). The remaining 19 soil borings (LBG-MW-1 through LBG-MW-6, LBG-TB-1 through LBG-TB-6 and LBG-TB-19 through LBG-TB-25) were drilled by SoilTesting, Inc. of Oxford, Connecticut with a hollow stem auger drill rig. Six of the soil borings (MW-1 through MW-6) were completed as monitor wells (table 3 and plate 2). During the initial investigation, all soil borings were drilled to at least 3 feet below the base of the identified fill and each boring was drilled to a minimum of 12 ft bg.

With exception of the soil borings completed as monitor wells, soil samples were collected continuously at all soil boring locations until completion. Soil samples were collected continuously at soil borings completed as monitor wells until at least 20 ft bg and at minimum 12 feet below the identified fill interface.

At soil borings drilled by the direct push method, soil and fill samples were collected utilizing a 2-inch outer diameter, 4-foot long steel Macrocore sampler containing an acetate liner.

At soil borings drilled with the hollow stem auger, soil and fill samples were collected utilizing a 4-inch or 2-inch outer diameter (dependant on recovery), 2-foot long split spoon. Split spoons were decontaminated before and between each use. Decontamination procedures included brushing with an Alconox wash and rinsing with deionized water.

Soil samples collected from split spoons and Macrocores were logged, photographed and then placed into dedicated, sealed plastic bags. The resultant headspace within each plastic bag was screened for the presence VOCs with use of a photoionization detector (PID) that was calibrated to an isobutylene standard. No VOCs were measured above 10 ppm in any soil samples except from the following soil borings; LBG-TB-4, LBG-TB-5, LBG-TB-19, LBG-TB-20, LBG-TB-22, LBG-TB-23 and LBG-TB-25. No VOCs were measured above 28 ppm in any of the soil samples screened from LBG-TB-4, LBG-TB-19, LBG-TB-22, LBG-TB-23 and LBG-TB-25; while peak VOC concentrations were measured to be 43 ppm and 66.7 ppm in soil samples collected from LBG-TB-5 and LBG-TB-20, respectively.

Geologic logs were completed for each boring and soils were logged in accordance with ASTM D 2488 and ASTM D 2487. The PID readings are included in the logs. Geologic Logs are presented in Appendix III.

The top two feet of material at the subject property has been extensively characterized by the CTDEP and determined not to present an imminent health risk. Therefore, soil samples collected from the top 2 feet were only collected for analyses if waste fill material was identified. The protocol for collecting soil samples for analyses is shown below:

1) 0 to 2 ft bg (only fill: no sample collected if fill is not encountered);
2) 2 to 4 ft bg (fill or native soil sample);
3) 4 ft bg to 10 ft bg (only fill: no sample collected if fill is not encountered);
4) 10 ft bg to end of fill (only fill: no sample collected if fill is not encountered); and
5) Unconsolidated material underlying fill material.

If no waste fill was identified in the boring, then only 1 sample (interval 2) was collected for analyses. If no waste fill was identified in intervals 1, 3 or 4, then only 2 samples (interval 2 and

5) were collected for analyses. If no waste fill was identified in interval 3 or 4, then only 3 samples (interval 1, 2 and 5) were collected for analyses.

The native soil/waste fill sample within each interval measured with the highest VOC concentration was chosen for analyses from the top four intervals. If no PID readings were detected, the sample identified with the greatest degree of staining and/or odor was sent from these intervals for analyses. The purpose of the bottom sample analyses was to define the vertical limit of impacts; therefore, this sample was collected at a depth that appeared not to be contaminated (i.e. no PID detections, normal color, no odor, etc.).

All soil samples were analyzed for the following:

- VOCs by EPA Method 8021B;
- SVOCs (full list) by EPA Method 8270;
- CTETPH, Carbon Range and Oil Identification;
- Priority Pollutant Metals and barium (hexavalent chromium was replaced total chromium analyses);
- cyanide;
- pesticides by EPA Method 8081; and
- PCBs by EPA Method 8082.

Target metals identified in soil samples from above the seasonal low water-table greater than 1.5 times the local background concentrations identified during the 2001 USEPA Hamden Site investigation or average concentration of the element references found in uncontaminated soil in the Eastern United States (ref. 30) (whichever is lower) were analyzed by synthetic precipitation leaching procedure (SPLP) for the target metal. SPLP cyanide and SPLP PCB analyses were run on samples in which the constituents were detected. Note that the laboratory did not have enough sample material left to complete the SPLP PCBs analysis on LBG-TB-13 (2.7 to 3.1 ft bg) and LBG-TB-16 (1.1 to 1.5 ft bg).

All soil samples collected for analyses were containerized, properly labeled, and then placed into an ice-chilled cooler for pick up by York Analytical Laboratories (York) of Stamford, Connecticut for analysis. Table 1 presents a summary of all samples analyzed and analyses completed. In total, 100 soil samples were collected during the initial investigation for laboratory analyses. Laboratory reports and chain-of-custody forms are presented in Appendix IV.

Each monitor well was installed with 0.010-inch slotted, flush-joint PVC screen set from the bottom of the borehole to above the water table observed in the field. Two-inch diameter PVC casing was installed from the top of the screen to grade. The annular space in the vicinity of the well screen was filled with FilterSil No. 1 gravel pack. A 2-foot bentonite seal was placed 2 feet above the screen setting. Grout was used for backfill from the top of the bentonite seal to approximately 2 ft bg. The monitor wells were completed with steel-cased road boxes set in cement. All the monitor wells were covered with watertight locking well caps. Construction details for each monitor well are presented in the geologic logs and well construction diagrams located in Appendix III and on table 3. Monitor wells were developed 24 hours after construction by surging with a trash pump until dry or until the purge water was free of heavy sediment. Water was contained in 55 gallon drums for later disposal.

Following completion of the monitor wells, LBG personnel surveyed the top-of-casing elevations for all six initial monitor wells. The survey was based on an arbitrary onsite benchmark of 100 feet. The data from the relative survey was used with depth to water level measurements to construct a general site water-table map to aid in the location of monitor wells during the second phase of the investigation. The initial water-table map indicated that ground-water at the Middle School Site flowed from the east to the west/southwest. This information, along with analytical results, was used to develop the monitor network to be installed during the second phase of the investigation.

### 4.1.2 Second Phase Investigation Drilling Program

Between August 6 and 13, 2002 LBG personnel supervised the drilling of 21 soil borings (LBG-MW-4A, LBG-MW-4B, LBG-MW-4C, LBG-MW-7A through LBG-MW-17 and LBG-TB-30 through LBG-TB-31) (plate 2 and table 3). Eighteen (18) of the soil borings were completed as monitor wells (LBG-MW-4A, LBG-MW-4B, LBG-MW-4C and LBG-MW-7A through LBG-MW-17). The soil borings and monitor wells were drilled/installed by SoilTesting, Inc.

As discussed, the ground-water flow direction identified flow to the west/southwest. Analytical data collected during the initial investigation identified halogenated VOCs in unconsolidated materials on the western side of the tennis courts (LBG-TB-4) and halogenated VOCs present in the ground water at LBG-MW-4. In addition, a potential semi-confining layer consisting of organic silt and clay was identified to be relatively prevalent in the central portion of the athletic field. Based on these initial results, LBG designed the monitoring network that included monitor well clusters above and below the suspected semi-confining unit and located wells in and downgradient of the potential VOC source area. Additional soil borings were also located in areas to try and define the lateral extent of fill at the Middle School Site.

LBG-MW-4 was removed and replaced with LBG-MW-4A and LBG-MW-4B. LBG-MW-4 was originally screened through a thin organic silt and clay layer. This organic layer was later found to be present in the central portion of the athletic field. As a precaution, the well was replaced to ensure cross contamination of potential aquifer layers did not occur. Note that the hydrogeologic data collected to date does not indicate the organic silt and clay layer near LBG-MW-4 to be a significant aquitard. Details concerning the hydrogeology throughout the Middle School Site is presented in Section 5.0.

Soil samples were collected at soil borings either every 5 feet or continuously, dependant on the location of the soil borings. If a soil boring was located in an area not previously investigated, then soil samples were collected continuously, if not, they were collected every five feet. As in the initial phase of the investigation, soil samples were logged, photographed, then placed in sealed plastic bags and screened for VOCs with use of a PID. The highest VOC measurement was identified at soil boring LBG-MW-14 (7 to 9 ft bg) at 54 ppm. No other notable VOC concentration was measured at any of the soil borings.

The intent of this phase of the investigation was to characterize the extent of fill and install a monitor well network to characterize the site ground-water quality and flow. Extensive soil sampling was completed during the initial phase of the investigation to determine the soil quality at the site. Therefore, soil samples were only collected for analyses f they were deemed unique from that observed during the initial investigation. A unique soft pliable material was observed during the drilling of LBG-MW-16. Therefore, the sampling protocols utilized in the initial drilling investigation were employed during the drilling of this soil boring. A total of three soil samples were collected from LBG-MW-16 and analyzed for the constituents previously presented. No other soil samples were collected during this phase of the investigation. Geologic Logs are presented in Appendix III. The laboratory reports and chain of custody form is presented in Appendix IV.

Monitor wells were installed and constructed as discussed in the previous section. Construction details for each monitor well are presented in the geologic logs and well construction diagrams located in Appendix III and on table 3. Monitor wells were developed between 24 hours and one week after construction by surging with a trash pump until dry or until the purge water was free of heavy sediment. As before, purge water was contained in 55 gallon drums for later disposal.

At the completion of the drilling investigation, elevation of grade, top of PVC casing (if applicable) and location of all monitor wells and soil boring locations were surveyed by the licensed surveyors at Gesick & Associates P.C. of Clinton, Connecticut. The elevations were surveyed to mean sea level, while locations were surveyed to Connecticut State Plane coordinates. Elevations were later converted to high sea level to match the Town of Hamden surveyed topographic contours.

### 4.1.3 Additional Drilling Program

On November 11, 2002, LBG supervised the drilling of an additional 14 soil borings at the Middle School Site. Soil borings LBG-TB-33 through LBG-TB-46 were drilled by Zebra Environmental using the direct push method. The purpose of the investigation was to further characterize the lateral extent of fill material at the Middle School Site. The location of the soil borings are shown on plate 2.

Soil samples were collected continuously with use of a 4-foot long macrocore sampler. All soil samples were geologically logged and photographed. No samples were collected for laboratory analyses. Geologic logs are presented in Appendix III.

### 4.2 Excavation of Test Pits

On August 13 and 14, 2002, LBG supervised the excavation of 8 test pits (LBG-TP-1 through LBG-TP-8 on plate 2) throughout the Middle School Site. The test pits were excavated with use of a backhoe by SoilTesting Inc. Photographs of the test pit investigation and artifacts identified during the investigations are presented in Appendix V.

### 4.3 Ground-Water Sampling

On July 26, 2002 LBG personnel collected ground-water samples from each of the six initial monitor wells (LBG-MW-1 through LBG-MW-6) (figure 2) for laboratory analyses by York. Table 2 presents a summary of wells sampled and constituents analyzed. The samples were analyzed for VOCs by EPA Method 8021B, SVOCs (PAHs only) by EPA Method 8270, CTETPH, priority pollutant metals plus barium, cyanide, pesticides by EPA Method 8081 and PCBs by EPA Method 8082.

A second round of ground-water samples were collected by LBG from the completed monitoring network plus two Town of Hamden installed monitor wells on August 21 and 22, 2002. Table 2 presents a summary of the wells sampled and constituents analyzed. Ground-water samples were analyzed for VOCs by EPA Method 8260 plus ketones and tentatively identified compound (TICS), SVOCs by EPA Method 8270 plus TICS, CTETPH plus carbon range and oil identification if applicable, priority pollutant metals plus barium, cobalt, vanadium and tin, cyanide, pesticides by EPA Method 8081, herbicides by EPA Method 8151, PCBs by EPA Method 8082, sulfides and sulfates, total dissolved iron and manganese, potassium, sodium, ammonia, nitrate, total suspended and dissolved solids, alkalinity, chlorides and 5-day biological oxygen demand.

All ground-water samples were collected using the low-stress purging and sampling technique; details follow. Ground water was drawn from the monitor wells through Tygon tubing with a peristaltic pump at and an approximate rate of 5 ml/min (milliliter per minute). Each sample was collected once stabilization for three consecutive readings was achieved for the following parameters and variance: turbidity (10 percent for values greater than 1 NTU), dissolved oxygen (10 percent), specific conductance (3 percent), temperature (3 percent), pH

(+/-0.1 unit) and oxygen reduction potential (+/- 10 millivolt). Once collected, ground-water samples were placed into an ice-chilled cooler for pick up by York for analyses. Field sampling sheets are shown in Appendix VI. Laboratory reports and chain-of-custody forms are presented in Appendix III.

As presented in Section 6.2.3, during the initial investigation, filtered an unfiltered ground-water samples were analyzed for PPM plus barium and cyanide.

## 5.0 GEOLOGY AND HYDROGEOLOGY

### 5.1 Composition of Unconsolidated Materials

Unconsolidated materials beneath the Middle School Site are mapped as sand deposits (ref. 31); however, during this investigation a series of unconsolidated materials were identified. Plate 2 and figure 2 shows the locations of 11 cross sections (figures 3 through 13) completed throughout the Middle School Site. The cross sections provide a good reference for viewing the complex mix of material deposited beneath the site.

In general, the upper surficial material (primarily top 1 to 4 feet) consisted of a top soil and sand mixture. Much of this cover material was placed as part of remedial measures during the 1995 and 1996. The extent and thickness of this cover material is discussed in greater detail in section 5.1.1. Immediately beneath the cover material is one of four materials. These materials are often found intermingled. The materials include:

1) Black matrix fill/industrial waste: The primary materials of the black matrix material are a black silt and/or slag. Numerous objects were encountered in this matrix; the most common were batteries, wood, ceramic and cardboard. Occasionally newspapers would be mixed in with this fill material. Newspapers were also identified as part of the domestic/municipal waste. Artifacts identified in this fill were often found with Winchester Repeating Arms labeling. The location and extent of this fill corresponds to areas known to be filled by Winchester Repeating Arms (Section 5.1.1).

2) Construction debris: Construction materials were generally found as part of a reddish-brown sand. Material most commonly associated with the construction/

building debris were stone blocks (generally rectangular, cobble size), bricks, wood, glass and plastics.

3) Domestic/municipal waste: This is the most general category of fill at the site. Domestic/municipal waste was identified with silt to medium sand ranging in colors from gray to brown. Materials associated with the domestic/municipal waste included bottles, household products (such as margarine containers), shoes, cinders, electrical conduits, newspapers, etc. The materials used as identifiers were generally unique and not found in other areas or in quantity, thus potentially representing an individual's waste.

4) Non-fill: Material primarily consists of reddish brown fine to medium grain sand with some silt.

Fill was deposited on either a non-fill layer or an organic silt and clay later. This organic silt and clay layer was identified in fourteen soil borings at depths ranging from 12 to 30 ft bg. The layer was identified to be 1 to 4 feet thick and generally underlain by a fine to medium sand and silt material. The silt and clay layer was observed at the shallowest depths along the eastern property boundary (LBG-TB-8, 12 to 16 ft bg). On the eastern portion of the Middle School Site, the layer was observed in only one location (LBG-TB-8 and LBG-MW-8) and, therefore, is believed to not be a prominent feature on this portion of the site. The organic silt and clay layer was identified in several soil borings throughout the central portion of the athletic field. In this area the material was identified consistently at greater depths, ranging from 22 to 30 ft bg. The extent and orientation of the layer is consistent with the original stream and wetland system.

### 5.1.1 Cover Material

As discussed, the Town of Hamden placed approximately two feet of cover material over the Hamden Middle School athletic field in 1995 and 1996 to address environmental concerns of the USEPA and CTDEP. As part of this investigation, soil samples were collected continuously in the shallow throughout the Middle School Site to identify the thickness and extent of protective cover material. Plate 3 shows the extent and thickness of the cover material present at the Middle School Site. In general, the athletic field has between 2 and 4 feet of this protective cover material. Small areas of shallower coverage are identified on the northwestern portion of the property. The remaining portion has approximately 1 to 2 feet of cover material. As shown on late 3, areas of less than 1 foot of cover material are present in small areas near the north central property site boundary (near LBG-MW-11), eastern central boundary (LBG-TB-9) and south-central boundary (LBG-TB-42 through LBG-TB-45).

### 5.1.2 Extent and Thickness of Fill Materials

Plate 4 shows the approximate lateral extent of all types of fill observed at the site. As shown, a large portion of the Middle School Site is underlain with fill; however, the fill is shown to be primarily contained on the site. The fill was identified to be as much as 22 feet thick. Plate 5 shows the thickest sections of fill are generally identified on the western portion of the property. Relatively thin sections of fill ranging from 0.6 feet to 8.8 feet were identified on the eastern portion of the property near Newhall Street.

The black matrix fill is the predominant fill material located on the eastern and central portions of the property. Plate 6 shows the extent of the black matrix fill overlaid on a 1951 aerial photograph. The 1951 photograph is utilized because the last parcel was sold by NHWC to the Town in 1950. The extent of this fill identified during the field investigation reasonably corresponds to locations shown to have been filled during this time period. Winchester Repeating Arms filling activities ceased by 1955, which corresponds to when the middle school was constructed. The spreading of the black matrix fill may have occurred during future filling and grading activities. Note that no black matrix fill was identified to extend beyond the southern Middle School Site boundary. The only area in which the black matrix fill potentially extends off of the site is to the northeast near Mill Rock extension.

Plate 7 shows a large section of construction debris fill located on the western portion of the Middle School Site. This type of fill was also identified on the northeast corner and south eastern portion of the site. The materials on the western portion of the site may represent part of the approximate 100,000 yards of fill reportedly brought in from the West Wood school site. During excavation of test pit 3 (northwest portion of Middle School Site), an orange plastic caution tape (gas) was identified in the material along with wood and rectangular stone blocks. The condition and construction of the caution tape (Appendix V) indicates a more recent filling event like that had reportedly occurred in the 1970s. Of note, similar stone blocks were identified in Test Pits 1 and 4 (Appendix V).

Plate 8 shows scattered areas of domestic/municipal waste fill. These areas may be more extensive than shown. The largest area of the domestic/municipal waste fill is shown on the southeastern portion of the Middle School Site. Newspapers included in the waste and collected from LBG-Test Pit-5 identify the date as 1955. The newspapers were collected from 4 to 5.5 ft bg. 1955 corresponds with the approximate period that Winchester Repeating Arms ceased filling on the Middle School Site. This domestic waste extends to the southern property boundary as shown in Test Borings LBG-TB-42 through LBG-TB-45. This domestic/municipal waste fill in the area of LBG-Test Pit-5 and LBG-Test Pit-12 was deposited on top of the black matrix fill.

Soil borings LBG-TB-42 through LBG-TB-46 were drilled on the top of a steep ridge along the southern property boundary (approximately 5 feet above the grade of the athletic field). As shown, a domestic/municipal waste was identified in the aforementioned borings; however, the soil matrix was not similar to that identified in LBG-Test Pit-5. Plate 8 shows domestic/municipal waste is shown to be located on several residential properties on the north side of Morse Street. Based on the aerial photographs in Appendix I, these houses and lots were fully developed before any filling occurred on the Middle School Site near their property lines. All of the houses located on the northern portion of Morse Street, which have a steep ridge at the rear edge of their properties, were developed in or before 1920.

It is likely that the filling that occurred on these residential properties actually slightly spilled over onto the Middle School Site. The domestic fill material identified in test borings LBG-TB-42 through LBG-TB-46 along the ridge that straddles these residential properties is similar to that observed during the offsite investigation completed by the Olin Corporation on these properties. No domestic/municipal waste from that era (pre-1920) was identified in any other test borings or test pits completed on the Middle School Site. Waste such as black matrix fill which was deposited in the mid to early-1920s to the early-1950s on the portion of the school site that is located in the vicinity of the homes was identified approximately 10 feet lower than the grade elevation of the these previously developed Morse Street residential properties. Therefore, any filling activities that occurred on the Middle School Site could not have spilled over onto the Morse Street residential properties (259 through 279 Morse Street), as it would have had to spill uphill and on top of previously developed residential properties.

## 5.2 Composition of Bedrock

Bedrock beneath the Middle School Site is mapped as New Haven Arkose (ref. 32), which is characterized as reddish, poorly-sorted arkose. Arkose is a granular sedimentary rock consisting of quartz and feldspar or mica. Depth to bedrock is mapped to be approximately 40 feet on the eastern edge of the Middle School Site, and approximately 140 feet on the western edge (ref. 33). Bedrock was not encountered during the investigation.

## 5.3 Characteristics of Ground Water

### 5.3.1 Depth to Water Levels

Depth to ground-water levels were measured at the site from July through October 2002 (table 4). The depth to ground water at the site ranged between 4.3 and 20.9 feet below the top of the well casing (ft bc). Ground water is shallowest on the eastern edge of the Middle School Site where the topography is the lowest. Ground water is deepest on the southwestern portion of the athletic field. During the reporting period, water levels were relatively stable. While six rounds of water-level measurements have been collected, the period is not long enough to analyze the effects of seasonal recharge on water levels.

### 5.3.2 Vertical Flow Direction and Magnitude

Five sets of cluster wells (LBG-MW-4, LBG-MW-7, LBG-MW-10, LBG-MW-14 and LBG-MW-15 clusters) were installed at the site to determine the water-quality on each side of a localized silt and clay layer. In addition, one well, LBG-MW-4C, was installed to evaluate deep ground-water quality leaving the site. As discussed, an organic silt and clay layer was identified primarily on the western portion of the site, generally contained within the limits of the athletic field. The organic layer was also identified in one location on the eastern edge of the Middle

School Site (LBG-TB-8 and LBG-MW-8). However, the layer was not identified in any of the soil borings surrounding this point. This location likely corresponds with the location of the original stream and wetland system.

Screen separation in monitor well clusters LBG-MW-7, LBG-MW-10, LBG-MW-14 and LBG-MW-15 clusters ranges from 10 and 11 feet. Monitor well cluster LBG-MW-4 includes a third deep well. The screen separation in this cluster ranges from 4 to 34 feet.

Depth-to-water levels were used with the top of casing survey elevations to determine ground-water flow direction at the site and magnitude of vertical flow gradients. Table 5 shows the difference in water levels between the shallow and deeper saturated unconsolidated materials within the athletic field. A generally strong downward flow direction is shown in monitor well clusters LBG-MW-7, LBG-MW-10 and LBG-MW-14. In these three clusters, the head difference, showing downward flow, ranges from 2.83 to 4.53 feet. A slight decline in head difference in these wells is observed from the August to October measurements. The decline in head difference is attributed to a rise in water elevations below the organic layer. Water levels above the organic layer remained generally stable.

A much smaller downward gradient is observed in the LBG-MW-15 cluster, with a head difference ranging from 0.02 to 0.81 foot. A nominal head difference was identified in the LBG-MW-4 cluster. In this area (southwestern portion of athletic field) the organic layer was observed to be thinning out. It is unlikely the unit is continuous on this portion of the site.

In summary, relatively significant downward flow gradients are observed in the west central and south central portions of the site. However, these areas seem to be relatively localized and do not seem to suggest a continuous aquitard is present. Wells screened in or above the fine-grained layer reflect higher water elevations supported by the layer. Wells screened below or outside the area of this layer represent the true regional ground water heads. As discussed in Section 6.2.4, the localized organic layer does reduce significant downward vertical migration of contaminants; however, it is not extensive enough to be mapped as a separate shallow aquifer.

### 5.3.3 Potentiometric Surface

When creating the ground-water flow maps, water elevations from all wells screened in a similar depth interval were initially mapped. However, this showed a radial flow pattern off of the athletic field region of the school site, as well as isolated areas of apparent mounds. Closer analysis showed that this mound was, in fact, reflecting the higher heads supported by the localized fine-grained layer, discussed above. These higher heads do not reflect the actual regional ground-water flow direction and chemical data from the wells show that there is no horizontal flow component from the regions where there are elevated heads above the fine-grained layer to adjacent locations where the layer does not exist. The map was then prepared utilizing the water elevations in the regional geologic material: the deeper wells of the clusters and the shallow wells where the fine-grained layer did not exist. This produced a uniform flow direction that was consistent with chemical patterns in the ground water. LBG incorporated water elevations from a total of 21 onsite monitor wells and 10 offsite monitor wells in developing the potentiometric surfaces discussed below.

Plate 9 is a detailed potentiometric surface for the Middle School Site on September 12, 2002. As shown, ground-water flow at the Middle School Site is generally from the east to the west/southwest. The hydraulic gradient throughout the site is approximately 0.001 ft/ft.

Plate 10 shows the regional potentiometric surface for September 23, 2002. In addition to the wells incorporated in the previous potentiometric surface, this map incorporates ground-water elevations from Rochford Field, Mill Rock Park, 499 Newhall Street, 109 Morse Street, 113 Bryden Terrace and 1067 Winchester Avenue. The potentiometric contours shows that regional ground water generally flows from the east to the west/southwest. Near the Newhall Street community center, ground water is shown to flow to the northwest and then eventually discharging to the southwest. This is consistent with the topography and geology of the community center site. Note that the potentiometric contours on this map are presented at a greater interval than the detailed site map. This is because the hydraulic gradient off site is much larger than the hydraulic gradient on site. The hydraulic gradient east of the Middle School Site is 0.01 ft/ft, an order of magnitude larger than observed at the Middle School Site.

## 6.0 RESULTS OF INVESTIGATION

The results of all analytical results completed during this investigation are presented in an MS Access database on the attached CD. Individual tables are presented in this report for specific constituents. Constituents in which concentrations are not detected are not included in the summary tables.

### 6.1 Soil-Quality Results

Although the site is currently classified as “GAA” and the land use is consistent with RDEC, the following sections, when applicable, include comparisons to 10 times GA PMC for mass (total) analyses, 10 times the GWPC for SPLP analyses, GB PMC and I/C DEC criteria. This is important because, 1) the RSRs allow 10 times the GA PMC for substances analyzed for total (mass) concentration and 10 times the GWPC for substances analyzed by SPLP to be utilized under certain conditions (which are met for this site), 2) the ground-water flow data show that the site is a strong candidate for reclassification to GB, thus the impacts of such a classification change are discussed, and 3) future use of the site may reasonably allow for I/C DEC to be applied. Due to space limitations, these alternative criteria are not shown on the plates discussed below.

#### 6.1.1 Pesticides

Table 7 and plate 11 presents a summary of all detected pesticides. Low concentrations of pesticides were detected shallow soil samples collected from soil borings LBG-TB-4, LBG-TB-9, LBG-TB-18, LBG-TB-19, LBG-TB-20, LBG-TB-21, LBG-TB-22, LBG-TB-24 and LBG-TB-25. The detections consisted of 4,4’-DDE (DDE), 4,4’-DDT (DDT), 4,4’-DDE (DDE) and/or chlordane. All of the aforementioned detections were below applicable remediation criteria and, therefore, no discussion of alternate criteria is presented.

Chlordane was detected at a concentrations of 511 ug/l in a soil sample collected LBG-TB-23 from 18 to 20 ft bg. The detection exceeds both the numerical threshold for the CTDEP RSRs RDEC and GA PMC; however, since the sample was collected below the seasonal low water table and below 15 ft bg, neither criterion applies.

As shown on plate 11 and table 7, pesticides were detected in the black matrix fill, construction debris fill and "non-fill" material. DDT and DDE were detected in 8 of the 105 samples analyzed, DDE in 7 of 105, while chlordane was detected in 2 of the 105 samples analyzed. The pesticides identified were in samples collected between 0.9 and 20 ft bg. No other pesticides were detected.

### 6.1.2 Cyanide and Metals

#### 6.1.2.1 Total Cyanide and Metals

One hundred and five (105) soil samples were analyzed for priority pollutant metals (PPM) plus barium, while 103 soil samples were analyzed for cyanide. As presented above, total chromium was replaced on the PPM list with hexavalent chromium. The priority pollutant metal list includes antimony, arsenic, beryllium, cadmium, copper, hexavalent chromium (replaced total chromium), lead, mercury, nickel, selenium, silver, thallium and zinc. Of the metals analyzed, only thallium was not detected, which is not unexpected because most naturally occur. Table 8 presents a summary of all detected total metals and cyanide.

No exceedances of the RDEC were identified for barium, beryllium, cadmium, cyanide, hexavalent chromium, nickel, selenium, silver, thallium and zinc. Antimony, arsenic, copper, lead and mercury were all detected at concentrations above the RDEC. Plate 12 summarizes the depth and locations of the detections and exceedances for these metals, and the types of material that were analyzed. Of note, hexavalent chromium was detected in 6 of 105 samples, while cyanide was detected in 10 of 103 samples.

Of the metals analyzed, mercury, copper, antimony, arsenic and lead exceed the RDEC. Plate 12 and table 8 shows the distribution and concentrations of all metals that exceed the RDEC at the Middle School Site.

Mercury was detected in 65 of 105 soil samples, while 3 of the samples exceeded the RDEC. All of the mercury soil samples that exceeded the RDEC were from black matrix fill samples. Mercury does not exceed the I/C DEC.

Copper was detected in 32 of 105 soil samples, while 10 of the samples exceeded the RDEC. Note that 78 percent of the copper results were below 1,000 mg/kg. The copper RDEC exceedances were identified in both black matrix fill and construction debris. Copper does not exceed the I/C DEC.

Antimony was detected in 92 of 105 soil samples, while 13 of the samples exceeded the RDEC. Note that 67 percent of the antimony results were below 3 mg/kg. All but two of the antimony RDEC exceedances were identified in black matrix fill. Antimony does not exceed the I/C DEC.

Arsenic was detected in 51 of 105 soil samples, while 34 of the samples exceeded the RDEC and I/C DEC; however, an ELUR with 2 to 4 feet of clean cover material would address the exceedances. Note that 90 percent of the arsenic results were below 60 mg/kg. Twenty-nine (29) of the 34 arsenic RDEC exceedances were identified in black matrix fill. It is reasonable to conclude that the presence of arsenic above the RDEC at the Middle School Site is primarily attributed to the black matrix fill.

Lead was detected in all soil samples, while 36 of the samples exceeded the RDEC and 24 exceed I/C DEC; however, as indicated above, an ELUR with 2 to 4 feet of clean cover material would address the exceedances. The CTDEP requested that 400 mg/kg be utilized for the RDEC to be consistent with the RCRA corrective action program. Note that this is currently not a regulatory change and is being applied on a case by case basis. With few exceptions, when lead is identified above the RDEC, it is much higher than the criterion. Twenty-six (26) of the 35 lead RDEC exceedances were identified in black matrix fill soil sample, however significant concentrations of lead were identified in other waste streams at the site.

**6.1.2.2 SPLP Cyanide and Metals**

The protocol for analyzing metals through SPLP was as follows: Target metals identified in soil samples from above the seasonal low water-table greater than 1.5 times the local background concentrations or average concentration of the element found in uncontaminated soil in the Eastern United States (whichever is lower) were analyzed by synthetic precipitation leaching procedure (SPLP) for the target metal. Because of cost savings achieved by analyzing the entire set of PPMs plus barium rather than analyzing a few individual metals, most samples were analyzed for all the metals regardless of which metal triggered the need to perform the analyses. All of the samples in which cyanide was detected were analyzed through SPLP. At minimum, 60 sets of PPM plus barium were analyzed through SPLP.

The threshold for analyzing metals by SPLP is shown below. Note that eight of 10 arsenic and lead samples collected during the USEPA investigation were analyzed with use of an XRF field sampling unit. The unit had a detection limit of 60 mg/kg. The two arsenic background samples analyzed by a laboratory were identified with concentrations of 3 and 8 mg/kg. Considering only two samples analyzed by a laboratory and the remaining 8 samples were analyzed with a field instrument with a high detection limit, 1.5 times the background in the eastern United States was utilized for the sampling threshold for arsenic. An average background in the eastern United States was not available for silver, cadmium and thallium. Therefore all detections of these constituents were analyzed by SPLP.

| Metal | 1.5 Times Local Background | 1.5 Times Background in the Eastern US |
|---|---|---|
| Antimony | -- | 1.14 |
| Arsenic | 10.5 | 11.1 |
| Barium | -- | 630 |
| Beryllium | -- | 1.275 |
| Cadmium | -- | -- |
| Chromium | -- | 78 |
| Copper | -- | 33 |
| Lead | 209 | 25.5 |
| Mercury | -- | 0.18 |
| Nickel | -- | 27 |
| Selenium | -- | 0.675 |
| Silver | -- | -- |
| Thallium | -- | -- |
| Zinc | -- | 78 |

-- Not Available

As shown on table 9, Cyanide was not detected in any of the samples analyzed.

Sixty (60) soil samples were analyzed for SPLP thallium, while 61 soil samples were analyzed by SPLP selenium and beryllium. As shown on table 9, thallium, selenium and beryllium were not detected in any of the samples.

Sixty (60) soil samples were analyzed for SPLP barium, chromium and silver, while 66 soil samples were analyzed by SPLP copper. SPLP barium, chromium, copper and silver were detected in 60, 11, 62 and one soil sample, respectively. None of the detections exceeded the GA PMC.

Antimony, arsenic, cadmium, lead, mercury, nickel and zinc all were identified at concentrations above the GA PMC. The table below summarizes the quantity of samples analyzed, those with detections, and quantity that exceeded the GA and GB PMC. Plate 13 and table 9 show the detailed distribution and individual concentrations of all metals that exceeded the RDEC at the Middle School Site.

| | Quantity of Samples Analyzed | Quantity Detected | Quantity Exceed GA PMC | Quantity Exceed GB PMC or 10 Times GA PMC |
|---|---|---|---|---|
| Antimony | 61 | 19 | 19 | 5 |
| Arsenic | 60 | 14 | 14 | 3 |
| Cadmium | 60 | 2 | 1 | 0 |
| Lead | 61 | 46 | 41 | 7 |
| Mercury | 63 | 10 | 3 | 0 |
| Nickel | 60 | 37 | 8 | 2 |
| Zinc | 63 | 63 | 5 | 0 |

The quantity of samples shown above that exceed the GB PMC does not account for samples between the seasonal high water table and seasonal low. The elimination of the exceedance was not completed because a seasonal high water table has yet to be established.

All of the mercury, cadmium, nickel and zinc GA PMC exceedances were from soil samples containing black matrix fill. Arsenic, antimony and lead GA PMC exceedances were identified in soil samples containing various fill and "non-fill" material. The distribution of exceedances was generally scattered throughout the site.

With the application of the 10 times the GWPC for the existing classification, or GB PMC for a GB classification, a significant reduction in exeedances is shown. With the application of either of these criteria, exceedances are only identified in six soil borings: LBG-MW-5, LBG-TB-6, LBG-TB-11, LBG-TB-12, LBG-TB-14 and LBG-TB-17.

### 6.1.3 Petroleum Hydrocarbons

Plate 14 and table 10 show the detailed distribution and individual concentrations of all soil samples analyzed and compares the results to the RSRs. Of the 105 soil samples analyzed, ETPH was detected in 87. As shown on plate 14 and table 10, ETPH was identified throughout the Middle School Site at all depths and materials. Of the 87 detections, 28 exceeded the RDEC, while 32 exceeded the GA PMC. The RDEC and GA PMC are both 500 mg/kg; however, the RDEC does not apply to soils below 15 feet and the GA PMC does not apply to soils below the seasonal low water table.

While ETPH was detected throughout the site, the majority (all but one, LBG-MW-3 (3.5 to 4 ft bg)) of the samples that exceeded RSRs criteria were located away from the property boundary.

LBG requested the laboratory to identify the petroleum hydrocarbon carbon range and, if possible, the type of hydrocarbon detected. The results are presented on Plate 14 and table 10. A wide range of carbon chains were identified, however the most common range was C-16 to C-36. Of the 87 soil samples detected with ETPH, the laboratory was able to identify 49 sources of the petroleum hydrocarbons. Forty-seven (47) of the soil samples were identified to contain motor oil, one soil sample was identified to contain hydraulic oil and one contained diesel fuel. Hydraulic oil was identified in the shallow domestic debris/municipal waste located on the south central portion of the Middle School Site (LBG-TB-12 (2.2 to 3.1 ft bg)). Diesel fuel was identified in the relatively deeper construction debris located on the western portion of the site (LBG-TB-24 (13.5 to 14 ft bg)).

With the application of the I/C DEC and/or GB PMC, 18 and 21 soil samples exceed the aforementioned criteria, respectively, down from 28 and 32, respectively. No significant change in the distribution of exceedances is achieved through the application of these criteria. However, an ELUR with 2 to 4 feet of clean cover material would address the DEC exceedances. The regulation, do not allow for 10 times the GA PMC to be utilized for ETPH in GA settings.

### 6.1.4 Semi-Volatile Organic Compounds

Table 11 presents a summary of detected SVOCs and compares the results to regulatory criteria. The table below presents a statistical summary of SVOC constituents detected and quantity that exceed regulatory criteria.

| | Quantity of Samples Analyzed | Quantity Detected | Quantity Exceed RDEC | Quantity Exceed I/C DEC | Quantity Exceed GA PMC | Quantity Exceed GB PMC | Quantity Exceed 10 Times GA PMC |
|---|---|---|---|---|---|---|---|
| SVOCs | 105 | 51 | 32 | 18 | 36 | 33 | 4 |
| Acenaphthene | 105 | 2 | 0 | 0 | 0 | 0 | 0 |
| Acenaphthylene | 105 | 2 | 0 | 0 | 0 | 0 | 0 |
| Anthracene | 105 | 16 | 0 | 0 | 1 | 0 | 0 |
| Benzo(k)fluoranthene | 105 | 38 | 2 | 2 | 28 | 28 | 2 |
| Benzo[a]anthracene | 105 | 39 | 29 | 3 | 32 | 32 | 2 |
| Benzo[a]pyrene | 105 | 30 | 16 | 16 | 18 | 18 | 2 |
| Benzo[b]fluoranthene | 105 | 29 | 17 | 2 | 18 | 18 | 2 |
| Benzo[g,h,i]perylene | 105 | 2 | 0 | 0 | 0 | 0 | 0 |
| Bis(2-ethylhexyl)phthalate | 105 | 4 | 1 | 1 | 3 | 1 | 2 |
| Chrysene | 105 | 40 | 2 | 0 | 30 | 30 | 3 |
| Dibenzofuran | 105 | 3 | 0 | 0 | 1 | 0 | 0 |
| Dibenz(a,h)anthracene | 105 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fluoranthene | 105 | 45 | 0 | 0 | 11 | 2 | 2 |
| Fluorene | 105 | 9 | 0 | 0 | 1 | 0 | 0 |
| Indeno(1,2,3-cd)pyrene | 105 | 7 | 2 | 0 | 2 | 2 | 0 |
| Naphthalene | 105 | 16 | 0 | 0 | 1 | 0 | 0 |
| Phenanthrene | 105 | 38 | 0 | 0 | 15 | 2 | 2 |
| Pyrene | 105 | 44 | 0 | 0 | 14 | 2 | 2 |

Note: The exceedance of the GB PMC shown above does not adjust for samples collected below the seasonal high water table.

The table above shows that the primary SVOCs detected at the site consist of polynuclear aromatic hydrocarbons (PAHs). Bis(2-ethylhexyl)phthalate is the only SVOC listed above which is not considered a PAH. Bis(2-ethylhexyl)phthalate is a common laboratory artifact and is associated with plastics, such as latex gloves used during field sampling. Therefore, since there were only 4 detections of bis(2-ethylhexyl)phthalate out of 105 soil samples analyzed, and bis(2-ethylhexyl)phthalate is a common lab and field artifact, it is unclear if the detections are related to the unconsolidated materials at the site.

PAHs are compounds that contain more than one benzene ring. They are commonly found in petroleum fuels, coal products, and tar. PAHs are released in considerable quantities from the combustion of fossil fuels such as coal, oil, gas and the burning of wood. Benzo(k)fluoranthene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene, fluoranthene, phenanthrene and pyrene were the most commonly detected SVOCs at the Middle School Site. Plate 15 shows the detailed distribution and individual concentrations of the primary SVOCs that exceeded the RDEC and GA PMC at the Middle School Site. SVOCs were detected in "non-fill" material, construction debris and black matrix fill soil samples. SVOCs were not identified in samples collected solely containing domestic debris. As shown on plate 15, SVOCs are detected throughout the site, with only sporadic detections along the athletic field property boundary.

If the I/C DEC is applied, SVOC exceedances would occur in 18 soil samples; however, an ELUR with 2 to 4 feet of clean cover material would address the exceedances. Little benefit is achieved in reducing the area of exceedance with applying the GB PMC, however a significant reduction in the areas of exceedances were shown when applying 10 times the GA PMC (self implementing for the existing GAA classification). When applying this option, pollutant mobility exceedances are only identified at three soil borings; LBG-TB-16, LBG-TB-19 and LBG-TB-25.

### 6.1.5 Volatile Organic Compounds

Table 12 presents a summary of detected VOCs and compares the results to regulatory criteria. Plate 16 shows the detailed distribution detected halogenated VOCs and benzene concentrations at the Middle School Site. A discussion of halogenated and aromatic VOC occurrences at the Middle School Site is presented below.

### 6.1.5.1 Halogenated Volatile Organic Compounds

Plate 16 shows the detailed distribution and individual concentrations of all halogenated VOCs detected. Trichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were detected in soil samples collected from soil boring LBG-TB-4 at 9 to 10 ft bg, 16 to 18 ft bg and 23 to 24 ft bg. No other halogenated VOCs were detected in soils at the Middle School Site. The table below summarizes the halogenated VOC detections in LBG-TB-4.

| Depth of Sample (ft bg) | Material Sampled | Trichloroethylene (ug/kg) | (cis) 1,2-Dichloroethylene (ug/kg) | Vinyl chloride (ug/kg) |
|---|---|---|---|---|
| 9 to 10 | Black Matrix Fill and Construction Debris | 38 | 40 | 24 |
| 16 to 18 | Black Matrix Fill | 3,100 | 5,200 | 620 |
| 23 to 24 | Non-Fill | 6 | 7 | 13 |
| CTDEP RSRs GA PMC | | 100 | 1,400 | 40 |
| CTDEP RSRs RDEC | | 56,000 | 500,000 | 320 |

As shown above, soil sample LBG-TB-4 16 to 18 ft bg exceeds the numerical threshold for the RDEC of vinyl chloride and the numerical threshold for the GA PMC for trichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride. However, the soil sample does not exceed the aforementioned criteria because the RDEC does not apply to soils below 15 ft bg and the GA PMC does not apply to soils below the seasonal low water-table (LBG-TB-14,16 to 18 ft bg, was collected below the seasonal low water-table). Thus, none would exceed the I/C DEC and GB PMC is not relevant for these particular samples.

As shown, halogenated VOCs were also detected in the unsaturated zone at this soil boring. It is reasonable to conclude that the source of the deeper halogenated VOC detections are related to the shallow detections. Note that (cis) 1,2-dichloroethylene is a breakdown constituent of trichloroethylene, while vinyl chloride is a breakdown constituent of (cis) 1,2-dichloroethylene. The presence of the breakdown constituents would indicate that this is the result of a historic release. Additional investigations would be needed in this area to fully characterize the extent of the VOCs and determine if dense non aqueous phase liquids are present (DNAPLs).

#### 6.1.5.2 Aromatic Volatile Organic Compounds

As shown on table 12, low concentrations of aromatic VOCs were detected 23 of 105 soil samples analyzed. The aromatic VOC detections consisted of benzene, ethylbenzene, toluene, xylenes, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 1,4-dichlorobenzene, n-butylbenzene, n-propylbenzene, sec-butylbenzene, tert-butylbenzene, isopropylbenzene and p-isopropyltoluene. These compounds were identified in the black matrix fill, construction debris and non-fill materials. None of the samples exceeded the RDEC or GA PMC, thus none would exceed I/C DEC or GB PMC.

With the exception of LBG-TB-10, no aromatic VOCs were detected in any borings completed along the Middle School Site boundary. 1,2,4-Trimethylbenzene was detected at 3 ug/kg at the 2 to 3 ft bg interval in LBG-TB-10.

Benzene was the only aromatic VOC identified in ground water (further discussed in section 6.2.4.2). As shown on plate 16, benzene was detected in three soil samples at soil borings LBG-TB-2 (5 to 6 ft bg), LBG-TB-4 (16 to 18 ft bg) and LBG-TB-23 (27 to 29 ft bg) at concentration ranging from 5 to 8 ug/kg. Soil samples LBG-TB-4 (16 to 18 ft bg) and LBG-TB-23 (27 to 29 ft bg) were collected from below the water table and soil samples collected in the unsaturated zones at those borings showed no detections of benzene. A soil sample collected at LBG-TB-2 in between the top of the water-table and LBG-TB-2 (5 to 6 ft bg) showed no detections of benzene. While benzene was detected in the one unsaturated soil sample at extremely low concentrations, the low concentrations of benzene detected in the ground water do not appear to be related to this detection.

### 6.1.6 Polychlorinated Biphenyls

#### 6.1.6.1 Total Polychlorinated Biphenyls

Plate 17 and table 13 show the detailed distribution and individual concentrations of all soil samples analyzed and compares the results to the RSRs. Polychlorinated biphenyls (PCBs) were detected above the laboratory detection limit in 11 of 105 soil samples analyzed. After receipt of initial analytical results, LBG requested that three of the soil sample be reanalyzed. The table below summarizes all PCB detections and reanalysis results.

| | Sample Interval (ft bg) | Total PCBs (mg/kg) |
|---|---|---|
| LBG-TB-5 | 1.6 to 2 | 0.1 |
| LBG-TB-12 | 2.2 to 3.1 | 0.09 |
| LBG-TB-12 (Reanalysis) | 2.2 to 3.1 | 0.08 |
| LBG-TB-12 | 13.4 to 13.9 | 0.05 |
| LBG-TB-13 | 2.7 to 3.1 | 0.04 |
| LBG-TB-13 (Reanalysis) | 2.7 to 3.1 | 0.04 |
| LBG-TB-16 | 1.1 to 1.5 | 0.07 |
| LBG-TB-17 | 1.6 to 2 | 0.08 |
| LBG-TB-21 | 15 to 16 | 0.12 |
| LBG-TB-22 | 15.5 to 16 | 0.2 |
| LBG-TB-25 | 9.5 to 10 | 0.78 |
| LBG-TB-25 (Reanalysis) | 9.5 to 10 | **2.88** |
| LBG-TB-25 | 13.5 to 14 | 0.26 |
| LBG-TP-5 | 3.4 to 3.7 | 0.12 |
| LBG-TP-5 (Reanalysis) | 3.4 to 3.7 | ND<0.02 |

As shown, none of the initial detections exceeded the RDEC, however the results of the reanalysis completed at LBG-TB-25 did exceed the criterion of 1 mg/kg. If the I/C DEC were applied, there would be no exceedances. The PCB detections are located in the central and southern half of the Middle School Site. As shown on plate 17, the vertical extent of the PCB occurrences has been characterized. The lateral extent of PCB occurrences is not fully characterized, control points are necessary along the southern and western athletic field property boundary. In general, PCBs detected were at low concentrations; however, additional investigations are necessary near LBG-TB-25 to determine if the soils in this area exceed the RDEC or I/C DEC.

#### 6.1.6.2 SPLP Polychlorinated Biphenyls

With the exception of LBG-TB-12 13.4 to 13.9, LBG-TB-13 2.7 to 3.1 ft bg and LBG-TB-16 1.1 to 1.5 ft bg, all soil samples detected with PCBs were analyzed for SPLP PCB. Not enough sample was left at the laboratory for the additional analyses of LBG-TB-12 13.4 to 13.9, LBG-TB-13 2.7 to 3.1 ft bg and LBG-TB-16 1.1 to 1.5 ft bg. As shown on table 13, no SPLP PCBs were detected above the laboratory detection limit.

### 6.2 Ground-Water Quality Results

As discussed in section 4.2, ground-water samples were collected from the Middle School Site on two occasions, on July 26, 2002 and on August 21 and 22, 2002. As shown on table 2, a more extensive ground-water parameter analytical list was completed during the second sampling event. A discussion of the results is presented below.

#### 6.2.1 Pesticides

No Pesticides were detected above the laboratory detection limit in any of the ground-water samples analyzed.

#### 6.2.2 Herbicides

No Herbicides were detected above the laboratory detection limit in any of the ground-water samples analyzed.

#### 6.2.3 Metals and Cyanide

Samples during the initial phase of the investigation were analyzed for filtered and unfiltered priority pollutant metals, barium and cyanide. Although low-flow samples for metals analysis should not need to be filtered due to low turbidity, samples were also filtered to ensure there was no unexpected interference from sediment. As shown on table 14, results of filtered and unfiltered samples were nearly identical. Therefore during the second round of sampling all metal and cyanide samples were collected unfiltered. In addition to the list analyzed during the first phase of the investigation, cobalt, vanadium and tin were additional compounds to be analyzed during the second phase of the investigation. Table 14 presents a summary of all detected metals and cyanide results. Antimony, arsenic, beryllium, cadmium, cyanide, mercury, selenium, silver, thallium and tin were not detected above the laboratory detection limit. Barium, chromium, cobalt, copper, lead, nickel, vanadium and zinc were detected.

Plate 18 shows the distribution and concentration of all detected metals. Note that the plate does not show the results of dissolved metals samples collected during the first phase of the investigation. Although some interior wells show an exceedance of SWPC, the furthest downgradient wells show compliance. Of the constituents detected, lead and barium were detected above the ground-water protection criteria. Lead was detected at LBG-MW-14A and LBG-MW-14B above the GWPC at concentrations of 0.256 mg/l and 0.045 mg/l, respectively. Barium was detected at five sampling locations above the criterion, at LBG-MW-7A, LBG-MW-12, LBG-MW-10A, LBG-MW-14A and LBG-MW-15A. The peak concentrations of barium detected was 9.07 mg/l at LBG-MW-10A.

Forty-one (41) exceedances of the GA PMC were identified for lead during the soil investigation. The distribution of the lead GA PMC exceedance does not indicate a single source location; however as discussed, lead was identified above the GWPC at only one location, in the LBG-MW-14 cluster. These wells were noted to have a higher turbidity during development than most other wells at the site. As shown in Appendix VI, turbidity concentrations at the LBG-MW-14 cluster were measured above 30 NTU prior to the start of sampling. These concentrations are higher than turbidity concentrations measured at most of the monitor wells prior to sampling. Considering the distribution of the lead GA PMC and lack of lead GWPC exceedances at the site, it is possible that the lead GWPC exceedances identified at the MW-14 cluster are related to sediment (turbidity) in the ground-water sample. LBG would recommend any additional ground-water samples collected from the LBG-MW-14 cluster be split, adding a filtered sample if a lower turbidity cannot be established.

No exceedances of the GWPC were identified on the downgradient portion of the Middle School Site. There is no indication that ground water above the GWPC is discharging off of the site. If the site were to be changed to a GB classification, there would not be exceedances of RSR criteria applicable to ground water anywhere on the site.

### 6.2.4 Petroleum Hydrocarbons

ETPH was detected at seven wells at the site. Table 15 summarizes all detections and identifies the source compound of petroleum hydrocarbon for each of the samples collected during the second phase of the investigation. As shown on table 15, each of the seven detections exceed the GWPC. Plate 19 shows the distribution and concentrations of ETPH detections and identifies the source compound of the oil when applicable.

As shown on plate 19, ETPH was detected in the seven wells west of the middle school building. The detections ranged from 0.12 to 0.49 mg/l. Of the detections, the laboratory was only able to fingerprint one of the samples. The ETPH detection identified at LBG-MW-7A was identified to be fuel oil No. 2. No ETPH detections were identified on the upgradient or downgradients portions of the site. It is reasonable to conclude that the source of the ETPH detections is located on the Middle School Site and that ETPH contaminated ground-water is not discharging off of the site.

The Town of Hamden completed an investigation of an onsite heating-oil UST during 2002. ETPH was detected in the ground water near the UST. The laboratory was unable to fingerprint the ground-water ETPH detections. The data do not suggest the presence of a non aqueous phase liquid (NAPL) source.

With a GB classification, there would be no exceedances of RSR criteria applicable to ground water.

### 6.2.5 Semi-Volatile Organic Compounds and Tentatively Identified Compounds

As shown on table 16 and plate 19, Bis(2-ethyl hexyl)phthalate was detected in monitor wells LBG-MW-6, LBG-MW-15B, LBG-MW-17 and HA-B11-OW at concentrations ranging from 10 to 72 ug/l. The detections of bis(2-ethyl hexyl)phthalate exceed the GPWC of 2 ppb. Bis(2-ethyl hexyl)phthalate is a common laboratory artifact. In addition, bis(2-ethyl hexyl) phthalate is often identified in samples collected with latex gloves. LBG field personnel were wearing latex during the collection of the ground-water samples. While the sampling technique utilized nearly eliminates any potential contact with the water sample, there is the potential that the bis(2-ethyl hexyl)phthalate detections may be attributed to contamination caused during the ground-water sampling. Therefore, it is unclear if these detections are related to any activities at the site.

Naphthalene (380 ug/l), 2,4-dimethylphenol (20 ug/l), dibenzofuran (12 ug/l), fluorine (16 ug/l), phenanthrene (20 ug/l) and carbazole (15 ug/l) were detected in LBG-MW-7A. Naptahlene was also detected in LBG-MW-10A at a concentration of 18 ug/l. The concentrations of napthalene and carbazole detected in LBG-MW-7A exceed the CTDEP RSRs

GWPC. Carbazole is produced during coal gasification, while naphthalene is the lightest PAH and associated with many types of fossil fuels. No other exceedances of SVOCs were identified at the site. SWPC are met at the downgradient property line.

A large list of Tentatively Identified Compounds (TICs) were identified. All identified TICs are shown on table 16. Note that the previously discussed carbazole was a TIC. No other TICs exceeded established regulatory criteria.

With a GB classification, there would be no exceedances of RSR criteria applicable to ground water due to compliance of SWPC at the downgradient portion of the site.

### 6.2.6 Volatile Organic Compounds, Ketones and Tentatively Identified Compounds

Table 17 summarizes all VOCs plus TICs and ketones detected in the ground-water samples. No ketones were identified in any of the ground-water samples above the laboratory detection limit.

#### 6.2.6.1 Halogenated Volatile Organic Compounds

Plate 20 shows the distribution and concentrations of all halogenated VOCs detected in the ground water. As shown, trichloroethylene, (trans) 1,2-dichloroethylene, (cis) 1,2-dichloroethylene, vinyl chloride and chloroethane were all detected in the site ground water.

Trichloroethylene, (trans) 1,2-dichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were all detected in the ground water samples collected from the LBG-MW-7 cluster. As discussed in section 6.1.5, trichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were all detected in the saturated and unsaturated soils near LBG-MW-7A. This location is presumed to be the source area of the halogenated VOC occurrences in the site ground water. LBG-MW-7 is hydraulically upgradient from each of the wells in which the halogenated VOCs have been detected (LBG-MW-4 cluster and LBG-MW-15B). No other halogenated VOCs were detected at the site. The halogenated VOC plume extends from LBG-MW-7 cluster, to the southwest towards LBG-MW-4, likely discharging off of the site. The plume is bounded to the southeast by LBG-MW-10 cluster and LBG-MW-16 and to the northwest by LBG-MW-14 and

LBG-MW-17. The migration pathway of the halogenated VOC plume confirms that the ground water at the Middle School Site discharges to the southwest.

The LBG-MW-4 cluster was installed to determine the vertical limit of the halogenated VOC plume. Halogenated VOCs were detected in LBG-MW-4B, while none were detected in LBG-MW-4C. Therefore, the vertical limit of the halogenated VOC plume is between 30 and 60 ft bg.

Concentrations of (cis) 1,2-dichloroethylene were detected above the GWPC at LBG-MW-7A and LBG-MW-7B at concentrations of 340 and 460 ug/l, respectively. Trichloroethylene was detected above the GWPC at LBG-MW-7A and LBG-MW-7B at concentrations of 27 and 45 ug/l, respectively; while vinyl chloride was detected above the GWPC at LBG-MW-4 (well has been replaced), LBG-MW-4A, LBG-MW-4B, LBG-MW-7A, LBG-MW-7B and LBG-MW-15B at concentrations ranging from 3 to 560 ug/l. As presented previously, vinyl chloride and chloroethane are breakdown constituents of (cis) and (trans) 1,2-dichlroethylene, which are breakdown constituents of trichloroethylene. The significant degradation of the source contaminant is an indication of historic release, and that anaerobic conditions are likely present so that degradation can occur.

Vinyl chloride was detected above the Residential Volatilization Criteria (RVC) at Monitor Well LBG-MW-4A. Vinyl chloride exceeds the numerical RVC at LBG-MW-4A, however since depth to ground-water at this location is greater than 15 ft bg, the criterion does not apply.

With a GB classification there would be no exceedances of RSR criteria applicable to ground water, except for RVC at LBG-MW-7A.

#### 6.2.6.2 Aromatic Volatile Organic Compounds

Plate 21 and table 17 shows the distribution and concentrations of all aromatic VOCs detected in the ground water. As shown, benzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, acetone, xylenes, toluene, chloroform and methyl tertiary-butyl ether (MTBE) were all detected in the Middle School Site ground water.

The most common aromatic VOC detected at the site was chloroform. Chloroform was detected in LBG-MW-6, LBG-MW-7, LBG-MW-9, LBG-MW-10B, LBG-MW-14A, LBG-MW-14B and HA-B111-OW. Note that chloroform was detected above the GWPC in HA-B111-OW. Chloroform can be formed at low concentrations when chlorine is added to water, as is typical of public supplied water. Chloroform easily volatilizes and is not a common persistent contaminant in ground water. Therefore the presence of chloroform in the Middle School Site ground water likely is unrelated to the historic filling activities. Other sources may include the Hamden Middle School sprinkler system, and it can also be a laboratory contaminant. During the investigation, the athletic field sprinkler system was observed to be leaking at two locations. Because the system was broken prior to the start of the field investigation, RWA repaired the system.

Benzene was detected in LBG-MW-7A and LBG-MW-15A above the GWPC. Concentrations of benzene detected ranged from 1 to 4 ug/l. In general, trace concentrations of various other aromatic VOCs (toluene, xylenes, 1,2,4-trimethylbenzene and/or 1,3,5-trimethylbenzene) were detected along with benzene. Only in one instance, LBG-MW-4B, was one of these constituents (xylenes) detected without benzene. No source of benzene or various other aromatic constituents were identified during the soil investigation. However, the detections may be related to the detections of ETPH. As discussed, the only petroleum hydrocarbon identified in the ground water was No. 2 fuel oil at LBG-MW-7A.

MTBE was the only TIC identified. MTBE was identified in LBG-MW-16 at 3 ug/l. The source of the detection is unknown. With a GB classification, there would be no exceedances of RSR criteria applicable to ground water.

### 6.2.7 Polychlorinated Biphenyls

No PCBs were detected above the laboratory detection limit in any of the ground-water samples analyzed.

### 6.2.8 Landfill Leachate Indicators

Table 18 summarizes the ground-water results for all landfill leachate indicators.

## 7.0 CONCLUSIONS

1. The first documented filling of the Hamden Middle School was identified in 1925. Prior to the first documented filling of the Middle School Site, a significant amount of filling had already occurred in the Highwood District. Areas of documented fill occurred throughout the entire region through the construction of roads, public and private dumping grounds and planned filling areas. In the later 19th century and early 1900s, the Highwood District was a dumping ground for New Haven. During 1917, the Town of Hamden maintained a dump in the Highwood District area which was located on Shelton Avenue between Morse and Goodrich Streets. The block surrounded by Edwards Street, Saint Mary Street, Morse Street and Goodrich Street was reportedly filled in by Winchester Repeating Arms during World War I (1914 – 1918).

2. Areas filled at the Middle School Site were identified to be overlain with a sand, silt and gravel cover material. In general, the athletic field has between 2 and 4 feet of cover material. Small areas of shallower coverage are identified on the northwestern portion of the property. The remaining portion of the Middle School Site has approximately 1 to 2 feet of cover material. Areas of less than 1 foot of cover material are present in small areas near the north central site boundary (near LBG-MW-11), eastern central boundary (LBG-TB-9) and south central boundary (LBG-TB-42 through LBG-TB-45). The cap, while not fully compliant with RSR criteria, successfully prevents contact with the underlying soil.

3. Unconsolidated materials beneath the protective cover material at the Middle School Site were identified to consist of four primary materials; black matrix fill/industrial waste, construction debris, domestic municipal waste and a non-fill consisting primarily of sands and silt. The fill material was identified to be as much as 22 feet thick. The fill material was identified to be underlain by an organic silt and clay layer and/or materials consisting primarily of sands and silt. This layer is related to the former wetlands that were filled.

4. The depth to ground water at the site ranged between 4.3 and 20.9 feet below the top of the well casing. Ground water is shallowest on the eastern edge of the Middle School Site where the topography is the lowest. Ground water is deepest on the southwestern portion of the athletic field.

5. A relatively strong downward magnitude of vertical flow was observed in cluster wells located in the central portion of the athletic field. The head difference is attributed to the semi-continuous organic silt and clay layer present in the central portion of the athletic field.

6. Depth to water levels along with survey data were utilized to construct potentiometric surfaces for the Middle School Site and property east of the school. Ground-water flow at the Middle School Site was determined to flow from the east to the west/southwest. The regional ground-water flow direction was also determined to flow from the east to the west/southwest. The ground-water flow direction at the site was confirmed during analyses of the halogenated VOC water-quality and soil-quality data. The migration pathway of a defined halogenated VOC plume was identified to match established ground-water flow path. This flow path would support a ground water classification change to GB. Existing GB areas are very close to the site.

7. Pesticides were detected in the black matrix fill, construction debris and "non-fill" material at the Middle School Site, however no pesticides were detected in any of the ground-water samples analyzed. No exceedances of the CTDEP RSRs criteria were identified for pesticides.

8. Three mercury, 10 copper, 13 antimony, 51 arsenic and 36 lead soil samples were identified at the Middle School Site above the RDEC. The exceedances were identified throughout the site. While the constituents and the quantity of exceedances are reduced by

applying the I/C DEC, little benefit is achieved on the distribution of the exceedances throughout the site; however, an ELUR with 2 to 4 feet of clean cover material would address the DEC exceedances.

9. Lead, antimony and arsenic are the primary metals in soil that exceed the GA PMC, with 41, 19 and 14 that exceed, respectively. The distribution of the GA PMC exceedances is spread throughout the site. With the application of GB PMC or the 10 times the GWPC (self implementing option), exceedances dramatically decline. Exceedances of the GB PMC or 10 times the GWPC are only identified at six soil boring locations; LBG-MW-6, LBG-TB-5, LBG-TB-11, LBG-TB-12, LBG-TB-14 and LBG-TB-17.

10. Only lead and barium in ground water exceed GWPC. Lead was detected above the GWPC at monitor well LBG-MW-14A and 14B. This is the only location of lead identified above the GWPC, despite lead being identified above the GA PMC throughout the site; the detections in these wells may be related to turbidity. Barium was detected at five sampling locations above the GWPC. If the site was changed to GB classification, there would be no exceedances of the RSR criteria with respect to lead or barium in water. Therefore, despite a fairly wide distribution of certain metals in onsite fill, few have impacted ground-water quality.

11. Of the 87 ETPH detections in soils, 28 exceeded the RDEC, while 32 exceeded the GA PMC. ETPH was detected throughout the site; however, the majority (all but one, LBG-MW-3 (3.5 to 4 ft bg)) of the samples that exceeded RSRs criteria were located away from the Middle School Site boundary. Application of the I/C DEC and GB PMC reduces the exceedances to 18 and 21, respectively. However, the distribution of the exceedances in not significantly impacted by the application of these criteria. The implementation of an ELUR with 2 to 4 feet of clean cover material would address the DEC exceedances.

12. ETPH was detected in seven monitor wells, all located west of the middle school building. Each of the detections exceeded the GWPC. Only one of the samples was successfully fingerprinted by the lab. The ETPH detected at LBG-MW-7A was identified to be fuel oil No. 2.

If the site were reclassified to GB, there would be no exceedances of the RSRs criteria with respect to ETPH water-quality.

13. SVOCs were identified throughout the Middle School Site soils. Thirty-two (32) soil samples exceeded the RDEC, while 36 were identified to exceed the GA PMC. Little benefit is achieved by applying the I/C DEC; however, an ELUR with 2 to 4 feet of clean cover material would address the DEC exceedances. Applying the option of 10 times the GA PMC significantly reduces the number of exceedances, to only four samples in three locations. The SVOCs were detected in "non-fill" material, construction debris and black matrix fill soil samples. SVOCs were not identified in samples collected solely containing domestic debris.

14. Concentrations of napthalene and carbazole detected in LBG-MW-7A exceed the GWPC. No other SVOCs were identified above the GWPC. SWPC are met at the downgradient property line. With a GB classification, there would be no exceedances of the RSRs with respect to SVOC water quality.

15. Bis(2-ethyl hexyl)phthalate, an SVOC, was detected in three soil samples and four ground-water samples. The samples may have been potentially contaminated during the sampling process through the use of latex gloves or in the laboratory. It is unclear if the detections are related to activities at the site.

16. No VOCs in soils were identified to exceed the RDEC or GA PMC. However, VOCs in soils in the LBG-TB-4 area are not fully characterized

17. Trichloroethylene, (trans) 1,2-dichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were all detected in the ground water samples collected from the LBG-MW-7 cluster (west side of athletic field tennis courts). Trichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride were all detected in the saturated and unsaturated soils near LBG-MW-7A. This location is presumed to be the source area of the halogenated VOC occurrences in the site

ground water. In addition, some or all of these halogenated VOCs have been detected downgradient in LBG-MW-15B and the LBG-MW-4 cluster. The plume is bounded to the southeast by LBG-MW-10 cluster and LBG-MW-16 and to the northwest by LBG-MW-14 and LBG-MW-17. The migration pathway of the halogenated VOC plume confirms that the ground water at the Middle School Site discharges to the southwest. Vinyl chloride was identified above the RVC at LBG-MW-7A. No other exceedances of the RVC were identified. Of the detected halogenated VOCs, trichloroethylene, (cis) 1,2-dichloroethylene and vinyl chloride exceed GWPC in one or more of the three locations with detections. With a GB classification, the only remaining exceedance is vinyl chloride for RVC. No other halogenated VOCs were detected at the site.

18. Benzene was detected in ground water above the GWPC at LBG-MW-7A and LBG-MW-15A. With a GB classification, there would be no exceedances of RSR criteria with respect to aromatic VOCs. No aromatic VOCs were detected in soils above RDEC or GA PMC.

19. PCBs were detected in 11 of the 105 soil samples collected from the Middle School Site. The initial analyses of the samples showed no exceedances of the RDEC, however, a reanalysis of soil sample LBG-TB-25 9.5 to 10 ft bg, identified concentrations above the RDEC. If the I/C DEC were applied, no exceedances would be present. No PCBs were detected in the SPLP analyses; therefore, no exceedances of the GA PMC were identified. PCBs were not detected in ground water.

20. No herbicides were detected above the laboratory detection limit in any of the ground-water samples.

21. Samples collected from monitor wells in the central portion of the site exceed the SWPC for a limited number of parameters; however, the furthest downgradient wells show compliance.

22. Overall, relatively few parameters that exceed PMC are above RSR criteria, or even detected, in ground water. A classification change to GB eliminates and/or applying 10 times the GA PMC/GWPC eliminates most of the PMC exceedances, with the exception of ETPH.

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December 3, 2002
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# PHASE III
# ENVIRONMENTAL SITE INVESTIGATION
# FORMER NEW HAVEN WATER COMPANY PROPERTY
# HAMDEN, CONNECTICUT

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**(Compact Disk)**

Prepared For:

South Central Connecticut Regional Water Authority

December 2002

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